Los Angeles County
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Westside Subway Extension

Final Environmental Impact Statement/Environmental Impact Report—Volume 4

APPENDIX E: *Construction Methods*

Metro

U.S. Department of Transportation
Federal Transit Administration

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Acronyms and Abbreviations

Cal/OSHA	California Occupational Safety and Health Administration
CY	cubic yards
EIS/EIR	environmental impact statement/environmental impact report
EPB	earth-pressure balance
HRT	Heavy Rail Transit
LEL	lower explosive limit
LPA	Locally Preferred Alternative
ppm	parts per million
TBM	tunnel boring machine
TPSS	traction power substation

APPENDIX E—CONSTRUCTION METHODS

E.1 Overview of Construction Sequencing and Duration

This Appendix presents an overall summary of the construction methods followed by more detailed descriptions of the construction stages, station and tunnel construction methods anticipated.

E.1.1 General Construction Scenario

In general, conventional construction techniques and equipment would be used, consistent with other similar projects in Southern California. This would include the use of pressurized-face tunnel boring machines (TBM) to excavate the tunnels. Construction would follow all applicable Federal, State, and local laws for building and safety. Standard construction methods would be used for traffic, noise, vibration, and dust control consistent with all applicable laws. The major project elements are tunnels, underground stations, station-related facilities, maintenance and operations yards and buildings, trackwork, ventilation equipment, and specialty systems, such as traction power, communications, and signaling equipment. Construction would begin simultaneously at several locations along the route, with overlapping construction of the various project elements. Working hours would be varied to meet special circumstances and restrictions. Also, the number of workers present at any one time on a particular site would vary depending on the activities being performed. During peak construction periods, work would be underway at several station sites while tunnel excavation progresses concurrently.

In addition to the primary system features of tunnels and stations, the following are other project elements:

- Building protection measures, such as underpinning or ground improvement (including grouting) to protect structures, as necessary
- Relocation, modification, or protection of existing utilities
- Removal or relocation of structures at construction staging sites and station entrances
- Entrances to the underground stations
- Urban design enhancements around station entrances
- Surface and subsurface drainage systems
- Traction power substations with electrical power feeds
- Trackwork, ventilation, traction power, communications, and signaling systems for train operations
- Emergency (backup) power systems
- Station finishes, including fare vending equipment, elevators, escalators, landscaping, signage, and other necessary amenities

- System integration testing and simulated revenue operation test runs
- Final commissioning of the system

A generalized sequence of activities that would occur is presented in Table E-1. The time necessary for each activity would vary depending on such factors as the nature of the subsurface conditions encountered at station sites and during tunneling, work hours and traffic restrictions, and contractor's means and methods. Other factors would include the number and type of utilities requiring relocation and the location and condition of nearby surface and subsurface structures. A schematic of the tunnel and station profile for a sample segment of the LPA, between Wilshire/Fairfax and Century City (Constellation), is shown in Figure E-1. The profile shows the relationship between the tunnel and the ground surface and the distance between stations.

Table E-1. Generalized Sequence of Construction Activities

Activity	Tasks	Average Time (months)[1]
Survey and preconstruction	Locate utilities; establish right of way (ROW) and project control points and centerlines; and establish/relocate survey monuments.	4 to 6
Site preparation	Relocate utilities and clear ROW (demolition); widen streets at station sites to improve traffic flow during construction; establish detours and haul routes; erect safety devices and mobilize special construction equipment; prepare construction equipment yards and stockpile materials.	12 to 18
Heavy construction	Construction of stations and entrances, construction of tunnels and associated structures; major systems facilities; disposal of excess material; backfilling of stations and portal and refinish roadways and sidewalks.	72 to 84
Medium construction	Lay track; construct surface facilities (including above-ground structures), drainage, and backfill; and reinstate streets.	12 to 24
Light construction	Install all system elements (electrical, mechanical, signals, and communication), traffic signals, street lighting, landscaping, signing and striping; close detours; clean-up and test system.	6 to 12
Pre-revenue (human use) service	Test power, communications, signaling, and ventilation systems; train operators and maintenance personnel.	5 to 6
Project Operations Begin		

[1]Portions of activities would be conducted at the same time as other activities. Therefore, the total cumulative duration may be less than the sum of the individual activities.

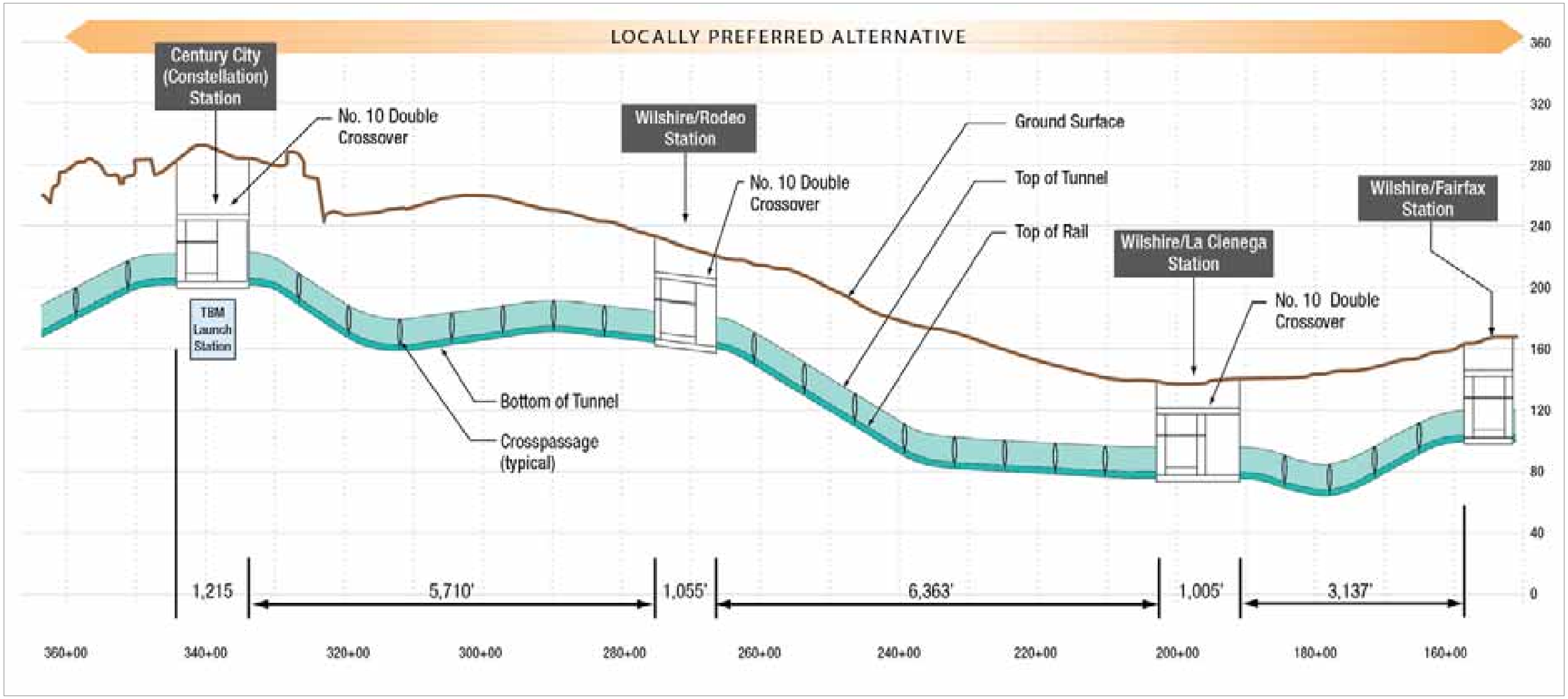

Figure E-1. Schematic Profile, Wilshire/Fairfax to Century City (Constellation)

E.1.1 Estimated Construction Duration

Two construction scenarios are under consideration for the LPA. The construction schedule for the LPA is partially dependent on the timing of Federal funding availability. The first construction scenario assumes that under the America Fast Forward (30/10) Scenario (Concurrent Construction), the LPA would open in its entirety to the Westwood/VA Hospital Station in 2022 with the three construction segments built concurrently. The second construction scenario assumes that under Metro Long Range Transportation Plan (LRTP) Scenario (Phased Construction), the LPA would open in three consecutive phases, with the entire LPA operational to the Westwood/VA Hospital Station in 2036.

The three construction segments/phases would be the same in either construction scenario—Wilshire/Western to Wilshire/La Cienega, Wilshire/La Cienega to Century City, and Century City to Westwood/VA Hospital. Under the Concurrent Construction Scenario, the three construction segments would be constructed concurrently. Construction would start at the primary tunnel boring launch locations (possibly at Wilshire/La Brea Station, Century City Station, and Westwood/VA Hospital Station). Construction is expected to take about 11 years for each of the three segments, from the commencement of the pre-construction activities through to the start of passenger service. Major street works, from the commencement of temporary station shoring and street decking to the removal of the street decking and street reinstatement, would be on the order of about 7 years. Early construction activities would focus on the potential paleontological deposit areas at Fairfax and La Brea and include implementation of the mitigation measures to avoid and minimize impacts to paleontological resources.

Construction time for the Wilshire/La Cienega Station to Century City Station segment would also depend on the station and alignment options chosen at Century City. Construction time for a Century City Station to a Westwood/VA Hospital Station would also be a function of the alignment and station locations chosen at Century City, Westwood/UCLA, and Westwood/VA Hospital. Work in each of the three tunnel segments can proceed independently and would not be affected by the timing of work in the other two segments. However, systemwide construction work, such as trackwork, traction power, signaling and communications systems, which follows on from tunnel and station construction, would be affected by events in any of the three segments and in turn may affect the completion of the project and start of passenger service

If the LPA is constructed in three phases under Phased Construction Scenario, then construction time for each phase would be of the order of seven years for the major street works, from the commencement of the temporary station shoring and decking to the removal of street decking and street reinstatement. Completion of station finishes,and systemwide construction work would continue on beyond the major street works.

The three construction segments would be constructed in order from east to west, so that a segment, once completed can be immediately incorporated into the operating system. Start and finish dates for each of the three construction segments are shown in Figure E-2.

Figure E-2. Construction Schedule under Phased Construction Scenario

E.1.2 Station

The project has been divided into three segments, which can if necessary be constructed sequentially and opened segment by segment for revenue service

Phase 1 from Wilshire/Western to Wilshire/La Cienega would be constructed in exactly the same way that it would be if all segments are constructed concurrently. The station box at Wilshire/La Brea Station will be excavated first, to be ready to receive the TBMs. A slurry processing plant and other TBM support facilities will be constructed on the laydown and storage sites at Wilshire /La Brea, timed to be ready to support the TBM's on their delivery from the manufacturer.

Excavation of the retrieval shaft at Wilshire/Western and excavation of the station boxes at Wilshire/Fairfax and Wilshire/La Cienega will follow the Wislhire/La Brea Station excavation. The excavation for the station box at Wilshire Fairfax will be started early to allow maximum time for recovery of fossils and to allow time for slow progress in tar sands and gassy ground conditions. Fossils may be temporarily stored at the Wilshire/Fairfax storage and laydown pending removal to a location where they can be processed by the Page Museum.

TBM's would be staged from the Wilshire/La Brea Station, and first tunnel the reach to Wilshire/Western. They would be removed through the TBM removal shaft to be constructed at the Western end of the Wilshire/Western Station and returned by road to Wilshire/La Brea. They would be re-assembled at Wilshire La Brea and then tunnel to the Wilshire/La Cienega Station. On arrival at Wilshire/ La Cienega Station, the TBM's and their support equipment will be dismantled and removed.

Once a tunnel section is clear of tunneling equipment, work will commence to complete the tunnel cross-passages, tunnel invert and walkways. There is no difference in the construction methods employed whether one segment or multiple segments are being constructed concurrently.

The construction of the station structure can commence as soon as work in the tunnels are complete, or when access to the tunnels through a particular station location is no longer required. Once the station structure is fully enclosed, the excavation above the station can be backfilled, station appendages constructed and the street decking removed. Enclosing the station structure will also allow trackwork to be built through the station, followed by cabling and equipment installation along the wayside. It is anticipated that rail will be welded into continuous welded rail (CWR) strings at the Division 20 yard, and then hauled through the operating system to segment 1 via a rail train. The shaft at Wilshire/ Western will be used for access to works in the tunnels.

Access to stations will generally be through the station entrance excavation and so construction of the station entrances will not commence until major construction within the station is complete. Once access requirements into the station are limited to small materials and equipment, the entrance construction can proceed without impacted to work inside the station.

Phase 2 runs from Century City to Wilshire/La Cienega. It is planned to commence Phase 2 prior to the completion of Phase 1 but Phase 2 construction would be separate. The contractor's laydown and staging area at Century City would be the main base of operations for Phase 2. The station box at Century City will be excavated first so that the TBMs for this phase can be delivered and assembled. The TBMs would then commence tunneling to the Wilshire/La Cienega Station. The tunneling support equipment for Phase 2 would be located at the Century City laydown and staging area. The station box at Wilshire/Rodeo will be excavated after the Century City box and in time to support the contractor's construction schedule for the Wilshire/Rodeo station.

A temporary TBM retrieval shaft may be constructed at the west end of the Wilshire/La Cienega station to allow the TBM's to be recovered, or the TBM's could be dismantled from within the tunnel and components transported back to the Century City station.

Constriction of tunnel invert, walkways and crosspassages would all be supported from Century City given the limited storage and laydown sites at Wilshire/Rodeo station. Once tunnel construction has been completed, work on the Wilshire/Rodeo and Century City stations would commence.

Depending on the timing of Phase 1 completion, it should be possible to weld trackwork at the Division 20 yard and bring the CWR strings through the operating system and Phase 1. However, it this proves to be impractical. Rail strings would be welded at Century City and moved through the Phase 2 tunnels from there. Century City would also be the staging location for systems cabling and wayside equipment

Phase 3 runs from Westwood/VA Hospital to Century City. Phase 3 is not planned to commence until several years after the completion of Phase 2 so Phase 3 would be a stand-alone project with no interfaces at all with the construction of the previous two phases. The base for operations would be the Westwood/VA hospital laydown and staging site. Phase 3 construction would be supported from this location in the same way as Century City was used to support the construction of Phase 2, though the laydown and staging at Westwood/UCLA is large enough to support station construction share some the support for tunnel construction and systems installation.

The tailtrack tunnels and emergency exit shaft west of the Westwood/VA Hospital station will be built concurrently with excavation of the Phase 3. The tailtrack tunnels can then be used for rail welding and storage of completed CWR strings until they can be distributed throughout the Phase 3 tunnels.

On arrival at Century City station, TBM's would be removed through a retrieval shaft constructed for this purpose, or dismantled within the tunnel and transported back through the tunnels to the Westwood/VA hospital Station.

The crossover box at the GSA will probably be constructed after tunneling is completed.

The stations at the Westwood/VA Hospital and UCLA will be constructed in a similar manner to Phase 1 and 2 stations with open cut excavations and street decking.

E.1.3 Construction

Construction of the underground stations would employ the cut-and-cover construction technique (discussed in further detail in Section 3.5.1). This technique generally begins by installing a system of temporary shoring to support the excavation in which the permanent station structure would be constructed and the temporary street decking above the excavation. The temporary shoring is also designed to support loads from adjacent building foundations. The temporary shoring is constructed in stages, first one side of the station excavation and then the other. Soldier piles and timber lagging is a shoring method that has been used successfully on previous Metro projects and this same method is expected to be used again for Westside Subway Extension. Soldier piles are steel beams that are concreted into pre-drilled holes and which carry the loads from the timber lagging placed against the excavated earth surface. Large steel struts support the soldier piles. Other shoring systems may be used where ground conditions dictate, but the soldier pile and lagging system is favored for the speed of installation and its flexibility in dealing with underground utilities. Once the temporary shoring has been constructed, excavation commences inside the area supported by the shoring. During a series of weekend street closures, the street is excavated down to an adequate depth to install the steel beams and precast concrete slabs which allow traffic and pedestrian movement to continue overhead while excavation proceeds beneath the decking down to the final depth. Utilities are supported from the steel beams as the soil is excavated from around them. The concrete station box structure is then built within the excavated space, backfilled up to street level, and the surface restored. Additional information on station construction is discussed in Sections 3.5 and 3.6.

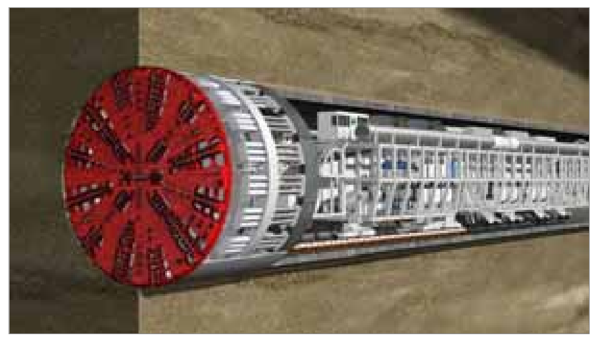

Figure E-3. Typical Tunnel Boring Machine

E.1.4 Tunnel Construction

Tunneling is expected to be performed with pressurized-face TBMs (Figure E-3). A TBM is a large machine that bores a circular tunnel by excavating rock and soil and installing precast concrete segments to support the ground around the tunnel opening. There are two distinct classes of TBMs, namely hard rock and soft ground. Soft ground TBMs would be used for the Westside Subway Extension Project. Soft-ground machines can be further subdivided into pressurized-face machines and non-pressurized-face machines. Pressurized-face machines give much better control of ground settlement and the ingress of ground water and gas into the tunnel. Pressurized-face machines would be used for the Westside Subway Extension Project. The actual TBMs used would be custom designed for a particular tunnel segment and would reflect the varying, site-specific requirements, including geologic conditions. For instance, where hydrocarbons or gases are expected to be encountered, it is likely that a slurry-face TBM would be required. For tunnel reaches where hydrocarbons or gases are not expected, it is expected that either a slurry-face or earth-pressure-balance (EPB) TBM would be used. The distinction between these machine types is presented later in this Summary.

The project would consist of two circular tunnels, approximately 20 to 21 feet in diameter, bored side-by-side and separated by a pillar of ground between. Tunnel excavation generally would range from 8 to 12 months for the typical 1-mile length between stations but would vary, depending on the ground conditions encountered, site and work area constraints, length of tunnel, and the number of TBMs used.

As indicated in Section 2.2, there would be three tunnel segments: Wilshire/Western to Wilshire/La Cienega, Wilshire/La Cienega to Century City, and Century City to Westwood/VA Hospital. Each segment would consist of two parallel circular tunnels. It is expected that a total of six TBMs would be used, one TBM for each tunnel within each of the three segments. Tunnel construction is discussed in further detail in Section 3.7.

E.1.5 Staging Areas

Staging areas, also known as *lay down* areas, would be necessary for construction of station excavations, tunnels, station entrances, crossover boxes, pocket tracks, mid-line structures, traction power substations (TPSS), and ventilation or emergency exit shafts. Staging areas are used principally for the operation of contractors’ equipment, storage of materials and for site offices, and for access to the station excavation. At TBM sites, the staging areas would also be used for storage and preparation of precast concrete segments, temporary spoil storage, ventilation lines, shaft support (air, water, electricity, spoil hoisting), workshops, mixing and processing slurry for excavation support or tunnel excavation, and post-excavation slurry treatment (separation), which would include filters, centrifuges, and vibrator equipment. Typically, these areas would be at station excavation sites to facilitate access to the tunnel.

Temporary easements, typically a portion of the sidewalk, traffic lanes, and parking areas, may be required at various locations for staging. Construction staging within the streets is also envisioned where no off-street areas can be identified.

In addition, contractors and construction managers would establish field offices in existing office space near work areas or in temporary jobsite trailers at the staging areas. Often these offices are operational on a 24-hour basis, consistent with construction activities.

Attachment A provides a summary of anticipated construction activities at the proposed construction staging areas identified for the project.

E.2 Construction Methods, Techniques, and Equipment

E.2.1 Preconstruction

During final design and prior to any construction, pre-construction evaluations would be completed to determine existing conditions that could affect construction methods and timing, as described in the following sections. In addition, traffic control plans would be prepared for station and tunnel construction and activities where street closures and excessive truck traffic would disrupt normal street operations.

E.2.2 Surveys and Investigations

Local Business Surveys

Individual businesses would be interviewed to identify business usage, delivery, shipping patterns, and critical times of the day or year for business activities. This information would be used by Metro to develop construction requirements and worksite traffic control plans and to identify alternative access routes and requirements to maintain critical business activities.

Geotechnical Investigations

Subsurface (geotechnical) investigations would further evaluate geology, groundwater, seismic, and environmental conditions along the alignment. These investigations would be spaced along the alignment to evaluate soil, rock, groundwater, seismic, and geo-environmental conditions, particularly to note locations where hydrocarbon or other contaminant deposits may be encountered. The results of these investigations would influence final design and construction methods for stations, tunnels, other underground structures, and foundations.

Cultural Resource Investigations

Paleontological Properties

Areas surrounding the Fairfax and La Brea stations are known to have tar deposits or tar sands with potential paleontological features that may have to be removed under special conditions. Because of this, preliminary preparation and excavation is likely to occur early on to remove the identified resources and prepare the ground for excavation.

In specific cases where paleontological resources are found, it may be possible to alter the cut-and-cover methods to allow sufficient time to evaluate and recover the resources without complete suspension of construction activities. It may be necessary to employ raised decking, which would allow traffic to be restored without disturbing the underlying resources. The decking system would be elevated above street level and would require ramps to allow traffic to transition to and from the decking.

Historic Properties and Archaeological Resources

Specific historic properties have been identified and construction activities would follow the Programmatic Agreement between Metro, Federal Transit Administration (FTA), and the State Historic Preservation Officer (SHPO). Such properties could include structures located above tunnels that are outside street limits, as well as structures adjacent to tunnels, stations, or cut-and-cover construction areas or areas proposed for acquisition. Cultural resources pertaining to intact archaeological deposits could be affected. Monitoring would follow the Programmatic Agreement.

Structure and Building Analysis

The condition of existing buildings and other structures (such as multi-level parking garages) in proximity to the stations, tunnels, and other underground structures would be evaluated with respect to excavation for underground stations and tunnels. This evaluation would determine whether additional protection work, such as special excavation support systems, underpinning, or grouting, is necessary to mitigate settlement. The integrity of adjacent structures would influence the method of excavation and type of support systems that would be utilized.

E.2.3 Site Preparation and Demolition

Prior to construction, contractors would prepare work sites to accept workers, equipment, and materials. This would include clearing, grubbing, and grading, followed by mobilization of initial equipment and materials.

At most sites, building demolition will be required to provide space for construction or construction work areas. Demolition necessitates strict controls to ensure that adjacent buildings and infrastructure are not damaged or otherwise affected. These controls include fencing and barricades, environmental monitoring, and limits on the types of equipment and demolition procedures. Demolition equipment typically includes bulldozers and front-end loaders, which are often specially developed or modified to allow for precise and controlled dismantling. Prior to demolition, contractor will have to remove any hazardous materials. Contractors may also salvage items, such as fixtures, mechanical equipment, and lumber. Where economical, materials such as steel and concrete may be recycled.

E.2.4 Utilities and Street Closures

Utilities Relocations

Underground utilities are researched and noted on drawings as part of the design phase. During preconstruction, existing utilities may be more closely inspected and evaluated, including depth, condition, and exact location. An operation called *potholing* is typically done to physically locate certain utilities, which can then be appropriately marked or protected. It would be necessary to either relocate, modify, or protect-in-place all utilities and underground structures that would conflict with excavations.

Protecting-in-place is the method of choice, as this is less disruptive to streets and less costly. Where in-place protection is not sufficient, relocation is required. Utility relocations can be done prior to or during construction, depending on the sensitivity of the utility. Utilities which would interfere with the installation of shoring or deck beams would have to be relocated during advance works ahead of construction. Affected utilities are expected to include storm drains, sanitary sewers, water lines, power lines, gas pipelines, oil pipelines, electrical duct banks and transmission lines, lighting, irrigation lines, and communications, such as phone, data, and cable TV.

Utility relocations would be coordinated with the utility owner. Relocation and protection of underground utilities would require excavation to the depth of the existing utility line and installation of a replacement utility in a new location. This would occur within the affected ROW and on nearby streets, as required. Utility relocations often entail some form of temporary service interruptions. These are typically planned for periods of minimum use (such as nights or weekends), so that outages have the least impact on users.

Utilities within the construction area, such as high-pressure water mains and gas lines, will be relocated around the construction area or supported in place by hanging from deck beams. The Contractor will determine whether or not to relocate utility lines that cross or parallel open excavation.

In addition to utility relocations, various new utilities would be installed to accommodate construction needs. These include, but are not limited to, communications cables (including fiber optic lines), electrical duct-banks, drainage facilities, water supply lines, and lighting.

Street Closures

Relocation of utilities that would conflict with the construction of shoring and decking would occur before excavation and will require closure of traffic lanes. In some instances, block-long sections of streets might be closed temporarily. Major cross streets would require partial closure while relocating utilities.

Construction of the temporary shoring needed for station excavation would require extended lane closures of two or three lanes for between 20 to 70 days. Pedestrian access (sidewalks) would remain open, and vehicular traffic would be re-directed. Special facilities, such as handrails, fences, and walkways, would be provided for the safety of pedestrians. Temporary sidewalk closures may be necessary in some locations for the delivery of oversized materials and for modifications of curbs and sidewalks. Minor cross streets and alleyways may also be temporarily closed, but access to adjacent properties would be maintained. Major cross streets would also be closed to construct shoring where station excavation extends across intersections. Detailed traffic planning and coordination of closures of north-south arterial streets would be required.

Street decking would be installed in a series of weekend closures. All traffic lanes over the station excavation would be closed for periods of approximately 56 hours (Friday evening through Monday morning) and deck sections of approximately 42 feet installed in each 56-hour closure. In certain locations, such as Wilshire Boulevard in Westwood and Santa Monica Boulevard in Century City, full street closures may not be required. When decking within intersections, the cross street would also be partly or fully closed. To reduce the number of street closures, multiple decking crews may work at more than one location during a single closure.

E.2.5 Underground Stations

All stations would be designed with approximately 450-foot-long platforms to accommodate Metro Heavy Rail six-car trains. Cut-and-cover construction is planned at all stations. The length of a station box could vary depending on the inclusion of certain components, such as TPSS and incoming service. Stations vary in length from 863 to 1055 feet long and are approximately 70 feet wide, with depths of 60 to 70 feet below street level. Side entrances would typically be about 60 feet long, 20 feet wide and 25 feet deep. Station excavation would occur over approximately 8 to 10 months and result in an average of approximately 250,000 cubic yards (CY) of excavated soil and approximately 60 to 100 haul truck trips per day to remove the excavated soils from the site.

Approximately 12 to 20 months would be needed to establish the surface work area, install the excavation support system and street decking,and complete excavation to the extent the station could be used for tunnel operations or could be concreted. The total sequences for underground station construction from the start of temporary shoring to completion of street restoration could be up to 78 months.

Excavation Support Systems

Earth support is an important factor in the construction of deep excavations, and there are various suitable methods to achieve the needed support. The initial support system for the station excavation is considered "temporary" over the period of construction; however, most of the support materials are not removed and remain in the ground after the final structure is completed. The final support is provided by the concrete station box structure, a permanent work element.

Figure E-4 illustrates a typical cut-and-cover station excavation and construction sequence. The excavation's initial support system(s) is typically comprised of braced soldier piles and lagging, although alternative systems could include reinforced concrete drilled-in-place piles, tangent pile walls, secant pile walls, diaphragm walls (slurry walls), and tied-back excavations. Initial support provides vertical stability while soil is removed from the excavation. This support remains in place for the duration of subsurface work. Final support includes concrete slabs, walls, and walkways for the station entrances.

Some lateral movement of the excavation walls will occur during soil removal and again during station concreting. The extent of movement depends on the excavation and shoring methods, wall design, and wall height. Project specifications require walls and adjacent ground to be monitored for lateral movement and surface settlement and to provide corrective measures as necessary.

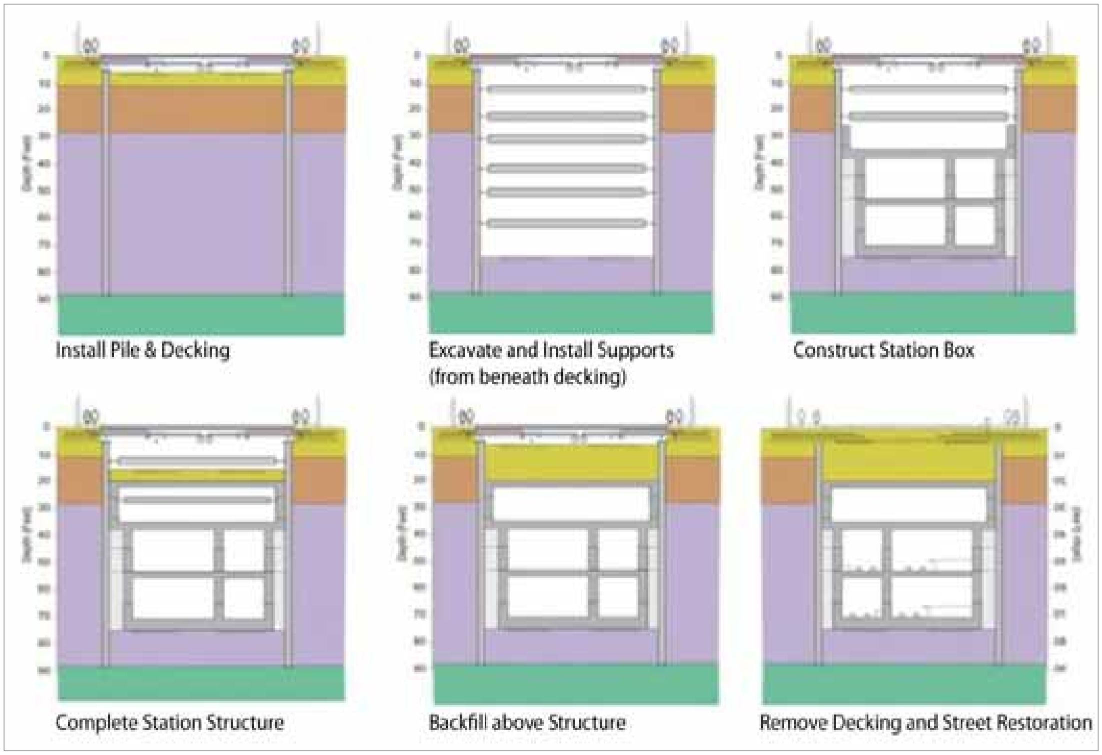

Figure E-4. Typical Cut-and-Cover Construction Sequence

Soldier Pile and Lagging

Soldier pile and lagging walls are a type of shoring system typically used along the perimeter of excavation areas to hold back the soil around the excavation. This is also the most common shoring system used in the Los Angeles area. This support system consists of installing vertical steel beams (soldier piles) at regular intervals and placing timber or shotcrete (lagging) between the piles to form the retaining structure. Soldier piles are installed in pre-augered holes and the annular space between the soldier pile and the holes is then filled with concrete. Pre-auguring allows for more accurate installation of the soldier piles and avoids the noise and vibration associated with pile driving. The lagging, which spans and retains the soil between the piles, is typically timber or sprayed-on concrete (shotcrete) and is installed progressively as the station is excavated.

Figure E-5. Typical Soldier Pile and Lagging System (Metro Gold Line Eastside Extension)

A soldier pile and lagging excavation and support system is shown in Figure E-5. To install the piles, one side of the street is occupied to install one line of soldier piles. The soldier pile installation requires partial closures of traffic lanes where the equipment would be staged.

After installation of soldier piles on both sides of the street at the station excavations, additional piles would be installed at the station ends, followed by installation of deck beams, installation of the precast concrete deck panels, and bracing. The deck panels (decking) would be installed in progressive stages and would allow continued traffic and pedestrian movement, as the decking typically is installed flush with the existing street or sidewalk levels. Installation of the deck beams and deck panels requires substantial lane closures and traffic detours, so is often done at night or on weekends.

A soldier pile and lagging system is generally used where groundwater inflow is not a concern, or where grouting or lowering of the groundwater level (dewatering) can be used to mitigate water seepage between piles. Alternatives to soldier pile and lagging walls include slurry walls and secant or tangent pile walls. Use of slurry-wall construction can provide a nearly water-tight excavation.

Other Shoring Systems

In general, shoring design along the alignment will have to address one of the following three general conditions : areas of no groundwater, areas of shallow groundwater, and areas with asphaltic sands and subsurface gases. For station and other excavations where water is not anticipated, conventional soldier piles and lagging, described above, are expected.

Groundwater along the alignment varies in depth and expected inflow rate. In the study area, underground excavations on the order of 50 to 60 feet deep have been constructed with minimum dewatering. Depending on the situation, dewatering can be successful with a few strategically located wells supplemented by gravel-filled trenches and sumps. In such cases, conventional soldier piles with lagging would be adequate.

However, at some locations along Wilshire Boulevard the groundwater is near the ground surface, potentially under artesian pressure. In such cases, dewatering through multiple wells is often necessary. Also, the use of soldier piles with lagging may be inadequate and a tangent pile, secant pile or slurry (diaphragm) wall, or similar system may be required.

Tangent Pile or Secant Pile Walls

Tangent pile walls consist of contiguous drilled piles that touch each other. The contiguous wall generally provides a better groundwater seal than the soldier pile and lagging system, but some grouting or dewatering is sometimes needed to control leakage between piles. Similar to soldier pile installation, the contractor would occupy one side of the street and drill the piles sequentially to form the retaining wall.

A secant pile wall is similar to the tangent pile wall, but the piles have some overlap, resulting in better water tightness and rigidity. This method consists of boring and concreting the primary piles at centers slightly less than twice the pile diameter. Secondary piles are then bored between the primary piles before the concrete can completely set. Because of the close spacing of tangent piles, utilities crossing the wall often require relocation. Construction of tangent or secant pile walls is slower than for soldier pile walls and requires longer lane closures for their construction.

Diaphragm/Slurry Walls

Figure E-7. Street Decking

Figure E-6. Rebar Cage for Typical Slurry Wall Panel

Diaphragm walls (commonly known as slurry walls) are structural elements used for retention systems and permanent foundation walls. Slurry walls are constructed using deep trenches or panels that are kept open by filling them with a thick bentonite slurry mixture. Bentonite is a natural clay mineral that, when mixed with water, increases its density. After the slurry-filled trench is excavated to the required depth, structural elements (typically a steel reinforcing cage [Figure E-6]) are lowered into the trench, and concrete is pumped through a tremie pipe from the bottom, displacing the slurry. Tremie concrete is then placed in one continuous operation through one or more pipes that extend to the bottom of the trench. As the concrete fills the trench, the concrete placement pipes are extracted. Once all the concrete is placed and has cured, the result is a structural concrete panel. Grout pipes can be placed within slurry wall panels to be used later, in the event that leakage through wall sections is observed. The slurry that is displaced by the concrete is saved and reused for subsequent panel excavations. Slurry wall construction advances in discontinuous sections such that no two adjacent panels are constructed simultaneously. Panels are usually 8 to 20 feet long, with widths varying from 2 to 5 feet. Slurry-wall construction would occur in stages, working on one side of the street at a time. These walls have been constructed in virtually all soil types and provide a watertight support system in addition to improving wall stiffness to control ground movement.

Decking and Cross-Bracing

After installation of the temporary shoring (support) system and initial excavation, the deck beams are installed, followed by multiple sequences of excavation and installation of cross-bracing. In special situations, such as where cross-bracing impedes access from above, tie-back systems may be used. Tie-backs are strong cable strands or steel bars that are installed and grouted into pre-drilled holes that extend outward and downward from the excavation support wall. After the grout sets and the cables or bars are firmly anchored into the ground, the tie-backs are tensioned to provide lateral support to the wall. The use of tie-backs may require temporary underground easements, if they extend into private property.

Decking (Figure E-7) is placed on the deck beams to allow traffic and pedestrian circulation to resume after the initial excavation. This decking is typically constructed of precast reinforced concrete and is installed flush with the existing street and sidewalk. Decking installation could require temporary street closures and would be installed in progressive stages.

Dewatering

Prior to installation of the ground support system, dewatering is likely to be required at the underground station sites to temporarily lower the groundwater level. This facilitates installation of the piles, improves soil stability, and allows excavation in dry conditions. Groundwater is pumped from wells installed around the perimeter of the area to be excavated. If contaminated water is encountered, it is typically treated at the site prior to discharge. At completion of construction, pumping is discontinued and groundwater is allowed to return to its natural level.

In general, water would be pumped out of sump pits as the excavation proceeds downward. Ditches and gravity flow would be used to drain the water into the low-lying sumps. Based on prior experience along Wilshire Boulevard, deep basement excavation dewatering has been accomplished by pumping from a limited number of deep wells augmented by gravel-filled trenches and sumps. It is anticipated that dewatering flows would be processed on-site to remove oils and solids and then discharged to the local storm drain or sewer systems, according to permitting requirements. Contaminated water would require additional treatment and disposal procedures.

Settlement

Underground excavation for stations using the cut-and-cover technique can result in some ground relaxation and deformation of the retained soils. The magnitude of ground movement depends on the strength of the surrounding ground and the rigidity of the shoring system. The zone potentially susceptible to ground movement generally extends a lateral distance approximately equal to the depth of the excavation. Buildings within this zone would be evaluated for susceptibility to settlement and provided with additional protection measures as needed.

Presence of Existing Tie-backs

At station locations adjacent to existing deep basements, abandoned tie-backs may project into the space of the planned station. Although no longer in service, these tie-backs would interfere with the construction of shoring and station walls. In many cases, the locations of these tie-backs can be reasonably well established. Accordingly, if soldier piles and lagging are used, the soldier piles can be spaced to avoid the tie-backs during drilling, and they can later be de-tensioned and cut off. Abandoned tiebacks can be more problematic if tangent or secant piles are installed or if slurry wall systems are used. Specialized methods and equipment to de-tension and cut the tie-backs may be used, or a soldier pile and lagging system would be used where tie-backs are known to exist.

Existing Foundations

Many of the station excavations would be near existing foundations. Depending on specific situations, foundations may have to be protected. A typical approach to building protection where buildings are near the excavation is to design a more rigid excavation support system that can resist the additional loads imposed by the adjacent foundations. In such cases, a stiffer tangent pile, secant pile, or slurry-wall shoring system may be used. Pre-loading of excavation support bracing may also be implemented. For buildings adjacent to cut-and-cover construction, it is anticipated that the shoring system, in conjunction with internal bracing, would provide a relatively rigid temporary support for the proposed excavation. In some cases, underpinning (added foundation systems) may be used to support the adjacent structures.

Disposal of Excavated Materials

With the decking installed and the utilities supported, the major excavation work for the station box can proceed. Spoils from station sites would be moved to an off-street work site or closed parking/traffic lane and loaded into haul trucks. The average volume of material from excavation would be approximately 250,000 CY. This assumes the soils expand by approximately 30 percent through the excavation and loading process.

Assuming the use of 15-CY haul trucks generally, and 10-CY haul trucks at restricted locations, the total number of haul truck loads required for one station would range from 16,600 to 25,000. For a typical station configuration, this would be approximately 60 to 100 truck trips per day.

Contaminated soils are separated as soon as they are identified during the excavation cycle. These soils would be temporarily stockpiled separately and managed in accordance with applicable regulations for handling and transporting contaminated materials.

Excavated materials will be hauled at night where possible due to the congested freeways and surface streets around station locations during daytime hours

Traffic

Traffic flow can be affected during the entire period of construction, which is anticipated to be approximately 8 to 9 years. Mechanisms available to control and maintain traffic at constricted intersections range from use of temporary street decking, to temporarily replacing pavement and sidewalks, and temporary bridges. Decking typically contains hatches or removable panels to facilitate lowering equipment or materials down into the excavation with minimal traffic disruption.

Cross streets would typically be carried through intersections on similar decked structures. Pedestrian access would remain open, although portions or sections of sidewalks may be closed temporarily. Where sidewalks are temporarily removed, pedestrian access would be maintained by bridges, temporary walkways, and other means. Some streets may also be temporarily closed under special circumstances, such as for deck beam and street decking installation.

Normal truck deliveries of supplies are estimated to average 5 to 15 trucks per workday for the duration of station construction. Worker/employee commutes would be greater. The number of workers would vary but, for a typical station, would be approximately 80 to 160 personnel daily.

E.2.6 Station Construction—Finished Structure

The stations would be constructed with cast-in-place concrete, and the time of construction would vary depending on the length and the design configuration for each structure. The duration for completing the concrete and architectural work is expected to be 30 to 36 months. The amount of concrete would likely be in the range of 45,000 to

55,000 CY, which would take approximately 5,500 to 7,000 transit mix truck loads for each station. Reinforcing steel would be in the range of 5,000 to 7,000 tons per station.

The construction sequence for the station structures would commence with the construction of the foundation base slab, followed by installation of exterior walls and any interior column elements. Slabs are typically poured as the columns and intermediate floor and roof wall pours progress. Station entrance locations are generally used as access points during construction. Exterior entrances would be constructed after completion of the structure.

During station construction, approximately 10 to 20 concrete trucks per day are anticipated. Large pours of concrete would also be needed, requiring 30 to 50 trucks per day. The larger pours are expected to be performed at night to ensure supply and delivery of concrete and to minimize traffic impacts. Other support and delivery trucks, up to 10 to 20 per day, would be anticipated during peak station construction periods to deliver materials, such as rails, structural steel, and mechanical and electrical equipment.

Station concrete construction and architectural finish work would take place after tunnel construction is completed. Once station structure work is complete, the station excavation would be backfilled, and the permanent roadway would be constructed.

Station Construction in Gassy Ground

The City of Los Angeles Municipal Code, Chapter IX, Building Regulations, Article 1, Division 71, Methane Seepage Regulations, requires construction projects located within the Methane Zone or Methane Buffer Zone to comply with the City's Methane Mitigation Standards to control methane intrusion emanating from geologic formations. Mitigation requirements are determined according to the actual methane levels and pressures detected on a site. Tunnels and stations would be designed to provide a redundant protection system against gas intrusion. The primary protection from hazardous gases during operations is provided by the physical barriers (tunnel segment gaskets, station liner membranes) that keep gas out of tunnels and stations. At the stations, it is anticipated that construction would be accomplished using slurry walls or similar methods to provide a reduction of gas inflows both during and after construction. Other station design concepts to reduce gas leakage include additional barriers and use of flexible sealants, such as poly-rubber gels, along with the high-density polyethylene (used on Metro's existing underground stations).

Station Drainage

Most of the stations are not expected to require subdrain systems or permanent dewatering wells. The station structures will be thoroughly waterproofed, though internal sump pump systems will be required to capture any leakage that might occure and to remove fire water in the even tof a train or ststion fire . Within the gassy areas, a special waterproofing system would be required to also provide a barrier against gas intrusion.

Backfilling

Station excavations would require backfilling over the top (roof) of the structure to fill the area between the structure and the street. This backfilling is typically done with imported soils, which are delivered by truck. Backfilling would be carried out in the last 3 to 6 months as the station is completed. Depending on the station configuration, this operation would be done in stages. Stations would require from 60,000 to 160,000 CY of imported backfill, or roughly 4,000 to 11,000 truck-loads, depending on the size and depth of the station. During peak backfill periods, approximately 80 to 120 trucks per day would be expected at each location.

The number of backfill deliveries during peak traffic times can be reduced by stockpiling excavated materials on site for re-use. Soils excavated from station sites may be suitable for re-use but would have to be stockpiled at remote locations due to the limited staging areas adjacent to stations. However, it may not be feasible to re-use excavated tunnel materials for backfill because of the conditioning agents or slurry used for tunnel excavation.

Ventilation Shafts and Emergency Exits

A number of ventilation structures and emergency exit structures would be required. The station structures would generally house emergency ventilation fan shafts plus separate emergency exit shafts at both ends of the stations. Ventilation fans are used for extracting smoke from tunnels and stairs for evacuation in the event of an emergency, such as a fire. These shafts are typically constructed as extensions of the station excavation.

Station Completion

Stations would include some above-ground structures that would be completed near the end of the station construction cycle. These above-ground structures may be limited to entrance features, stairways, and elevator/escalator entry points. In some cases, Metro operations and maintenance spaces, including power equipment, communications facilities, and control rooms, may be housed in above-ground structures. Street and site restoration activities and appurtenant features, such as signage and landscaping, would complete each station.

E.2.7 Tunnel Construction

Tunnel construction consists of a variety of activities. These include TBM procurement and mobilization, which also involves preparation of the work area and assembly of the machine and its components, followed by tunnel excavation. Tunnel excavation generally would range from 8 to 12 months for a 1-mile length, but would vary, depending on the ground conditions encountered, site and work area constraints, and the number of TBMs used.

Figure E-8. Typical Pressurized-Face TBM

Tunnels would be constructed by pressurized-face TBMs to optimize control of the ground and to minimize settlement overlying and surrounding the tunnels (Figure E-8). In addition, this technology allows the tunnel lining to be installed concurrently and without lowering groundwater levels. Entrances for TBM operations (tunnel portal locations) would follow similar construction methods as the station excavations. Because TBM entrances to the tunnel are typically from the station in street locations, side entrances are often required for access underground in adjacent off-street locations. In these cases, the excavation in adjacent off-street locations may remain open to ground surface level, so no decking would be used.

TBM Staging Areas

Construction staging areas would be necessary for tunnel construction, similar to what is required for stations and ancillary facilities. Off-street space would be needed for setup, insertion, operation, and extraction of TBMs. Work areas to support tunnel excavation operations would include areas for processing and removing tunnel spoils, handling precast concrete tunnel-lining segments, and for tunnel utilities (such as ventilation, water supply, wastewater removal, power supply). In-street work areas would only be utilized when no off-street alternative exists.

Typically, a tunnel staging site of approximately 3 acres is required at the starting point of each tunnel drive. In addition to direct TBM support, this space is needed for loading/ facilities, construction equipment, worker facilities, and offices. A TBM drive is the section of tunnel to be bored by a particular TBM. TBM drives normally start and finish at station excavations and generally pass through one or more intermediate stations. Thus, not all station sites are required to be TBM staging areas. Tunnel staging sites are planned at Wilshire/La Brea, Century City and Westwood/VA Hospital.

TBM Transport, Delivery, and Removal

TBM components would be shipped to the tunnel staging sites by truck. Several oversize deliveries would be required, some during nights and weekends. However, these large component deliveries are limited to the initial setup period for the TBM, as well as during the removal period. If a TBM is to be re-used to excavate a subsequent tunnel, the entire machine may be transported by road from one site to the next. This would require full or partial road closures, typically at night.

TBM Tunnel Excavation

TBMs are large-diameter horizontal “drills” that continuously excavate circular tunnel sections. There are two types of pressurized-face TBMs—EPB or slurry-face TBM. Different machine types are designed for different geologic conditions. The excavated materials are removed through the tunnel using hopper-type rail cars, conveyor belt systems, or closed spoil transport pipelines. As the machine advances, both the ground in front of the machine and the horizontal “hole” it creates are continually supported by the TBM shield and pre-cast concrete tunnel liners that are installed as the machine progresses. This method creates a tunnel with little or no disruption at the surface and is especially suitable for creating a circular opening at greater depths than would be practical for cut-and-cover construction. The concrete tunnel liner segments would have rubber gaskets between them to prevent water from entering the tunnel and also allow the excavation to advance below the groundwater level.

The TBMs require a launching area to start each tunneling operation. Following excavation, the TBM would be dismantled and retrieved at the designated end point. On the first tunnel segment between Wilshire/La Cienega and Wilshire/Western, the TBMs would be launched from Wilshire/La Brea Station towards Wilshire/Western. They would be retrieved at Wilshire/Western through a specially constructed retrieval shaft, then transported back to the launching area at Wilshire/La Brea, reassembled, and launched towards Wilshire/La Cienega .For the second tunnel segment, TBM's would be launched at Century City towards Wilshire/La Cienega and for the third tunnel segment, TBM's would be launched at Westwood /VA Hospital towards Century City. it is anticipated that two TBMs would be utilized at the same time in each tunnel segment.

A tunnel drive consists of a series of activities. The TBM is advanced a small distance (typically 4 to 5 feet) by means of hydraulic jacks, which push against the previously installed tunnel lining ring. Following a complete "push" to advance the TBM, the hydraulic jacks are retracted and the next lining ring is installed. This process is repeated as the tunnel advances from one station to the next. When starting a tunnel drive from a shaft or station excavation, a heavy steel frame is typically erected to allow a rigid structure for the TBM to react against so that it can start to push forward (Figure E-9). Temporary precast concrete segmental liners are erected behind the TBM, which allow for continued advancement. The initial tunnel lining segments erected within the shaft are later removed once the TBM is fully "buried" and is mining continuously. Following tunnel excavation, the TBMs may be dismantled underground with the shield (outer shell) left in place. An alternative to dismantling the TBM would be to excavate a separate retrieval shaft. However, from a traffic management standpoint, due to traffic impacts at the retrieval shaft, retrieving the TBM is less desirable than dismantling it. An exception is if the TBM could be re-used immediately or in a reasonable time frame for constructing the next reach of tunnel. In such cases, the disruption caused by retrieval from the street may be justified.

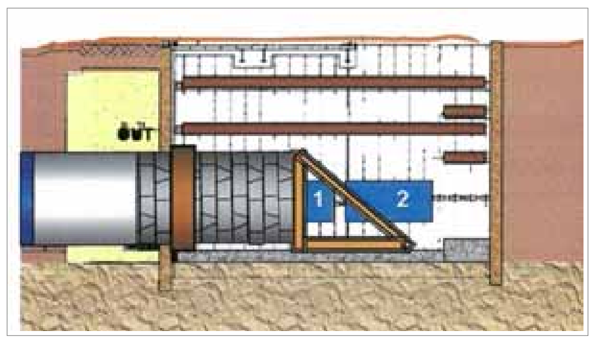

Figure E-9. Launching a TBM from the Station Excavation

The pre-cast concrete liners are pre-fabricated off-site and delivered to the site by truck. Truck loads for segments are estimated to be 6 to 10 per day for the duration of tunneling based on an estimated overall excavation rate of 30 to 50 feet per day. Segments needed for at least several days' production are generally stored at the work site to allow continuous tunneling. Tunneling operations are typically continuous, occurring 6 or 7 days a week, usually with two 10-hour shifts per day. A typical TBM tunnel is shown in Figure E-10.

Excavated material (spoils) is moved to the rear of the TBM by a screw conveyor and deposited on a conveyor belt. The conveyor belt drops the spoils into hopper-type mine cars that are then taken back to the launching area by a locomotive operating on temporary rail tracks fastened to the bottom of the tunnel. At the shaft, the mine cars are lifted out by a crane or hoist, and the material is loaded into trucks or temporarily stockpiled for off-site disposal. Alternatively, belt conveyor or pipe systems could be used to transport spoils through the tunnel and from the shaft to the surface. With the use of pressurized-face TBMs, the spoils must generally undergo partial treatment before being loaded on trucks for off-site disposal.

Disposal of Tunnel Spoils

Generation of Spoils

Spoils would be transported off-site for disposal. However, because all tunneling would be performed with pressurized-face TBMs, the spoils would first undergo some treatment (such as drying or de-sanding) before being loaded onto trucks for off-site disposal. For mostly sandy soils, drying can likely be accomplished on-site. For soils with higher water content (clays), and in the event that the volume of such soils is substantial, an additional temporary off-site storage/drying location may be needed.

For a typical tunnel excavation, boring two tunnels at approximately 20 feet per 10-hour shift, the rate of spoil removal would be approximately 75 loose CY per hour. or approximately 5 trucks per hour, or 1 truck every 10 to 12 minutes. With temporary stockpiling of spoils on the site, the hauling could be partially deferred to nights and weekends.

Anticipated Ground Conditions

In tunnel terminology, the tunnels would be excavated through soft ground, not rock, and in some locations below the groundwater table. Some of the alignment may be in gassy ground conditions, including methane and hydrogen sulfide.

Selection of the type of pressure-face TBM, an EPB or slurry-face TBM, may be determined based on the expected performance of the TBM in the anticipated ground conditions. To some extent, EPB TBMs are better suited to less permeable soils (clays), while slurry-face TBMs are better suited to more permeable soils (sands and gravels).

Figure E-11. Typical TBM Tunnel during Construction

Earth Pressure Balance (EPB) TBMs

In North America, EPB TBMs are the most common and have been used successfully in the project area. These TBMs rely on balancing the thrust pressure of the machine against the soil and water pressures from the ground being excavated. The EPB TBMs are generally well suited for boring in soft ground, as expected with the proposed project. These TBMs can also mine through variable soils and groundwater. The excavation method for an EPB TBM is based on the principle that tunnel face support is provided by the excavated soil itself (Figure E-12).

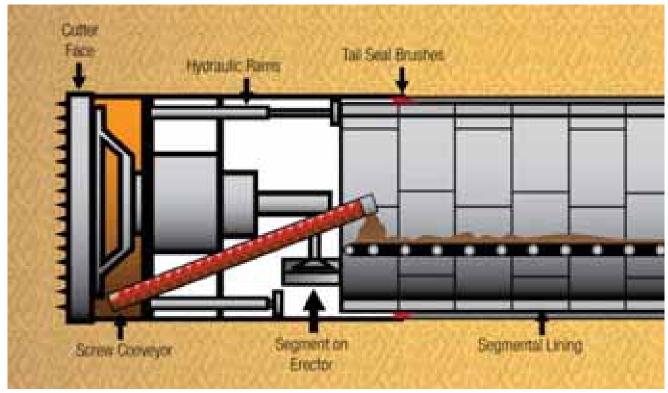

Figure E-12. Schematic of EPB TBM

Slurry-face TBMs

Slurry-face TBMS would likely be required for tunneling in gassy zones, where the addition of the slurry and the closed spoil removal system provides more protection against gas intrusion into the tunnel environment (Figure E-13). Where lower gas concentrations are expected, EPB TBMs may be suitable.

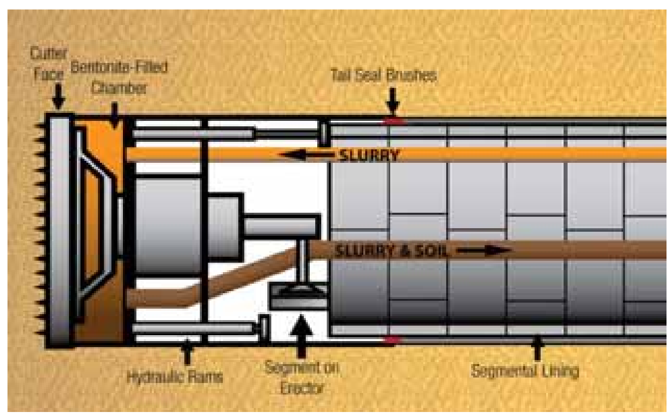

Figure E-13. Slurry Face TBM

With slurry-face TBMs, bentonite (clay) slurry is added in a pressurized environment at the tunnel excavation face. This combination of pressure and slurry stabilizes and supports the soils during excavation. Depending on the ground encountered, conditioners may be added to the slurry. Excavated soil is mixed with the slurry fluid and then pumped out of the tunnel to an above-ground separation plant through large (approximately 18-inch diameter) pipelines with in-line booster pumps. The excavated materials are treated at a separation plant, where they are separated from the slurry mixture. This also allows safe dispersion of any potentially gaseous components without endangering tunnel personnel.

Slurry

With the slurry-face TBM method of tunneling, bentonite slurry is used to apply fluid (hydraulic) pressure to the tunnel face and to transport soil cuttings from the tunneling machine's pressure chamber to the surface. The slurry mixed with soil cuttings is processed to separate the soil from the slurry. Soil is disposed of at locations approved by

Metro and selected by the tunnel contractor(s), and the cleaned bentonite slurry is returned to the machine's cutting chamber. The slurry that would be mixed at a surface plant is pumped in and out of the tunnel, and the TBM pressure chamber through a series of pipes. As a result, excavated material is kept enclosed and in a fluid state until it reaches the surface-based slurry separation plant (Figure E-14).

Figure E-14. Typical Slurry Mixing Plant

This method involves the setup of one or more temporary slurry treatment plants at the surface. The slurry treatment plant provides two basic functions: (1) prepares the bentonite slurry by mixing the slurry for use in the tunneling process and (2) treats the used slurry (slurry discharge). The slurry discharge is pumped out via pipeline to the ground surface where it undergoes a separation process for soil removal. The removal process involves settling and the use of sieves for separation of large particles and centrifuges for small particles. Once the excavated material is separated from the slurry, the resulting soil can

The slurry plant is anticipated to require an approximately 1-acre site for the equipment and enclosure (Figure E-15). Water removed from the discharge slurry would be recycled for further use in preparing the bentonite slurry. As necessary, treatment plants may be containerized for size reduction and sound proofing.

Tunnel Excavation Settlement and Settlement Protection

During the TBM tunnel excavation, the machine excavates slightly more soil than is taken up by the final lining. This is often referred to as "ground loss," the term for the small excess of excavated volume. Such ground loss can produce surface settlement. The settlement can occur during mining or, depending on ground conditions, days or weeks after the mining. The use of pressurized-face TBMs minimizes this settlement.

Figure E-15. Slurry Treatment Facilities (Stacked Configuration)

The amount of ground surface settlement would be a function of tunnel depth, tunnel size, proximity of adjacent tunnels, ground conditions, TBM characteristics, and excavation techniques. In addition to ensuring adequate face pressures through the use of pressurized-face TBMs, the requirement for precast segmental linings, grouted as the TBM advances, also minimizes settlement potential. The grouting operation is performed within the tunnel behind the TBM to promptly fill the annular space between the segmental lining and the surrounding ground.

Pressure is maintained at the face of the TBM tunnel excavation to reduce the potential for ground loss, soil instability, and surface settlement. In addition, a rigid, precast, bolted, gasketed lining system would be employed. In combination with the face pressure, grout would be injected immediately behind the TBM, in the annular space between the installed precast concrete liners (tunnel rings) and the excavated ground.

For shallow tunnels below sensitive structures or utilities, additional measures described below can be employed to further reduce settlement. The measure utilized would depend on the ground conditions and structure details at specific areas.

Permeation Grouting

Permeation grouting is used to improve the ground prior to tunneling. Chemical (sodium silicate) or cement-based grouts are injected into the ground to fill voids between soil particles and provide the soils with greater strength and stand-up time. This grout can be placed through pipes from the surface before the tunnel reaches the grouted area, from pits or shafts adjacent to the grouted area, or in some instances from the tunnel face. In this latter case, the tunneling machine must be stopped for a period of time to drill ahead, install grout pipes, pump grout, and allow the grout to solidify. Permeation grouting is typically used in sandy soils, which are common in the project area.

Compaction Grouting

Compaction grouting involves consolidating the ground prior to or following tunnel excavation. Compaction grouting entails the controlled injection of a stiff grout (typically sand with a small amount of cement) into soils at and above the planned tunnel excavation. Grout pipes are installed in advance of tunneling, and grout is injected to pre-consolidate the ground prior to the TBM or to replace ground lost after tunnel excavation. In either case, the grout improves the soil integrity and makes the ground more resistant to deformation.

Compensation Grouting

With compensation grouting, the grout is injected as the tunnel is excavated. This involves controlled injection of grout between underground excavations and structures that require protection from settlement. For tunnel applications, the grout pipes are installed above the intended tunnel position, ahead of the TBM. Grout is injected above the tunnel crown as the TBM excavation advances. The grout thickens the soil above the tunnel crown and replaces some of the ground that may be lost during the tunneling. This method prevents ground loss from propagating to the surface, thus avoiding settlement. A key component in compensation grouting is monitoring both structures and ground movements to optimize the timing and quantities of grout injected.

Prior to grouting, surface preparation would likely be required (traffic controls, removal of landscaping, etc.) to allow space for drilling equipment, installation of grout pipes, and injection of grout. In cases where large structures are over the tunnel, access into the buildings or basements could be required. In such cases, the use of the building could be restricted during grouting operations. After grouting is completed, the area would be restored. These grouting methods can in some cases use directional drilling, which can be done from off-street locations and can allow for horizontal orientation of grout holes along the tunnel alignment.

Underpinning

As mentioned above for building protection adjacent to stations, underpinning involves supporting the foundations of an existing building by carrying its load-bearing element to deeper levels than its pre-construction configuration. This helps protect the building from settlement that may be caused by construction near that foundation and permanently extends the foundations of a structure to an appropriate level beyond the range of influence of the construction activity. This can be accomplished by providing deeper piles adjacent to or directly under the existing foundation and transferring the building foundation loads onto the new system.

Underpinning may not be appropriate if the building is directly above the tunnel alignment, as building foundations could impart additional loads on the tunnel lining. In such cases, the tunnel lining would be designed for the additional loads.

Presence of Existing Tie-backs

Abandoned tie-backs could project into the planned tunnel excavation. Such situations are problematic because the TBMs cannot excavate through such tie-backs. In such cases, the tie-back cables must be cut and removed so the TBM cutter-head is not damaged. Tiebacks are anticipated at areas adjacent to deep basements or parking garages in buildings generally constructed after 1965.

Where the locations of tie-backs can be reasonably well established, it is possible to mine up to the tie-back and stop. The forward chamber of the TBM can then be pressurized with compressed air, and workers can enter ahead of the machine to cut and remove the tie-backs. A preferred procedure would be to excavate a small-diameter shaft from the ground surface and cut the tie-backs prior to tunneling.

Depending on the number of tie-backs intruding into the tunnel envelope and the depth of the tunnel, a short section of cut-and-cover excavation may be required in the tie-back zone. The TBM would “walk-through” the open excavation and erect the precast tunnel segments. Once the TBM had progressed completely through the area, backfill would be placed and compacted around the precast segments and up to the ground surface, which would then be restored.

In any of the situations above, the ground in the tie-back areas may need to be improved or strengthened by grouting prior to cutting the tie-back to minimize ground losses and associated settlement.

Tunnel Safety Considerations

Worker Safety

All underground construction would require reviews and consents from the Metro Tunnel Advisory Panel and the Metro Fire Life Safety Committee, which includes members from the Los Angeles City and County Fire Departments, as well as Metro safety specialists. In California, tunnel construction safety is governed by the California Occupational Safety and Health Administration (Cal/OSHA) Tunnel Safety Orders and worker safety training. California Electrical Safety Orders would apply to use of electric equipment. Where methane or hydrogen sulfide gases could be encountered, the regulations are specific and begin with the tunnel classification. The classifications range from “non-gassy,” where there is little likelihood of encountering gas, to “gassy,” which is applied when gas in the tunnel is likely to exceed concentrations greater than 5 percent of the lower explosive limit (LEL) of the gas.

Tunneling in Gassy Ground

TBMs and support equipment would be designed for the ground conditions and, where gassy ground is anticipated, TBMs would likely use an enclosed mucking system to prevent spoil and groundwater from releasing gas into the tunnel. In conjunction with TBM design, an adequate ventilation system, which dilutes and transports gases out of the tunnel, would be mandated. In addition Cal/OSHA requires for Gassy tunnels: monitoring devices to detect gas and trigger automatic shut down electric power to the TBM. TBMs and other equipment used in the tunnel would be sealed and be of explosion-proof design for use in a gassy environment. In addition, for tunnels classified as Gassy, Cal/OSHA requires a refuge chamber or alternate escape route to be maintained within 5,000 feet of the face of a tunnel. Refuge chambers would be equipped with a compressed air supply, a telephone, and means of isolating the chamber from the tunnel atmosphere. These chambers are typically prefabricated and travel with the TBM.

Ventilation

The tunnel must have adequate ventilation to dilute gasses to safe levels. Methane is combustible when mixed with air in the range of between 5 percent and 15 percent by volume. Below the 5 percent LEL, methane is not explosive. Similarly, hydrogen sulfide levels must be maintained well below the safe worker exposure limit of 10 parts per million (ppm). Project tunneling specifications would require excess ventilation capacity. Gas levels would be monitored continuously to ensure maintenance of safe exposure levels. The main ventilation systems would exhaust flammable gas or vapors from the tunnel, be provided with explosion-relief mechanisms, and be constructed of fire-resistant materials.

Tunnel Lining Construction

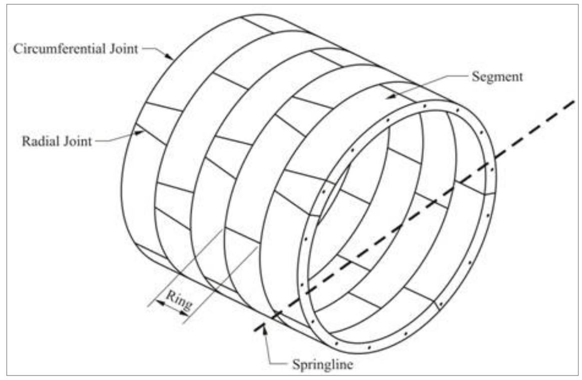

Figure E-16. Typical Precast Concrete Segmental

Precast concrete segments (Figure E-16) with gaskets would furnish the initial and final support of the tunnel. Single-pass, double-gasketed, precast concrete segments are the lining system of choice to limit infiltration of water and gas through the final lining. These systems provide a high-quality tunnel lining close behind the TBM excavation. In areas of gassy ground, however, additional steps may be required to provide greater protection against gas leakage into the tunnel environment, either during or following tunnel excavation.

The precast concrete segments are fabricated off-site and delivered by truck. Several days or weeks of segments may be stored at the work site to ensure an uninterrupted supply to the tunnel excavation operations. A typical precast segment storage area is shown in Figure E-17. Care is required to ensure that the segment gaskets are not damaged during transport, shipment, or by prolonged exposure to sunlight. Depending on the gasket composition and the typical storage period, the segment gaskets may need to be installed at the site, rather than at an off-site pre-fabrication facility. If this is necessary, a small enclosure is required to install the gaskets under controlled conditions.

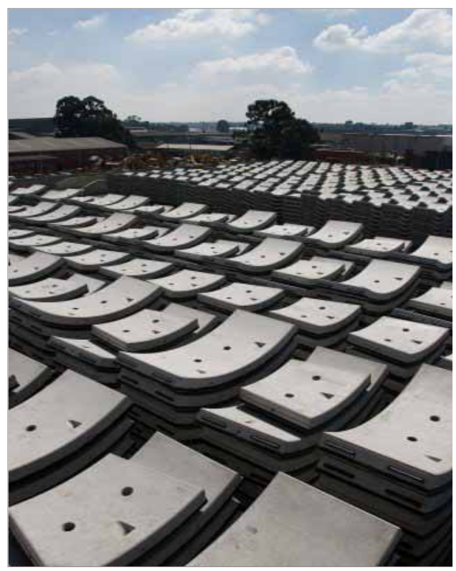

Figure E-17. Precast Concrete Segments Storage

E.2.8 Cross-passage Construction

Cross-passages between adjacent tunnels would be constructed at intervals within the tunnels. These openings would be almost entirely hand-excavated and concreted. Before exposing the ground, particularly where water or gas would be encountered, a tight seal of improved soils (using grout or other soil improvements) would be installed around the perimeter of the area to be excavated. Because excavation and construction of these structures is particularly sensitive to ground, water, and gas conditions, locations would be determined based on ground conditions.

Individually, ground conditions would dictate the method and detail of preparing the cross-passage site for excavation. After ground treatment, a tight ring with grouted holes would be drilled from within the tunnel and then grouted with chemical or cement grout. Steel spiling bars (pre-reinforcing) may also be employed and would be drilled or driven from the tunnel above the cross-passage envelope.

Alternately, drilling and grouting might take place from above the tunnels. Although surface drilling is often more disruptive to surface activities, it may provide for greater control. In areas of weaker soils or higher groundwater, jet grouting from the surface may be utilized to provide a higher-strength and more consistent area of improved ground for cross-passage excavation. When below the water table, freezing the ground is another method that could be considered.

Cross-passages would be excavated by sequential excavation and support methods that require the ground to be excavated incrementally in small areas and stabilized or supported prior to advancing to the next area. The ground can be stabilized by different methods, including steel supports, spiling pre-reinforcing, and shotcrete (sprayed concrete). Excavated soils would be removed through the TBM tunnels. The sequence of excavation would be predetermined and modified as needed during construction.

In areas with potential exposure to gas, special monitoring would be employed. At break-outs from the main tunnel, grouting and other aspects of the construction would not vary substantially from the normal procedure. Pre-treatment of the ground to reduce the potential for gas exposure is an option. Also, probe holes extending into the cross-passage area from the main tunnel would likely be drilled prior to cross-passage excavation. Such probe holes would be beneficial for detecting water or gas and can allow for excavation plans to be adjusted.

E.2.9 Crossovers

The rail system would require crossovers for proper operation. Crossovers allow trains to cross from one track to the other. Crossovers would be constructed using cut-and-cover construction. Cross-overs are generally located immediately next to a station, e.g., on the east side of Wilshire/La Brea Station, though this is not always so. The crossover at Westwood/VA Hospital south is located on the opposite side of I-405 from the station.

Each crossover would be approximately 450 feet long, 60 feet wide, and 60 feet below ground (depending upon the distances between track centers).

E.2.10 Systems Installations and Facilities

Trackwork

Trackwork would be constructed below grade in the completed tunnels and station structures. Trackwork construction involves installation of trackbed components on the completed concrete structures, followed by the laying of rails. In general, third rail (traction power) and conduits for systems installations would be constructed at the same time as, or closely following, the trackwork. Rails, conduits, and associated components would be brought into the tunnels at selected station locations with appropriate off-street access and, in some cases, via the existing system. Rails would be delivered in stock lengths of 40 feet or 80 feet and welded into long strings typically 480 feet either within the station boxes or at the Division 20 Train Storage and Maintenance Facility.

Electrical Substations and Facilities

In general, electrical substation and facilities would be located within available spaces in the stations, cross-passages, ventilation shafts, and emergency exits. Some electric power equipment may be located within street-level spaces. Substations would include TPSSs and smaller substations. The substations would be spaced along the alignment and may be located at or near to each station. These electrical facilities would be separated from public areas of the system and would include appropriate security.

Communications and Signaling

Communications and signaling systems would be accommodated within rooms and niches in the stations, tunnels, cross-passages, ventilation shafts, and emergency exits. These systems would be spaced along the alignment and positioned at or near each station. They would be separated from public areas and would include appropriate security.

Operations and control facilities would be housed within existing Metro facilities or may be incorporated into the above-ground ROC or maintenance yards.

E.2.11 Street/Site Restorations

This work restores the street or ground surface to its original condition, or better. Site restoration operations would closely follow completion of the station structures.

Backfill material would be trucked in, placed, and compacted and, during backfilling over stations, utilities would be installed along with new sewer manholes and cable/duct vaults. Sidewalks would be restored, and the permanent street would be constructed, including paving, striping, and signage. Streets, sidewalks, and landscaping would be restored in accordance with City standards.

Street decking and deck beam removal will mirror the installation procedure. Full street closures will be required with beams and decking removed in short sections and the space occupied by the decking backfilled and paved. A series of consecutive weekend street closures will be required to remove the decking and restore the street at each station location.

Attachment A
Construction Laydown Areas

ATTACHMENT A—CONSTRUCTION LAYDOWN AREAS

This appendix provides a summary of the proposed construction staging and laydown areas during construction for the Westside Subway Extension project. Table A-1 shows anticipated construction staging activities organized by locations along the proposed alignment. The following sections describe the principal activities at each of the construction staging and laydown areas in detail.

Table A-1: Contractor Staging and Laydown Areas—Principal Activities by Location

Facility	Wilshire/Western	Wilshire/Crenshaw	Wilshire/La Brea	Wilshire/Fairfax	Wilshire/La Cienega	Wilshire/Rodeo	Century City	Westwood/UCLA	GSA	Westwood/VA Hosp	Emergency Exit Shaft
Principal Activity	TBM Retrieval Shaft	Construct-ion Laydown	Station and TBM Support	Station	Station and TBM Retrieval	Station	Station and TBM Support	Station	Crossover	Station and TBM Support	Emer-gency Exit shaft
Contractor field office	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
MTA field office			✔	✔	✔	✔	✔	✔		✔	
Parking	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Foam/slurry plant			✔				✔			✔	
Grout plant			✔				✔			✔	
Electrical substation			✔	✔	✔	✔	✔	✔		✔	
Air compressor station	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Dry house			✔				✔			✔	
Materials storage	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Tunnel segment storage			✔				✔			✔	
Crane	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Mechanical shop			✔				✔			✔	
Electrical shop			✔				✔			✔	
Desilting basin	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Water treatment plant	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Muck storage (excavation)	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Muck storage (TBM)			✔				✔			✔	
Truck loading	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Concrete pumping	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Wilshire/Western

At Wilshire/Western, a shaft will be constructed to retrieve the two TBMs tunneling to Wilshire/Western from Wilshire/La Brea. Once the TBMs have been retrieved, the shaft can be used for personnel to access the western end of the tunnels without the need to pass through the Wilshire/Western Station and to move materials into and out of the tunnels, e.g., a location to pump concrete into the tunnels for the construction of tunnel invert and walkways and for the construction of cross-passages.

A laydown area is required adjacent to the shaft to store materials and equipment used to construct the shaft and decking and for an "access adit" into the shaft from the laydown area that will allow the contractor to freely move personnel, materials, and equipment between the laydown area and the shaft beneath the decked street without need to close traffic lanes. During the shaft construction, the "access adit" will allow excavated materials to be removed without disruption to traffic. It will allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area also will allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times.

The laydown area will also serve as a location for contractor field offices, for off-street parking and amenities for the site-based workforce, and for any plant needed for treatment of dewatering effluent.

Wilshire/Crenshaw

This proposed construction laydown area is located at the Metro-owned property on the south side of Wilshire Boulevard between Lorraine Boulevard and Crenshaw Boulevard. The property would be used for construction staging activities by the contractor such as storage of materials not immediately required at work sites or for sites where the available laydown area is scarce. The site would also be used as a location for the contractor's office. The laydown area would also serve as a location for off-street parking and amenities for the site-based workforce, and for any equipment needed for treatment of dewatering effluent. This site would also serve to store and process fossil bones removed during the Wilshire/Fairfax Station excavation.

Wilshire/La Brea

Wilshire/La Brea is a station site that will also be a launch site for TBMs and the location for the equipment needed to support the operation of the TBMs. Approximately 3 acres of laydown area is needed at La Brea. Initially, the laydown area will be used to support advance works associated with the relocation of utilities within the station footprint, street modifications and similar, and to store the materials and equipment used for installing the temporary shoring and street decking. This will include precast concrete panels for the street decking and steel beams and columns.

Laydown areas are required adjacent to the station excavation to store materials and equipment used to construct the station excavation and decking and for "access adits" into the shaft from the laydown areas that will allow the contractor to freely move personnel, materials, and equipment between the laydown area and the station excavation beneath the decked street without need to close traffic lanes. During the station excavation, the "access adit" will allow excavated materials to be removed without disruption to traffic. It will allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and be able to work through peak traffic periods without lane closures. The laydown area also will allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times. In the event that fossils are found at Wilshire/La Brea, the laydown area could be used to temporarily store the fossil boxes pending transportation to location for processing.

The laydown area will also be used as a staging area to receive and inspect TBM components and support equipment as they are delivered to site and to store such equipment until it is ready to be assembled within the station excavation.

The laydown area will also serve as a location for contractor field offices, for offstreet parking and amenities for the site-based workforce, and for the plant and equipment supporting tunnel drives to Wilshire/La Cienega and Wilshire/Western. TBM support equipment and facilities will include an electrical substation, compressed air plant, a grout plant, storage for bentonite slurry and/or EPB conditioner, a slurry plant, storage for tunnel supplies and materials, including precast concrete segments, pipe, rail and sleepers, power cables, workshops to repair and maintain equipment, and spare parts storage. The laydown area will also be used to stockpile and dry tunnel spoil prior to its being trucked away for offsite disposal.

Once the tunnel excavation is completed, the laydown area will also be used to receive and store the rebar and concrete formwork needed for the station structural concrete and later for architectural materials and mechanical and electrical equipment.

Wilshire/Fairfax

Wilshire/Fairfax is a station site without TBM support facilities. Approximately 1-1/2 acres of laydown area is needed at Fairfax to support the construction of the station and for the storage of boxed fossils removed during station excavation. Initially, the laydown area will be used to support advance works associated with the relocation of utilities within the station footprint, street modifications and similar, and to store the materials and equipment used for installing the temporary shoring and street decking. This will include precast concrete panels for the street decking and steel beams and columns.

Laydown areas are required adjacent to the station excavation to store materials and equipment used to construct the station excavation and decking and for "access adits" into the shaft from the laydown areas that will allow the contractor to freely move personnel, materials, and equipment between the laydown area and the station excavation beneath the decked street without need to close traffic lanes. During the station excavation, the "access adit" will allow excavated materials and fossil boxes to be removed without disruption to traffic. It will allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area also will allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times.

Fossil boxes removed from the station excavation will be stored at this or at other sites (e.g. behind LACMA, at La Brea, or at Crenshaw) either until the boxes can be transported offsite for processing or stored while fossil processing is done directly at the Wilshire/Fairfax site.

The laydown area will also serve as a location for contractor field offices, for offstreet parking and for amenities for the site-based workforce, and for the plant and equipment supporting station work at Wilshire/Fairfax and for any plant needed for treatment of dewatering effluent.

Once the tunnel excavation is completed the laydown area will also be used to receive and store the rebar and concrete formwork needed for the station structural concrete and later for architectural materials and mechanical and electrical equipment.

Wilshire/La Cienega

Wilshire/La Cienega is a station site that will also be used as the retrieval site for TBMs arriving from Century City and from Wilshire/La Brea. Approximately 1 acre of laydown area is needed at La Cienega, principally for the construction of the station. Initially, the laydown area will be used to support advance works associated with the relocation of utilities within the station footprint, street modifications and similar, and to store the materials and equipment used for installing the temporary shoring and street decking. This will include precast concrete panels for the street decking and steel beams and columns.

Laydown areas are required adjacent to the station excavation to store materials and equipment used to construct the station excavation and decking and for an "access adit" into the station excavation from the laydown areas that will allow the contractor to freely move personnel, materials, and equipment between the laydown area and the station excavation beneath the decked street without need to close traffic lanes. During the station excavation, the "access adit" will allow excavated materials to be removed without disruption to traffic. It will allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area also will allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times.

The laydown area will also serve as a location for contractor field offices, for offstreet parking and amenities for the site-based workforce, and for any plant needed for treatment of dewatering effluent. Once the tunnel excavation is completed, the laydown area will also be used to receive and store the rebar and concrete formwork needed for the station structural concrete and later for architectural materials and mechanical and electrical equipment.

Wilshire/Rodeo

Wilshire/Rodeo is a station site without TBM support facilities. Approximately 1 acre of laydown area is needed at Wilshire/Rodeo to support the construction of the station. Initially, the laydown area will be used to support advance works associated with the relocation of utilities within the station footprint, street modifications and similar, and to store the materials and equipment used for installing the temporary shoring and street decking. This will include precast concrete panels for the street decking and steel beams and columns.

Laydown areas are required adjacent to the station excavation to store materials and equipment used to construct the station excavation and decking and for "access adits" into the shaft from the laydown areas that will allow the contractor to freely move personnel, materials, and equipment between the laydown area and the station excavation beneath the decked street without need to close traffic lanes. During the station excavation, the "access adit" will allow excavated materials to be removed without disruption to traffic. It will allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area also will allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times.

The laydown area would also serve for amenities for the site-based workforce and for the plant and equipment supporting station work at Wilshire/Fairfax and for any plant needed for treatment of dewatering effluent. Given the limited size of the laydown area available, contractors are likely to look for alternative locations for field offices and for parking.

Once the tunnel excavation is completed, the laydown area will also be used to receive and store the rebar and concrete formwork needed for the station structural concrete and later for architectural materials and mechanical and electrical equipment.

Century City/Santa Monica Boulevard

Century City/Santa Monica Boulevard is a station site that will also be a launch site for TBMs and the location for the equipment needed to support the operation of the TBMs. Approximately 3 acres of laydown area is needed at Century City/Santa Monica Boulevard. Initially, the laydown area will be used to support advance works associated with the relocation of utilities within the station footprint, street modifications and similar, and to store the materials and equipment used for installing the temporary shoring and street decking. This will include precast concrete panels for the street decking and steel beams and columns.

Laydown areas are required adjacent to the station excavation to store materials and equipment used to construct the station excavation and decking and for “access adits” into the station excavation from the laydown areas that will allow the contractor to freely move personnel, materials, and equipment between the laydown area and the station excavation beneath the decked street without need to close traffic lanes. During the station excavation, the “access adit” will allow excavated materials to be removed without disruption to traffic. It will allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area also will allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times.

The laydown area will also be used as a staging area to receive and inspect TBM components and support equipment as they are delivered to site and to store such equipment until it is ready to be assembled within the station excavation. The laydown area will also serve as a location for contractor field offices, for offstreet parking and amenities for the site-based workforce, and for the plant and equipment supporting tunnel drives to Wilshire/La Cienega. TBM support equipment and facilities will include an electrical substation, compressed air plant, a grout plant, storage for bentonite slurry and/or EPB conditioner, a slurry plant, storage for tunnel supplies and materials, including precast concrete segments, pipe, rail and sleepers, power cables, workshops to repair and maintain equipment, and spare parts storage. The laydown area will also be used to stockpile and dry tunnel spoil prior to its being trucked away for off-site disposal.

Once the tunnel excavation is completed, the laydown area will also be used to receive and store the rebar and concrete formwork needed for the station structural concrete and later for architectural materials and mechanical and electrical equipment.

Century City/Constellation

Century City/Constellation is a station site that will also be a launch site for TBMs and the location for the equipment needed to support the operation of the TBMs. Approximately 3 acres of laydown area is needed at Century City/Constellation. Initially, the laydown area will be used to support advance works associated with the relocation of utilities within the station footprint, street modifications and similar, and to store the materials and equipment used for installing the temporary shoring and street decking. This will include precast concrete panels for the street decking and steel beams and columns.

Laydown areas are required adjacent to the station excavation to store materials and equipment used to construct the station excavation and decking and for "access adits" into the station excavation from the laydown areas that will allow the contractor to freely move personnel, materials and equipment between the laydown area and the station excavation beneath the decked street without need to close traffic lanes. During the station excavation, the "access adit" will allow excavated materials to be removed without disruption to traffic. It will allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area also will allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times.

The laydown area will also be used as a staging area to receive and inspect TBM components and support equipment as they are delivered to site and to store such equipment until it is ready to be assembled within the station excavation. The laydown area will also serve as a location for contractors field offices, for offstreet parking and amenities for the site-based workforce, for any plant needed for treatment of dewatering effluent, and for the plant and equipment supporting tunnel drives to Wilshire/La Cienega. TBM support equipment and facilities will include an electrical substation, compressed air plant, a grout plant, storage for bentonite slurry and/or EPB conditioner, a slurry plant, storage for tunnel supplies and materials, including precast concrete segments, pipe, rail and sleepers, power cables, workshops to repair and maintain equipment, and spare parts storage. The laydown area will also be used to stockpile and dry tunnel spoil prior to its being trucked away for offsite disposal.

Once the tunnel excavation is completed, the laydown area will also be used to receive and store the rebar and concrete formwork needed for the station structural concrete and later for architectural materials and mechanical and electrical equipment.

Westwood/ UCLA

Westwood/UCLA is a station site without TBM support facilities. While there are two locations for the Westwood/UCLA Station under consideration, a single laydown and staging area has been identified that will serve either station location. Initially, the laydown area will be used to support advance works associated with the relocation of utilities within the station footprint, street modifications and similar, and to support advance works in that location, including relocation of utilities. Later the area will be required to store the materials and equipment used for installing the temporary shoring and street decking. This will include precast concrete panels for the street decking and steel beams and columns.

Laydown areas are required adjacent to the station excavation to store materials and equipment used to construct the station excavation and decking and for "access adits" into the shaft from the laydown areas that will allow the contractor to freely move personnel, materials and equipment between the laydown area and the station excavation beneath the decked street without need to close traffic lanes. During the station excavation, the "access adit" will allow excavated materials to be removed without disruption to traffic. It will allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area also will allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times.

The laydown area would also serve for amenities for the site-based workforce and for the plant and equipment supporting station work at Westwood/UCLA and also for Wilshire/Manning and for any plant needed for treatment of dewatering effluent.

Once the tunnel excavation is completed, the laydown area will also be used to receive and store the rebar and concrete formwork needed for the station structural concrete and later for architectural materials and mechanical and electrical equipment. It will also be used for the receipt and storage of materials for the vent shaft at Wilshire/Manning.

GSA

The GSA location is the site of a crossover. Approximately 1 acre of laydown area is needed at GSA to support the construction of the crossover. Initially, the laydown area will be used to support advance works associated with the relocation of utilities within the crossover box footprint, street modifications and similar, and to store the materials and equipment used for installing the temporary shoring and street decking of the I-405 on and off ramps. This will include precast concrete panels for the street decking and steel beams and columns.

Laydown areas are required adjacent to the crossover excavation to store materials and equipment used to construct the crossover excavation and decking. The laydown area also will allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times.

The laydown area would also serve for amenities for the site-based workforce and for the plant and equipment supporting station work at the GSA and for any plant needed for treatment of dewatering effluent.

Once the tunnel excavation is completed, the laydown area will also be used to receive and store the rebar and concrete formwork needed for the crossover structural concrete and later for mechanical and electrical equipment.

Westwood/VA Hospital

Westwood/VA Hospital is a station site that will also be a launch site for TBMs and the location for the equipment needed to support the operation of the TBMs. There are two locations under consideration for the Westwood/VA Hospital Station, and the following commentary applies to both locations.

Approximately 3 acres of laydown area is needed at Westwood/VA Hospital. Initially, the laydown area will be used to support advance works associated with the relocation of utilities within the station footprint, street modifications and similar, and to store the materials and equipment used for installing the temporary shoring and street decking. This will include precast concrete panels for the street decking and steel beams and columns.

Laydown areas are required adjacent to the station excavation to store materials and equipment used to construct the station excavation and decking and for locating equipment needed to move personnel, materials, and equipment between the laydown and staging area and the station excavation. The laydown area also will allow excavated materials from the station to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue on regularly scheduled shift times.

The laydown area will also be used as a staging area to receive and inspect TBM components and support equipment as they are delivered to site and to store such equipment until it is ready to be assembled within the station excavation. The laydown area will also serve as a location for contractor field offices, for offstreet parking and amenities for the site-based workforce, for any plant needed for treatment of dewatering effluent, and for the plant and equipment supporting tunnel drives to Wilshire/La Cienega. TBM support equipment and facilities will include an electrical substation, compressed air plant, a grout plant, storage for bentonite slurry and/or EPB conditioner, a slurry plant, storage for tunnel supplies and materials, including precast concrete segments, pipe, rail and sleepers, power cables, workshops to repair and maintain equipment, and spare parts storage. The laydown area will also be used to stockpile and dry tunnel spoil prior to its being trucked away for offsite disposal.

Once the tunnel excavation is completed, the laydown area will also be used to receive and store the rebar and concrete formwork needed for the station structural concrete and later for architectural materials and mechanical and electrical equipment.

Emergency Exit Shafts

Emergency exit shafts will be constructed at the extreme western end of the tail track tunnels. A laydown area adjacent to the shafts is required for any advance utility relocations or street modifications, to locate the crane to lift materials into and out of the shaft, an area to park trucks delivering materials (primarily steel beams, formwork, and concrete) and being loaded (primarily with spoil from the shaft excavation), and a location to treat ground water from the shaft. There will be no room at the emergency exit shaft site for any significant storage of material and equipment (other than the crane servicing the shaft), and it is expected that the contractor will use the laydown and staging area at the Westwood/VA Hospital Station for a field office and for the storage of materials and parking of equipment.

The laydown area at the emergency exit shaft will also be used to receive and unload ventilation equipment for installation in the shaft and as a staging point for the construction crews installing equipment.