Preliminary Review Comments of Century City Area Fault Investigation Report Westside Subway Extension Project Century City and Beverly Hills, CA

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1.0 EXECUTIVE SUMMARY

This report presents the results of our review of the Century City Area Fault Investigation (Fault Report) and Century City Area Tunneling Safety Report (Tunnel Report) for the Westside Subway Extension (WSE) project. The reports were prepared by Parsons Brinkerhoff (PB) in October 2011 for the Los Angeles County Metropolitan Transportation Authority (Metro). The report also includes our observations of fault tunneling on the campus of the Beverly Hills High School (BHHS) completed by BHHS geotechnical consultant. The following summarizes our review opinions of PB's studies as requested by the City of Beverly Hills (City). Details of our report reviews used to develop our opinions are provided in the following sections.

Constellation Station Studies –When compared with the studies completed at the Santa Monica Station, the relatively sparse exploration data presented for the Constellation Station does not indicate, nor fully negate, the presence of faulting. It is our opinion that the current studies for this station are not as thorough as for the Santa Monica Station. Therefore, we recommend that comparable geological and geotechnical explorations be carried out for the Constellation Station.

Santa Monica Station Relocation – Relocating the station further south or east along Santa Monica Boulevard, including the gap (see Figure 2) between the Santa Monica Fault Zone (SMFZ) and West Beverly Hills Lineament/Newport Inglewood Fault Zone (WBHL), has risks similar to the current proposed Santa Monica Station owing to high probability of ground deformation stemming from earthquakes originating from the SMFZ or by previously unmapped fault splays. Data collected at the recent fault trenching performed at BHHS, does not appear to indicate that the WBHL is an active fault. Relocating the Santa Monica Station further east as shown in Figure 2 could be feasible if the WBHL is also shown to be inactive where it crosses Santa Monica Boulevard, and if the SMFZ terminates west of the Beverly Hills City Limits. We recommended fault trenching occur at the station location.

Tunneling Beneath Beverly Hills High School – The proposed tunnel crown is approximately 50 to 70 feet below the existing ground surface along the BHHS campus. The tunnel is therefore not likely to directly impact the campus facilities (as we understand their current use). The proposed BHHS underground parking garage could be constructed above the tunnel to a maximum depth of about 30 to 50 feet below grade, leaving at least 20 feet of undisturbed soil above the tunnels. Risks associated with ground loss during construction, vibrations during construction and operation, and hazards from methane and other gasses should be mitigated by the design and plans and specifications for the project.

Precedents for Stations on Fault Zones – While there are case histories of tunnels surviving earthquakes in relatively good condition, damage has been noted in references we reviewed for stations subjected to strong ground shaking. The California Geological Survey could designate the SMFZ as "active," and thus place it into the category of an Alquist-Priolo Earthquake Hazard Fault Zone (AP Act). Since enactment of the AP Act in 1972, no underground transit stations in California have been knowingly sited across regulatory-defined active faults. Accordingly, if the SMFZ is defined as active the Santa Monica Station should not be located underground where the SMFZ is mapped. The WBHL does not appear to be active based on the trenching completed at BHHS, but as discussed above, should be confirmed with additional trenching along Santa Monica Boulevard.

2.0 INTRODUCTION

The proposed WSE will be a heavy-rail subway connecting to the existing Wilshire/Western station at the Purple Line. The proposed alignment travels west along Wilshire Boulevard through Beverly Hills and westward into the Century City and Westwood areas of Los Angeles. The proposed subway alignment in the study area is shown in Figure 1. A proposed station is located on Santa Monica Boulevard (Santa Monica Station) with an alternate at Constellation Boulevard (Constellation Station). The tunnel alignment for the Constellation Station passes beneath residential and commercial buildings, including the BHHS campus. The draft environmental impact report (DEIR) cites that one of the reasons to consider the Constellation Station as an alternative site is the possibility that active faults might cross the Santa Monica Station. The active SMFZ and the likely inactive WBHL, are shown in Figure 2.

We previously prepared a DEIR Summary Letter dated October 14, 2010 for the City of Beverly Hills (City). In our DEIR Summary Letter, we provided the following recommendation to the City about faults potentially impacting the proposed WSE in Century City:

> "Given the uncertainty of the Santa Monica Fault and West Beverly Hills Lineament, further evaluation to identify fault traces should be completed prior to final location of the Santa Monica base station. The Santa Monica Fault could have one or more distinct fault traces that could impact the station location. The trace(s) would be identified during the geotechnical investigation of the project using a combination of geophysical

techniques, subsurface explorations, and/or trenching (where possible). If a trace is discovered passing through the proposed station, then the station would likely need to be relocated."

The WSE project owner (Metro) commissioned the Fault and Tunnel Reports to address selection of the Century City area station location. The Fault Report presents conclusions regarding the potential for fault rupture at the station locations. The Tunnel Report presents safety concerns regarding tunneling below occupied structures, specifically the BHHS.

3.0 SCOPE OF SERVICES

The primary purpose of our services is to evaluate the geotechnical reports produced for the Final Environmental Impact Report (FEIR) in order to form an opinion on the potential impacts to the City from project construction. A secondary purpose was to provide observation of the fault trenches completed at BHHS. The City authorized our services on September 27, 2011.

4.0 PROJECT TEAM

To provide opinions to the questions above, we have retained a paleoseismologist or fault specialist as part of our team to evaluate the Fault and Tunnel Reports. Dr. Roy Shlemon is a recognized expert for evaluating activity on Quaternary-age faults in southern California and his qualifications are attached to this letter as Appendix A. Dr. Shlemon's report is attached as Appendix B. In addition to Dr. Shlemon, our team consists of our Director of Underground Services, Robert Robinson; engineering geologist, Dean Francuch; and geotechnical engineer, Travis Deane. Resumes of the project team are also provided in Appendix A. Note that Dr. Shlemon was invited by BHHS representatives to view the fault trenching completed at BHHS by their geotechnical consultant, Leighton & Associates. His observations are included in his report.

5.0 CONSTELLATION STATION STUDIES

5.1 General

We reviewed the fault studies performed at the proposed Constellation Station and compared them to fault studies completed at the Santa Monica Station. The intent of our review was to assess that a reasonable investigation had been undertaken to confirm that fault strands were not present in the proposed Constellation Station site, nor that the possible presence of faults in the vicinity do not impact the Constellation Station. The next section references the relevant pages in the Constellation Station studies in the Fault and Tunnel Reports followed by our review and opinion.

5.2 Century City Reports

5.2.1 Fault Report

The following pages of the Fault Report discuss or depict the studies completed for the Constellation Station:

- Pages 1 and 2
- Figure 8
- Page 23
- Page 28

5.2.2 Tunnel Report

The focus of the Tunnel Report is on the safety of tunneling for the Constellation Boulevard alignment and refers to the Fault Report for the fault studies. Therefore, the Tunnel Report does not comment on active faults crossing the Constellation Station.

5.3 Technical Review

Based on the findings near the Santa Monica Station alternative location, the proposed location of the Constellation Station alternative appears to show less probability of active faulting. Page 2 of the Fault Report states that *"…no faulting was found passing through or in close proximity to the proposed Constellation Boulevard Station*." This assertion that Constellation Station is not within a fault zone and that it is a viable option is premature based on the level of study presented in the Fault Report. Note that the WBHL fault trenching completed on the BHHS campus is east of the Fault Report studies.

In our opinion, the study at Constellation Station was not as thorough as that completed for the Santa Monica Station. Transects in the vicinity of the SMFZ and WBHL generally included closely-spaced CPTs and borings as well as seismic reflection profiles. However, along the Constellation Boulevard alignment, the evaluation was limited to a northeast-southwest oriented subsurface profile drawn using existing explorations of variable quality, age, and marginal depth, and a few widely-spaced new CPTs and borings performed for the Fault Report. One transect was also drawn perpendicular to the station (northwest-southeast); this transect was fairly well studied to a similar level of effort to the SMFZ and WBHL areas.

The profile provided along the Constellation Boulevard alignment in the Fault Report interprets lateral continuity of strata, and therefore no obvious signs of faulting. We reviewed the boring logs along the Constellation Boulevard alignment and generally agree with their interpretations with the following exceptions. The interpretation of lateral continuity relies on the identification of marker beds (e.g., discrete gravel beds). Since their interpretation is based largely on existing logs from several different sources, those marker beds are potentially more difficult to correlate than if they were identified in a series of explorations performed in a new, single study, such as that completed for the Santa Monica Station.

Furthermore, the soil profiles shown on Figures 4 and 5 of the Tunnel Report interpreted three fault strands, with the western-most strand based on only two borings, spaced about 500 feet apart. As a result of the wide borehole spacing, the strand is interpreted to lie midway between two borings (69-036-1 and G-168B), about 350 feet east of the station/crossover (see Figure 2). This fault strand could occur anywhere within this 500-foot interval, and consequently might be located as close as 100 feet from the east end of the station/crossover. Also to the west of this western-most fault strand, the boundaries between the San Pedro Formation (Qsp) and the overlying Lakewood Formation (Qlw), and between the Qlw and the overlying older alluvium (Qalo) are shown inclined upward, rather than horizontal, as interpreted within the fault strand-bounded block to the east that show uplifted and depressed blocks along interpreted fault strands. An alternate interpretation, in the absence of available data from additional borings, might be to interpret yet another fault strand within the east end of the station/crossover structure. The report states that the fault line locations are also interpreted from seismic reflection surveys, but this particular strand does not appear to be crossed by a seismic reflection line performed for the fault study. Additional borings and possibly trench explorations, and geophysical studies should be completed in this area to determine the absence or presence and locations of potential fault strands crossing the proposed station.

Several shallow borings were drilled at the Constellation Station, but their primary purpose appears to have been for gas testing, as identified on Figure 5 of the Tunnel Report. It is not clear if soil samples were obtained that might be used for age-dating. Detailed logs of these borings were not provided in the Fault and Tunnel Reports. Groundwater levels are not noted on these borings (M-19, B-1, B-2, B-3, B-4, and B-7). These borings also do not extend down to the station invert, and none extend to 40 or 50 feet below station bottom, as might normally be required for design. We believe that a seismic profile and deeper borings with piezometers should be considered for the station. The deeper borings would be required for station design in order to analyze the station excavation bottom stability, dewatering requirements, presence of methane and hydrogen sulfide gas, temporary shoring depths and support, and other design elements.

It is our opinion that the Fault Report authors should provide justification that the profile drawn from the existing explorations along the Constellation Boulevard alignment is sufficient, or label it as preliminary, warranting a much greater level of study as was undertaken in other areas (even in some areas where faults were not previously mapped).

In summary, we agree with the conclusions of the Fault Report that the Constellation Station location appears to be more favorable than the Santa Monica Boulevard location based on the exploration data that is interpreted to show no faulting in the station area. However, in our opinion, additional explorations at Constellation Station are warranted based on the questions we discussed above regarding the Fault Report studies, coupled with the directive for these studies. The directive on Page 1 of the Fault Report states that "*…Metro staff was directed to fully investigate the nature and location of faults in the Century City area and their potential impact on the proposed station locations*." Based on this directive, we do not believe the WBHL and the Constellation Station were fully investigated particularly when compared with the studies performed at the Santa Monica Station.

6.0 RELOCATION OF SANTA MONICA STATION

6.1 General

We reviewed the potential for relocating the Santa Monica Station along Santa Monica Boulevard to avoid the SMFZ and WBHL. The next section highlights possible relocation of the Santa Monica Station in the Fault and Tunnel Reports followed by our review and opinion.

6.2 Century City Reports

6.2.1 Fault Report

The following pages of the Fault Report discuss relocation of the Santa Monica Station:

- Pages 1 through 5
- Page 8
- Page 10 Pages 12 through 14
- Page 28

6.2.2 Tunnel Report

The focus of the Tunnel Report is on the Constellation Boulevard alignment. Therefore, this report does not comment on relocating the Santa Monica Station.

6.3 Technical Review

6.3.1 General

We generally agree that placing a station along the Santa Monica Boulevard alignment will be more risky than at Constellation Boulevard due to increasing likelihood of faults to the north, along the SMFZ. Based on the results of the fault trenches recently completed at the BHHS, it is our opinion that the WBHL may not be considered active, contrary to what was asserted in the Fault Report. Specifically, we recommend trenching be performed within the WBHL zone in the median of Santa Monica Boulevard near Moreno Drive to confirm the findings of the BHHS studies. If it is confirmed that the SMFZ and WBHL are not present, or determined to be inactive, if present, then a station could be considered feasible at this location from a fault hazards perspective.

From our review of the Fault Report and from our knowledge of regional and site-specific tectonics, we recognize that many more faults may underlie the upper plate (north side) of the SMFZ. The most recent and highest rate of slip is topographically expressed by a generally east-west, pre-urbanization en-echelon series of escarpments along Santa Monica Blvd. and within the Los Angeles Country Club. South of this alignment, fault presence and relative activity is likely less, but additional studies are warranted. The SMFZ is more active towards the north side with more recent topographic expression, but less active towards the south with less topographic expression, though fault traces are identified to the south.

There are three possible adjustments or modifications to the proposed Santa Monica Station location that should be assessed: 1) moving the station to the “gap” between the SMFZ and WBHL, or eastward over the WBHL if it is demonstrated to be inactive, 2) moving the station to the southern margin of Santa Monica Boulevard, and 3) placing this section of the alignment at grade.

6.3.2 Station in the “Gap”

As shown in Figure 2, traces of the SMFZ are interpreted to curve northeast near the intersection with the WBHL, leaving a gap between the two faults along Santa Monica Boulevard. However, the apparent curves of the fault traces may be due to topographic variations and could be misleading. Also, fault rupture is not the only potential issue associated with displacement of the SMFZ. Ground deformation due to complex fault movements could increase stresses on the buried walls at the station. However, based on the recent BHHS trench investigations, the WBHL may not be present or active in this area. Consequently additional studies may be warranted to assess if moving the station into this apparent “gap”, or even further to the east, is a viable alternative.

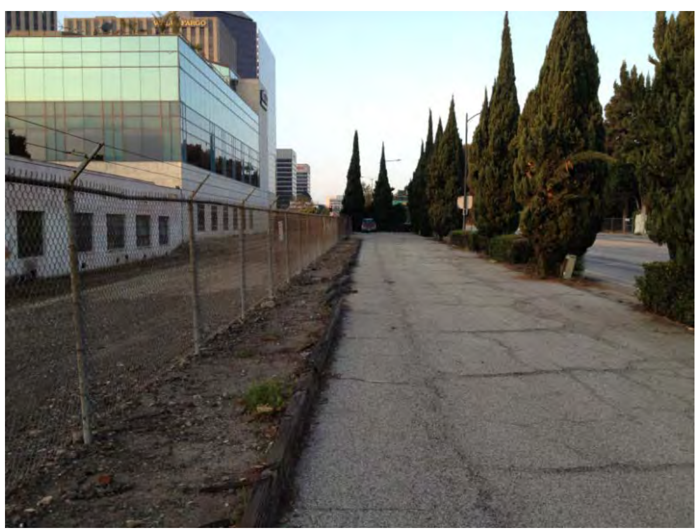
It is uncertain if the main trace of the SMFZ, or a fault splay, lies within the gap, even though maps presented in the Fault Report indicate otherwise. The Fault Report notes that the portion of the SMFZ that bends away from Santa Monica Boulevard is within an area that may have been modified by stream activity. The erosion could have modified the topographic expression of the SMFZ to make it appear that the fault curves to the north, when in actuality it could follow Santa Monica Boulevard in a more straight-line fashion until it intersects with the WBHL. As a result, there is a reasonable chance that the SMFZ crosses the gap.

Moving the station further northeast into the WBHL could be a feasible option based on our interpretation of the Fault Report data and trenching at BHHS. The Fault Report concludes that the WBHL is structurally connected to the active Newport-Inglewood Fault zone to the southeast, and therefore is also considered active. However, the recent trench mapping at the BHHS contradicts this conclusion. Also, the Fault Report geologic sections showing displacements of geologic units by the WBHL (Plate 4 of Fault Report) terminate in the Older Alluvium Sand Deposits (geologic symbol: Qfo). The unit is identified as late Pleistocene (Table 1 of Fault Report), which makes it too old to be an indicator of Holocene fault activity. This is an important issue in deciding if a fault is “active”, which relies on movement within the recent Holocene Epoch (the last 10,000 to 12,000 years).

The BHHS excavated several fault trenches on campus which are detailed in Dr. Shlemon’s report (Appendix B). Based on the observations presented in Dr. Shlemon’s report and our discussions with him, the probability of the WBHL being active at the BHHS study area is low (see Section 8.0 below for discussion on defining faults as “active”). Therefore, we recommend that considerations should be given to excavating a confirming trench along Santa Monica Blvd, across the WBHL. If similar conclusions are derived regarding the absence of active faults along the WBHL, or that the ages of any such offset precede the state’s cutoff date for active faulting, then the potentially active fault zones shown in Figure 2 from the Fault Report that pass through the BHHS study area should be deleted.

With tentative reclassification of the WBHL fault splays and zone through the BHHS study area as "in-active", the extrapolated WBHL features crossing Santa Monica Boulevard to the northwest of the BHHS campus should be further explored to confirm absence or inactivity of fault splays at this location. While the faulting observed at the BHHS trenches is now considered inactive, this does not negate activity in the area of Santa Monica Boulevard due to the presence of the SMFZ. The possible intersection of the likely active SMFZ at Santa Monica Boulevard complicates WHBL activity at this location. Furthermore, fault traces east of the Beverly Hills city limits could be present and/or active as they are further east of the BHHS campus (and thus unexplored by the BHHS fault trenches).

As discussed above, we recommend that additional studies be considered to determine fault activity of the WBHL in the vicinity of Santa Monica Boulevard. An east-west fault trench could be excavated in the old railroad right-of-way on the south side of "Big" Santa Monica Boulevard as shown in Figure 2 and Photograph 1 below, to confirm the WBHL findings at the BHHS. A north-south fault trench perpendicular to the trace of the SMFZ should also be considered at the west end of the proposed station in this area to confirm the termination of the SMFZ at the WBHL. Depending on the results of these additional studies, locating the station within the currently denoted WBHL may be feasible.



Photograph 1 – South Side of "Big" Santa Monica Boulevard looking southwest along the old railroad right-of-way.

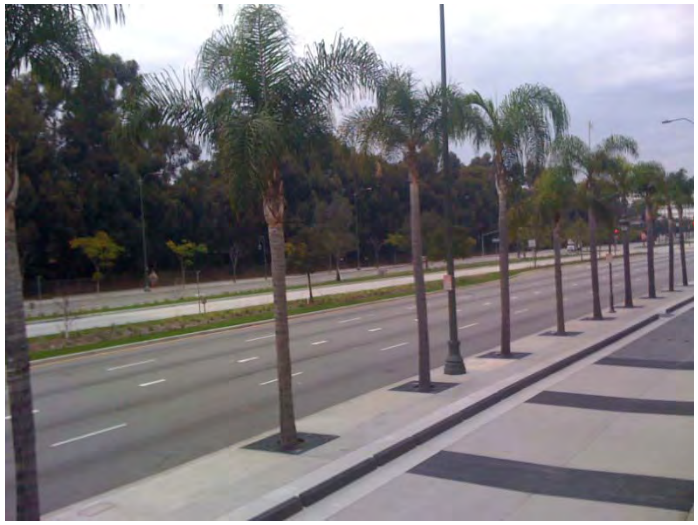
6.3.3 Santa Monica Boulevard Right-of-Way (ROW)

One option could be to locate the station on the south edge of Santa Monica Boulevard rather than at the current center of the ROW. Santa Monica Boulevard is approximately 300 feet wide from the edge of the golf course to the buildings of Century City. However, while fault activity could be less along the south side of Santa Monica Boulevard, the Fault Report (p. 12) indicates that the SMFZ may be up to 300 feet wide.

We also suggest consideration be given to placing the Santa Monica Station at grade. While the WSE is proposed underground throughout the alignment using an electrified third rail, an above-grade, third rail "subway" has precedence on several transit systems both domestic and international. Examples include Long Island (Photograph 2 below), New York, Chicago, Tokyo, and Berlin transit systems.

Photograph 2 – Long Island Railroad Third Rail

An at-grade platform for the Santa Monica Station would still be subject to the potential of fault rupture; however, it is our opinion that the threat to life safety would be significantly less than a below grade station. Such a station location would likely require reassessment by Metro of federal and state regulations regarding above ground transit station locations relative to active faults. An at-grade alignment could run along the existing busway along Santa Monica Boulevard as shown in Photograph 3 below.



Photograph 3 – Santa Monica Boulevard Busway looking northeast

An at-grade station would require approaches of the track out of the tunnels that could be constructed using cut-and-cover excavations. Traffic access along lanes of Santa Monica Boulevard would require modifications, including the possibility of at-grade crossings such as shown in Photograph 4 below. However, these challenges should be weighed against cost savings from elimination of a below grade station and potential impacts to project schedule and budget from potential conflicts with the BHHS and other parties along the proposed Constellation Boulevard alignment.

Photograph 4 – Third Rail Grade Crossing in Tokyo

7.0 TUNNELING BENEATH BHHS

7.1 General

We reviewed the Tunnel Report regarding the safety of constructing the Constellation Boulevard alignment below the BHHS and other occupied structures. The intent of our review was to comment on assertions made in the Tunnel Report regarding the practicality and safety of tunneling and present our opinions regarding stated and unstated tunneling risks based on our experience on several similar tunneling projects. The next section highlights tunneling studies in the Fault and Tunnel Reports followed by our review and opinion.

7.2 Century City Reports

7.2.1 Fault Report

The focus of the Fault Report is on the fault studies for Santa Monica and Constellation Stations while the safety of tunneling for the Constellation Boulevard alignment is described in the Tunnel Report. Therefore, this report does not comment on safety of tunneling below structures such as BHHS, and consequently is not relevant to this section of our report.

7.2.2 Tunnel Report

The following pages of the Tunnel Report discuss risks associated with tunneling below the BHHS campus:

- Pages ES-1 through ES-3
- Pages 2-7 and 2-8
- Page 3-4
- Page 4-1
- Pages 4-4 and 4-5
- Page 5-4
- Page 8-1
- Page 8-4
- Page 8-6
- Page 8-10

7.3 Technical Review

7.3.1 General

The Tunnel Report provides a generalized review of relevant case history data and an optimistic perspective on likely behavior and approaches to construction of the WSE in the

Beverly Hills and Century City areas. Nevertheless, the conclusions that construction of tunnels, using state-of-the-practice closed-face Tunnel Boring Machines (TBMs) can result in negligible to minor settlements, and little to no impacts from gas, groundwater, and soil variability is a generally realistic assessment. The details of the specifications developed by Metro, the procurement of the appropriate TBMs, and construction implemented by an experienced contractor will be essential to complete a quality tunnel project with little or no impacts on overlying and adjacent buildings.

The information provided in the Tunnel Report does not provide detailed information on the correct operation of a closed-face TBM to preclude or minimize surface settlement. Typically, TBM operational requirements are provided in the contract documents (plans and specifications) that guide the contractor's selection and design of the TBM, his operation of the TBM including allowable minimum face pressure, means of monitoring muck weights or volumes, maximum allowable settlements, and settlement monitoring instrumentation and surveying. Ground improvement techniques and settlement compensation techniques that might be used to minimize surface settlements and compensate for excessive ground losses (if they occur) should also be included in the Contract Documents.

7.3.2 Ground Settlement

We agree that closed-face TBMs provide the best means, methods and opportunities to achieve negligible ground losses and small to unmeasurable settlements (p. 4-4). Overall, our experience with closed-face TBMs has been good, although there has been much more experience with earth pressure balance machines (EPBM) than slurry-pressure balance machines (SPBM) in the United States. Ground losses of 0.5% or less and resulting settlements of fractions of an inch are typical of most closed-faced TBM projects. However, large ground losses and surface settlements have occurred on a small percentage of international projects, and over a small percentage of the length of these projects. Isolated large ground losses have more frequently occurred where the TBM exits and enters the stations or shafts, where mixed-face conditions occur (e.g., flowing cohesionless soils in contact with cohesive and hard soils or rock), or where face pressures have not been maintained equal to or greater than the ambient soil and groundwater pressures. Ground losses can occur due to excessive intake of soil into the cutterhead, an enclosed excavation cross section due to poor TBM alignment control (particularly on curves), inadequate grout filling behind the gasketed concrete segmental lining, and lowered face pressure during extended maintenance.

These settlement and ground control issues should be identified during the normal risk assessment process undertaken during preliminary and final design phases and mitigated through the specification of appropriate construction methods and safeguards in the Construction Documents and with the selection of an experienced contractor, who brings experienced staff to the project, a TBM with characteristics that promote a small overcut, continuous monitoring and real-time reporting and review of critical machine parameters (e.g., face pressures, conditioner usage, muck volumes or weights, and cutter tool wear), constant review of TBM operational data, frequent monitoring of deep ground movements around the advancing TBM and surface settlements, and daily collaboration between the construction management staff and contractor.

The Tunnel Report does not discuss ground improvement methods in any detail, but ground improvement techniques, appropriate to various soil conditions, are typically specified for most major tunneling projects to stabilize soils and compensate for tunneling induced ground losses before they progress up to ground surface to impact utilities and structures. Ground improvement methods such as jet grouting, soil/cement mixing, permeation grouting, compaction or compensation grouting, dewatering, and freezing, are commonly used on many major tunnel projects and all provide opportunities for stabilizing the soils and reducing ground losses, particularly beneath critical structures, at launching and retrieval pits, and at cross passages. Remedial grouting measures, such as compaction grouting or compensation grouting, and fracture grouting have been used successfully to compensate for known excessive ground losses and prevent adverse surface settlements in real-time as the TBM moves forward through the ground. All of the preventative and remedial measures should be handled in the specifications, and where possible, with incentives to the contractor to optimize the quality of his work product on this project.

From Metro's experiences on the Gold Line project (or MGLEE), where closed-face TBMs were very successful in minimizing settlements to about 0.3 inches (Robinson and Brogard, 2007) , there is a good discussion of "a comprehensive program of instrumentation and surveying conducted to monitor ground movement above the MGLEE tunnels…"(p. 4-4). Similar instrument and survey systems should be included throughout the WSE project, as well as settlement points on buried utilities and buildings, and tilt meters and crack gages on building components. Borehole extensometers should be installed to provide useful information on the location and source of ground losses immediately above the advancing TBM. The collected and plotted deformation data should be shared with BH staff and building owners.

The 0.5 percent ground loss that is noted in the Tunnel Report is a reasonable number particularly given that the MGLEE tunnels resulted in about 0.3 percent ground loss, and has been used on many recent projects in reasonably competent ground such as is present along the alignment (p. 4-5) as a starting point for developing settlement predictions. Actual surface settlements measured over most of the lengths of tunnel alignments constructed by closed-face TBMs in the United States in the last 15 years are generally equivalent less than 0.5 percent ground loss. Consequently, measured settlements along tunnel or project centerline are generally less than 1 inch, and are often less than 0.25 inch, which is about the level of accuracy of most standard surface surveying. Larger ground losses and resulting settlements typically relate to inappropriate operation of the closed-face TBMs, and can be detected with the instrument monitoring systems and corrected at the insistence of the owner, construction manager and contractor.

7.3.3 Noise and Vibration

Construction related vibrations are likely to be transitory, since the tunnel heading will be advancing at the average rate of about 50 to 100 feet per day beneath and beyond any one single property. Perceptible tunnel vibrations due to subway trains are more likely to occur in curves, at cross-overs or switches, and where track is misaligned due to poor construction and/or poor maintenance. However, a Metro test programs had indicated no adverse noise or vibration due to transit tunnel operations along both the Red and Gold Lines.

The Tunnel Report notes that noise and vibration tests have already been performed on the BHHS and indicate that construction and train operation noises and vibration will be below FTA limits. Measurements would be made under BHHS during construction (p. ES-2). However, there is no indication that these would be used as “not to exceed” baselines for construction. There should also be comments, and eventually specification requirements on using sound-damping noise walls, low noise fans, and minimizing trucks entering and leaving staging areas during hours that would disrupt local residents, businesses, and public facilities

Underground construction typically mutes most of the construction related noise and vibration. However, surface activities such as ventilation fans, cranes, muck removal and loading into dump trucks, and bringing construction materials on site could result in noise and vibration impacts to nearby and adjacent homes and businesses. Noise walls, 12 to 20 feet high, erected around the construction site have been effective on other recent tunnel projects in significantly reducing impacts such as noise and dust to neighbors.

7.3.4 Gassy Ground

For gassy ground, the Tunnel Report notes that "volume of gas released from the soil during TBM tunneling is confined to the excavated material chamber because of the closed-face and gas-tight lining that is installed immediately behind the TBM" (p. 5-4). This would be the case if the contractor is required to utilize a SPBM, where the excavated muck and bentonite slurry is pumped to the ground surface for treatment. However, this would only be partially true if the contractor uses an EPBM, in which the excavated soil is brought out of the "chamber" or cutter-head via a cased screw auger and then dumped onto a conveyor belt for conveyance via any of several means (muck trains, extended conveyor or slurry pipeline) to the portal. When the excavated soil is expelled from the screw auger onto the conveyor belt, entrained gas may bleed off into the air. However, the volume of gas will be limited to that which is only entrained in the excavated soil and will be limited by the earth pressure maintained on the face. On many tunnel projects, high ventilation rates have been used effectively to dilute and expel this gas from the tunnel. If the muck is fluidized and carried out by slurry line, then the gas bleeds off from the slurry at the ground surface. There are also options for neutralizing hydrogen sulfide in the ground, or in transit through the tunneling machine, by injecting chemicals such as bleach, hydrogen peroxide and permanganate. We understand that on the Gold Line tunnel construction, a SPBM was required where methane and hydrogen sulfide gas concentrations were anticipated to be high by the designers.

The recent Metro Gold line specifications required the installation of double-gasketed segmental liners coupled with high ventilation rates for either an EPBM or SPBM along with continuous monitoring for gas concentrations. Similar specification requirements should be applied to the WSE to provide sufficient redundancy to prevent methane and hydrogen sulfide buildup in the tunnel during construction and operations. Most longer than 15-foot diameter TBM-excavated soil tunnels in the U.S. are supported with a bolted precast concrete segments with a gasket around each segment that mates with adjacent segments. Metro has implemented the use of double-gasketed, bolted concrete segments for tunnel lining in order to greatly reduce the potential for gas and groundwater entering the tunnels. This double-gasketed lining system was extensively tested for and is unique to Los Angeles tunnel projects. In addition, the double-gasketed, bolted, precast segmental liner will be fully encased in a 4- to 6-inch thick annulus of grout that is pressure injected around the lining as it is installed at the rear of the advancing TBM. The double gaskets and grouted annulus will virtually eliminate the potential for gas to enter the tunnel through the lining. Federal and state required active ventilation implemented during construction and operation of the tunnels will further dilute gas that enters the tunnel.

Lastly, the contractor is required, in potentially-gassy and gassy ground to install gas detection monitoring systems to continuously monitor the tunnel atmosphere for gas. On most tunneling projects the tunnel foreman or safety engineer also carries a portable gas detector to check the tunnel atmosphere for gas levels. This multiple redundancy of sealing, ventilation, and monitoring has precluded gas from being an issue in most tunnels during and following soil tunnel construction with precast concrete gasketed segmental linings during the last 30 to 40 years.

Based on review of the Tunnel Report, only boring C-119B involved gas testing at three elevations at the Santa Monica Station; whereas, six borings were tested for gas concentration at multiple elevations at the Constellation Station. Additional borings should be drilled and tested for gas concentrations, along with groundwater levels along the final tunnel alignment.

7.3.5 Groundwater

The Tunnel Report notes 500-foot spacing for the borings (p. 2-8). In our opinion, this spacing is too wide with regards to the complexity of the faulted geology and variable groundwater levels in the West Beverly Hills/Century City area. The borings do not appear to have been drilled through the faults, which are shown as steeply inclined to vertical features. Ideally borings, possibly angled, should be drilled through the faults to look for clay gouge, soil consistency, ground water levels changes, and other properties that could impact the tunnel construction. The presence of high groundwater levels to the north of the SMFZ and to the east of the WBHL, and substantially lower groundwater levels to the south and west of these features suggests the presence of clay gouge that is impeding groundwater flows.

Subsurface conditions at BHHS were explored with 14 borings; however, only four are deep enough to go below the tunnel horizon. Only three borings have monitoring wells installed, and water levels were measured in three of the borings during drilling. The three borings with monitoring wells show water levels 10 to 40 feet above the proposed tunnel crown, however, without information on screen locations and sealing methods, it is not possible to determine from which soil horizon(s) the water is originating. From our review, it is unclear if a perched water table is present for some of the upper soil units, or possibly a confined artesian condition for some of the lower soil units. Also, it is unclear how the groundwater levels change across the various postulated faults as water levels were measured in only three borings in the three fault strand bounded blocks.

The fault block furthest to the west apparently has no groundwater measurements. A complete discussion on a postulated groundwater barrier to the northwest of the Constellation Station site is lacking (p. 2-7). We recommend that additional borings with wells and piezometers be installed and a map of contoured groundwater levels be developed to help identify the location, orientation, and cause of the "groundwater barrier." Identification of this feature will be important for both the tunnels and stations.

7.3.6 Existing and Future Structures

Beneath the BHHS, the top or crown of the proposed tunnels are 50 to 70 feet below ground surface. This should provide adequate depth for future development of parking garage/basements down about three to four levels or 30 to 50 feet deep. Normally, construction is limited to no closer than one tunnel diameter above the crown or to the sides of a tunnel. However, closer excavation may be permitted by Metro with adequate design evaluation, lateral support, and protection of the transit tunnels.

The Constellation Boulevard alignment passes below significantly more house, commercial buildings and other structures (including the BHHS) than the Santa Monica Boulevard alignment. The number of structure directly above the tunnels increases the challenges of adequate exploration as well as the need for more careful construction methods and additional monitoring of settlements and ground behavior. Agreements with Metro on design and construction limitations and requirements for any new structures built over the tunnels would be needed from at-grade property owners above the tunnels. These agreements would likely include a maximum basement depth, any special tall building support constraints, such as proximity of piers or pile tips, and basements adjacent to the tunnels.

8.0 PRECEDENCE FOR STRUCTURES ON FAULT TRACES

8.1 General

We reviewed the Fault and Tunnel Reports for comments on locating transit structures on or adjacent to fault traces. The intent of our review was to evaluate case histories of transit structures placed along fault zones, and structures that were impacted by fault displacements. The next section highlights similar structures along fault zones in the Fault and Tunnel Reports followed by our review and opinion.

8.2 Century City Reports

8.2.1 Fault Report

The following pages of the Fault Report discuss structures placed on or near fault traces:

- Page 16
- Page 30

8.2.2 Tunnel Report

The following pages of the Tunnel Report discuss structures placed on or near fault traces:

- Page ES-3
- Pages 7-1 and 7-2

8.3 Technical Review

8.3.1 Overview of the Alquist-Priolo Act

This section provides additional history of and use of the AP Act than is discussed in the Fault Report (p. 16). The authors of the Fault Report note that the assumed likely inclusion of the SMFZ and WBHL into the AP Act is a sufficient reason enough to select the Constellation Boulevard alignment. However, if the results of the recent trenching on the BHHS campus are to be believed, then the WBHL should not be classified as "active".

The original name of the AP Act was the Alquist-Priolo Geologic Hazards Zones Act established on December 22, 1972. The State Geologist delineated earthquake fault zones for active traces of the San Andreas, Calaveras, Hayward, and San Jacinto faults. Preliminary review of 175 quadrangle maps occurred between 1973 and 1974. Official maps were issued on July 1, 1974, and Earthquake Fault Zones became effective at that time. The cities and counties were required to implement programs to regulate development within mapped AP Act zones.

Faults were mapped as "active" if they had surface displacement in the last 11,000 years (Holocene). Faults were mapped as "potentially active" if they showed evidence of surface displacement during Quaternary time (last 1.6 million years). "Potentially active" faults are now referred to as "recently active" faults.

The AP Act was renamed the Alquist-Priolo Special Studies Zones Act on May 4, 1975. On January 1, 1976, 81 maps of new zones and five maps of revised zones were implemented.

Beginning in 1977, the State Geologist decided fault zones must meet the criteria of "sufficiently active and well defined." However, the term "potentially active" continued to be used as a descriptive term on map explanations until 1988.

Since 1977, an earthquake fault zone boundary (EFZ) is defined to extend 500 feet to either side of a "major" active fault and about 200 to 300 feet to either side of a well-defined, minor fault. Exceptions exist where faults are locally complex or where faults are not vertical. Within these zones owners of new or rebuilt structures may be required to complete subsurface investigation to delineate faulting on the project boundaries. EFZ maps are typically issued every year or two to delineate additional and revised zones.

The AP Act was again renamed the Alquist-Priolo Earthquake Fault Zoning Act on January 1, 1994. By August 16, 2007, a cumulative total of 547 official maps of active fault locations had been issued. Of these, 148 maps have been revised since their initial issue and four maps have been withdrawn. Additional faults will be zoned as "active" in the future and some will be revised.

Sufficiently Active-This is defined as evidence of Holocene surface displacement along one or more of a fault's segments or branches. Holocene surface displacement may be observable or inferred; it need not be present everywhere along a fault to qualify that fault for zoning. Note that the amount of fault displacement is not specified.

Well-Defined-This is defined as a fault trace that is clearly detectable by a trained geologist as a physical feature at or just below the ground surface. The fault may be identified by direct observation or by indirect methods. The critical consideration is that the fault (or some part of it) can be located in the field with sufficient precision and confidence as to indicate that the required site-specific investigations would meet with some success. Determining if a fault is sufficiently active and well defined is a matter of judgment. Certain faults considered to be active at depth are so poorly defined at the surface that zoning is impractical.

The AP Act is applicable to any project defined under Section 2621.6 of the AP Act. This includes:

- Any subdivision of land which is subject to the Subdivision Map Act, and which contemplates the eventual construction of structures for human occupancy.
- A structure for human occupancy is any structure used or intended for supporting or sheltering any use or occupancy, which is expected to have a human occupancy rate of more than 2,000 person-hours per year.

- Exemptions for structures with human occupancy include either of the following:
    - A single-family wood-frame or steel-frame dwelling to be build on parcels of land for which geologic reports have been approved
    - A single-family wood-frame or steel-frame dwelling not exceeding two stories when that dwelling is not part of a development of four or more dwellings.

In practice, the minimum setback distance from an active fault trace is typically 50 feet. With respect to building set back, the act simply states that: "No structure for human occupancy shall be permitted to be placed across the trace of an active fault. Furthermore, the area within 50 feet of such active faults shall be presumed to be underlain by active branches of that fault unless proven otherwise by an appropriate geologic investigation and report." (CGS, 2007).

All sections of the AP Act apply to proposed human occupancy structures. When a property pre-dating the AP Act is located within an EFZ, the transferor or agent acting for the transferor must disclose to the prospective transferee the fact that the property is located within a delineated EFZ. The disclosure must include proof and must be disclosed by an appropriate agent as defined by this section.

8.3.2 Stations and Tunnels Subjected to Fault Displacements

We reviewed case histories of fault displacement for several types of structures, including tunnels, subways, stations, buildings, and underground pipelines. We did not find references to stations knowingly placed across an active fault trace. The following discussion highlights tunnels and subways that had been directly subjected to earthquake shaking and fault displacements.

A study of tunnels affected by strong earthquakes revealed multiple cases of tunnels damaged by seismic fault offsets, including the Bolu twin tunnels (Turkey), Wrights Railway Tunnel (California), Kern County Tunnel (California), Balboa Inlet Tunnel (California), and several tunnels in Japan. Research indicates that tunnels may be vulnerable tectonic deformations. Very little or no evidence exists indicating that relatively recent concrete lined tunnels have experienced significant damage or collapse due to seismically induced shaking. There is some evidence that some underground stations have experienced minor damage, particularly at connections with tunnels, and in some of the associated utilities.

The Bolu Tunnels are 50 feet wide and 2 miles long and cross the North Anatolian Fault Zone (strike-slip), along a 500-1000 foot wide shear zone. After a 7.2 Moment Magnitude earthquake in 1999, deformation up to 30 inches was observed in the tunnel and a section of the tunnel, temporarily under construction, collapsed (Kontogianni, V. I. and Stiros, S. C., 2003).

In 1906, the Southern Pacific Railroad's Wrights Tunnel was damaged by a 7.7 Moment Magnitude earthquake occurring in the San Andreas Fault Zone (strike-slip). This 1.2 mile tunnel experienced offsets of between 5 to 6 feet. The tunnel, above which two parallel seismic surface ruptures were observed, collapsed along a 300 foot long section crossing the fault zone (Kontogianni, V. I. and Stiros, S. C., 2003). In this location, the tunnel was timber-supported and considerable crushing of timbers and upward heave of rails occurred (Brown et al., 1981).

The Kern County Tunnel, crossing the White Wolf Fault (reverse strike-slip), was damaged during a 7.5 Moment Magnitude earthquake in 1952. The tunnel, lined with timber and about 1 to 2 feet of reinforced concrete, was located in an area where fault displacements occurred during the earthquake. After the earthquake, both compressive and lateral displacements were detected along the ground surface. The liner was offset just over 4 feet (Kontogianni, V. I. and Stiros, S. C., 2003).

The partially completed Balboa Inlet Tunnel was affected by the San Fernando Magnitude 6.6 earthquake in 1971. The tunnel crossed the Santa Susana Thrust Fault, along which displacement occurred about 1,000 feet from the portal. The reinforced concrete liner was cracked and there was spalling along a 300-foot section at the fault crossing. On each side of the fault, there was also longitudinal cracking in the tunnel liner for about 1,000 feet (Brown et al., 1981).

The San Pablo Tunnel, used to transport water through the Berkley Hills from the San Pablo reservoir, was constructed between 1917 and 1920 and is about 2.5 miles long with a cross-section about 8 feet wide. The tunnel crosses two major fault zones, the Hayward Fault, and the Wildcat Fault, as well as several unnamed faults. In 1969, control points were set up for alignment checks after circumferential and longitudinal cracks were observed. It was not reported whether or not this occurred because of fault rupture or creep (Brown et al., 1981).

During the 7.6 Magnitude Chi-Chi Earthquake in 1999, a portal for water intake tunnels was ruptured for a distance of 30 feet as a result of thrust faulting in Taiwan (Aydan, O., 2003).

Japan has several instances where fault rupture crossed tunnels. The Tanna Railway tunnel on the main line between Tokyo and Kobe was under construction in 1930 when it was damaged by an earthquake with a magnitude estimated at 7.1. Tunneling conditions were very wet and required drainage drifts. Near one of the drainage drifts, a shear zone displaced about 9 feet left lateral and 2 feet vertical. This completely closed the drainage drift. At the surface, about 500 feet above the tunnel invert, fault displacement was less and measured 3 feet left lateral and 1.5 feet vertical (Brown et al., 1981).

The Inatori Tunnel in Japan experienced surface rupture along the Tanna Fault during the 1977 Izu earthquake. With a surface wave magnitude of 6.8, the earthquake caused damage to the 65-foot long railway tunnel with a relative displacement of 40 inches. The railway tunnel crossed the fault at right angles, with a cover of 300 feet. This movement caused extension of the tunnel (Brown et al., 1981).

Similar damages occurred due to the motions of the Rokko, Egeyama, and Koyo faults to the tunnels of Shinkansen and subway lines through the Rokko Mountains. The underground rapid transit subway line in Kobe experienced collapse of 3 of the 10 stations as a result of strong ground shaking during movement of the nearby Egeyama fault (strike-slip). In particular, the Daikai station collapsed after it was subject to torsional failure due to permanent ground displacement from nearby fault displacement (Aydan, O., 2003).

In addition, Shannon & Wilson had staff in San Francisco during and following the 1989 Loma Prieta Earthquake who observed several railroad tunnels immediately after the earthquake and observed no damage other than minor spalling of thin concrete, grout and gunite patches in brick- and concrete-lined tunnel crowns.

We also reviewed highway tunnels and transit tunnels in the Seattle area immediately after the 2001 Nisqually Earthquake in western Washington. None of the four tunnels that were reviewed showed any indications of shaking related damage; however, minor damage was observed in one of the cut and cover stations at the intersections with the running tunnels.

The Tunnel Report indicates that a special tunnel liner design may be required, such as a strong but flexible lining to withstand several feet of movement without collapse (p. 7-2 note above). The use of such a specialized liner would only be required where displacements might occur across an “active” fault, which at this point may only apply to the SMFZ. This could require a localized larger diameter liner, which means that the larger diameter TBM would be needed. The larger diameter tunnel might be on the order of 23 to 26 feet in diameter to accommodate fault offset. Alternately, a flexible lining and a lining backed with crushable grout could be used, but this could also require a larger diameter TBM. The larger diameter TBM might be accommodated with shafts to either side of the SMFZ. It appears that the design team and Metro have not yet settled on a design for the fault crossing.

9.0 LIMITATIONS

This report was prepared for the exclusive use of the City of Beverly Hills for specific application to this project. This report is a review of information provided in the Century City Reports.

The analyses, conclusions, and recommendations contained in this report are based on information provided in the Metro Reports and our experience in the project vicinity. We assume that the exploratory borings provided in the Metro Reports are representative of the subsurface conditions throughout the project alignment (i.e., the subsurface conditions everywhere are not significantly different from those disclosed by the explorations).

Within the limitations of the scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practices in this area at the time this report was prepared. We make no other warranty, either express or implied. These conclusions and recommendations were based on our understanding of the project as described in this report and the site conditions as interpreted from the Metro Reports.

Shannon & Wilson, Inc. has prepared the document, "Important Information About Your Geotechnical/Environmental Report," in Appendix C to assist you and others in understanding the use and limitations of this report.

SHANNON & WILSON, INC.

R. Travis Deane, P.E., G.E.
Senior Associate

Dean G. Francuch, C.E.G., P.G.
Associate

PHZ:DGF:RTD:RAR/rtd

10.0 REFERENCES

Aydan, O, 2003, Proceedings of the Eighth U.S.-Japan Workshop on Earthquake Resistant Design of Lifeline Facilities and Countermeasures against Liquefaction: held at the Edmont Hotel, Tokyo, Japan, December 16-18, 2002, p 227-237.

Brown, I. R.; Brekke, T. L.; and Korbin, G. E., 1981, Behavior of the Bay Area Rapid Transit tunnels through the Hayward fault: Washington, D. C., U. S. Department of Transportation, Report no. UMTA-CA-06-0120-81-1, 208 p.

California Geological Survey, 2007, Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps, Special Publication 42, Interim Revision.

Kontogianni, V. A. and Stiros, S. C., 2003, Earthquakes and Seismic Faulting: Effects on Tunnels: Turkish Journal of Earth Sciences, v. 12, p 153-156.

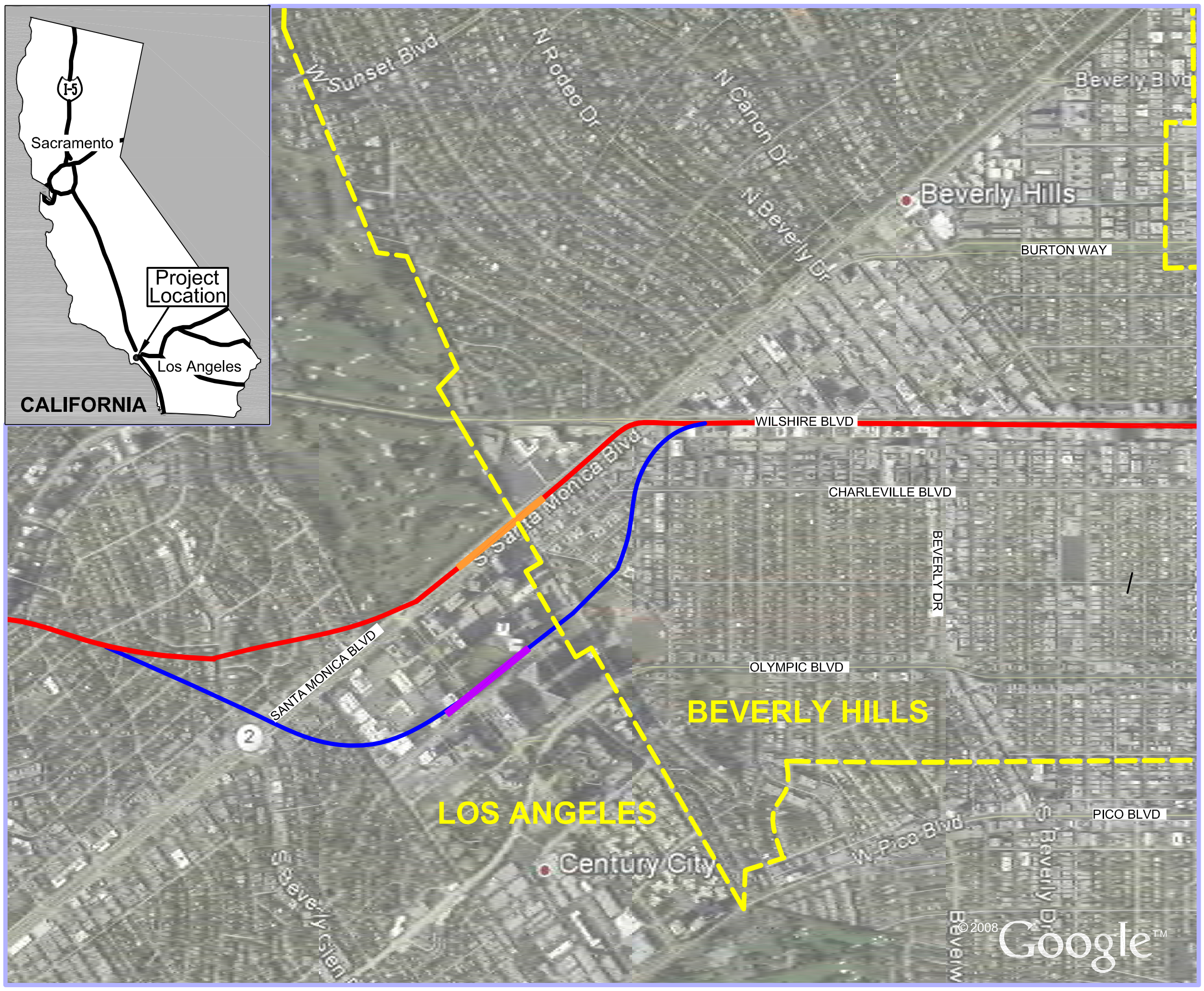
Parson Brinckerhoff, 2011, Century City Area Tunneling Safety Report, Westside Subway, Extension Project, report prepared by Parson Brinckerhoff, Los Angeles, CA, Contract No. PS-4350-2000, for Metro, October 14, 2011.

Parson Brinckerhoff, 2011, Century City Area Fault Investigation Report, Westside Subway, Extension Project, report prepared by Parson Brinckerhoff, Los Angeles, CA, Contract No. PS-4350-2000, for Metro, October 14, 2011.

Robinson, B. and Bragard, C., 2007, Los Angeles Metro gold Line Eastside Extension-Tunnel Construction Case History, Proceedings, Rapid Excavation and Tunneling Conference, Toronto, Canada, p. 472 – 494.

Shannon & Wilson, 2010, Geotechnical Engineering Report, Westside Subway Extension, Review of Draft Environmental Impact Report: report prepared by Shannon & Wilson, Inc., Glendale, CA, Project No. 51-1-10024-001, for the City of Beverly Hills, October 13, 2010.

Shannon & Wilson, 2010, Geotechnical Engineering Comments Letter, Westside Subway Extension, Review of Draft Environmental Impact Report: letter prepared by Shannon & Wilson, Inc., Glendale, CA., Project No. 51-1-10024-001, for the City of Beverly Hills, October 14, 2010.



LEGEND

- Proposed Santa Monica Alignment
- Proposed Constellation Alignment
- Proposed Santa Monica Station
- Proposed Constellation Station
- City Boundary

0 1000 2000 4000

SCALE: 1"=2000'

NOTE

Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth ™ Mapping Service.

Westside Subway Extension Review
Beverly Hills, California

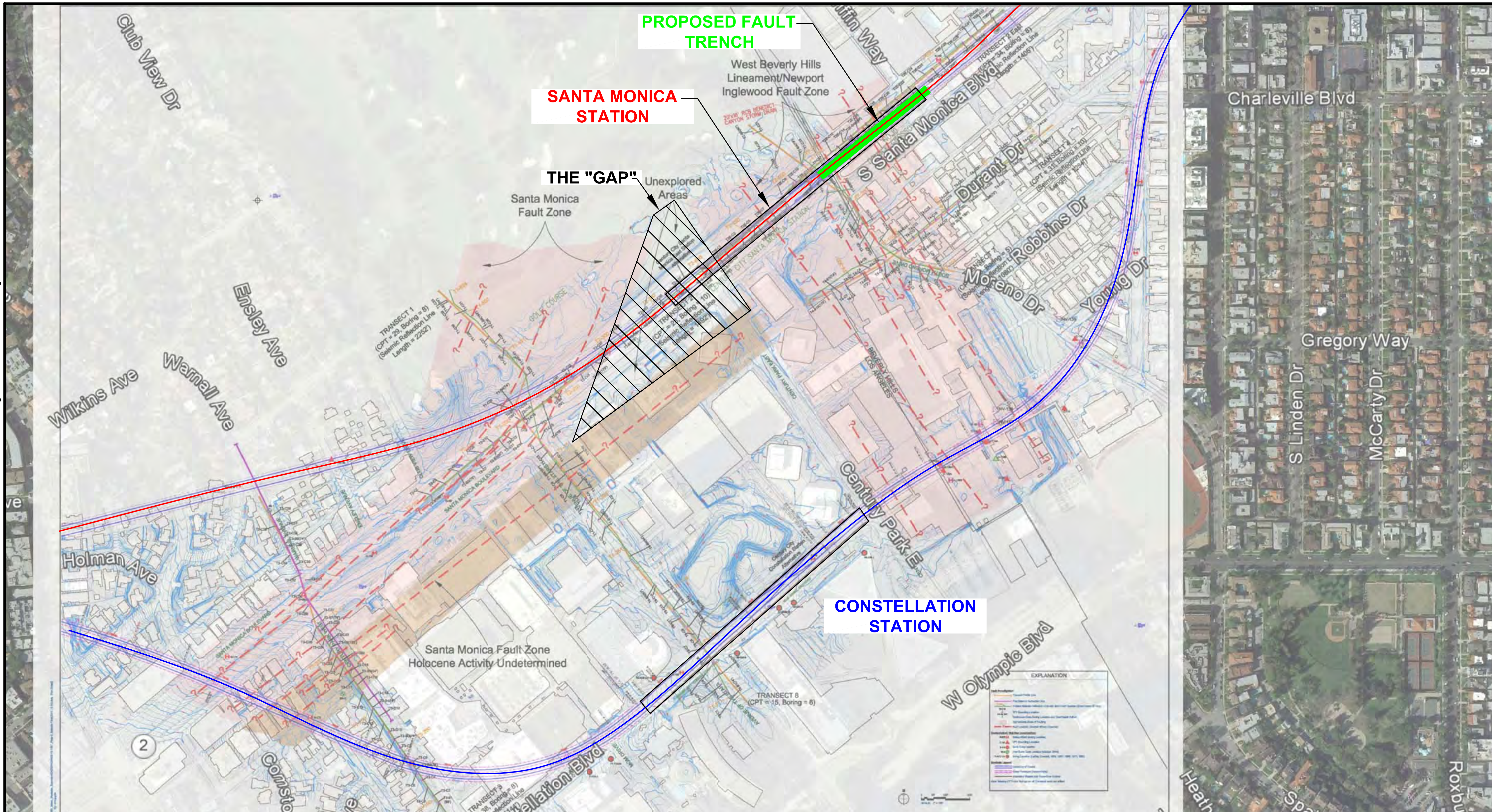
VICINITY MAP

March 2012 51-1-10024-003

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 1

Filename: I:\PROJECTS\10024 Beverly Hills WSE Review\003 FEIS Review\GRAPHICS\Vicinity Map.dwg Date: 03-08-2012 Login: Louis Larios



Filename: I:\PROJECTS\10024 Beverly Hills WSE Review\003 FEIS Review\GRAPHICS\FIG 2 - ALTERNATE PROPOSED ALIGNMENT.dwg Date: 03-08-2012 Login: Louis Larios

NOTE

Map adapted from Fault Exploration Plan Century City Area, by AMEC, 10-14-2011 .

0 200 400 800

SCALE: 1"=400'

Westside Subway Extension Review
Beverly Hills, California

ALTERNATE ALIGNMENT

March 2012 51-1-10024-003

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FIG. 2

APPENDIX A

PROJECT TEAM QUALIFICATIONS

ROY J. SHLEMON & ASSOCIATES, INC.

Geologic and Environmental Consultants

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Fax: 949-675-5088
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Quaternary Geology
Economic Geomorphology
Soil Stratigraphy
Geoarchaeology

ROY J. SHLEMON

SUMMARY OF RESUME

Education: B.A. Fresno State College, 1957
M.S. University of Wyoming, Laramie, 1959
Ph.D. University of California, Berkeley, 1967

University Positions (Teaching/Research):

Univ. California, Davis (Assistant Professor; and current Research Associate)
Louisiana State Univ., Baton Rouge (Assoc. Professor)
Stanford University (Consulting Professor, [part time])
Univ. California, Los Angeles (Lecturer [part time])
Calif. State Univ., Los Angeles (Lecturer [part time])
Univ. California, Irvine (Lecturer [part time])
San Diego State Univ. (Lecturer [part time])

Consulting Practice: (Principal, R. J. Shlemon & Assoc., Inc., Newport Beach)

Approximately 40-years, full-time consulting geologist specializing in Quaternary geology, geomorphology, geoarchaeology, soil stratigraphy and erosion and sedimentation control. Applications to engineering and engineering-geologic practice: fault-activity investigations (neotectonics/paleoseismicity), landslides, ground-fissure and differential settlement evaluations; independent and contract reviewer to government agencies and private organizations; forensic expert-witness testimony; Superior Court neutral referee (Orange County); advisory services and boards for U.S. Bureau of Reclamation, Corps of Engineers and other federal, state, local and international government agencies. Mining: Pleistocene auriferous and tin-bearing channels; sand and gravel deposits. Contaminant pathways: buried Pleistocene channel systems. Geoarchaeology: reconstruction of Quaternary environments, age of sediments and soils.

Representative Applications:

Investigations for nuclear power plants, liquefied natural gas terminals, large dams, high- and low-level radioactive waste facilities, Class I-III landfills (California); assessment of ancient and modern landslides, origin and age; natural hazard appraisals, seismic risk; paleohydrology: flood frequency, natural *vs* anthropologic rates of erosion and sedimentation; standards of practice.

Professional Organizations and Service:

Professional Geologist, State of California (PG 2867).

Certified Professional in Erosion and Sedimentation Control (CPESC 2167).

Professional Geologist, American Institute of Professional Geologists (CPG 1766).

Member/Fellow approximately 25 international, national and local professional and honorary organizations.

Trustee and Vice-Chair Emeritus, Geological Society of America Foundation.

Director Emeritus, Engineering Geology Foundation (Association of Engineering Geologists).

North American Representative, Emeritus, International Geological Union, Commission on Geology for Environmental Management.

Member Emeritus, Technical Advisory Committee, California Board of Geology and Geophysics.

Trustee, University of Wyoming Foundation; Chair, Stewardship Committee.

Member, Board of Visitors, University of Wyoming, College of Arts and Sciences.

Member Emeritus, Independent Review Panel: Delta [California] Research and Management Strategy.

Senior Fellow: University of California, Davis, Division of Mathematics and Physical Sciences.

Trustee, University of California at Davis, Foundation; member Nominating Committee; Chair, Working Group on Stewardship.

Member, Deans' Advisory Council, College of Letters and Sciences, University of California at Davis; member, Development Committee.

Member, Advisory Council, Earth and Soil Science Program, California Polytechnic University, San Luis Obispo.

Editor-in-Chief, Elsevier international journal "Engineering Geology."

Member, Technical Advisory Committee, California State Mining and Geology Board, Geohazards Committee.

Member, Technical Advisory Council, Center for the Study of First Americans, Texas A&M University.

Professional Awards/Recognition

National Science Foundation Educational Awards, 1960 through 1965.

"Best Paper Award" – 1985, "Applications of Soil Stratigraphy to Engineering Geology," Bulletin, Association of Engineering Geologists.

"Distinguished Lecturer" – Richard H. Jahns Distinguished Lecturer, Association of Engineering Geologists.

"Distinguished Practice Award" – Geological Society of America, Engineering Geology Division.

"Honorary Member" – Association of Engineering Geologists.

"Scientific Achievement Award" – Orange County Engineering Council.

"Honorary Member" – American Institute of Professional Geologists.

"Outstanding Alumnus" – College of Arts & Science, University of Wyoming, Laramie.

"Senior Fellow" – University of California, Davis, Division of Mathematics and Physical Sciences.

"Outstanding Alumnus" – College of Mathematics and Sciences, Fresno State University.

Professional Awards/Recognition (continued)

"Recipient and Honoree" - Presidential Medal, Geological Society of America (Boulder, CO).

"Honorary Member", South Coast Geological Society (Santa Ana, CA).

"Recipient and Honoree" – Presidential Citation, Association of Environmental & Engineering Geologists (Denver, CO).

Recipient: "Presidential Citation:" Association of Environmental & Engineering Geologists (Charleston, SC).

Publications:

Approximately 275 professional journal publications (monographs, articles, abstracts, reviews) since ~1965 dealing with mining (hydraulic and placer); and with Quaternary geology, geomorphology, geoarchaeology and soil-stratigraphic applications to engineering-geologic practice. Topics range from landslide and debris-flow recognition, risk and age, to delta formation, fault-activity assessments, anthropic-induced sedimentation and erosion, and cause of ground fissures and differential settlement. An additional 300 technical reports focus on site-specific investigations of faults, landslides, ground fissures and differential subsidence and other Quaternary geologic phenomena worldwide (list of publications and technical reports available upon request).

Seismotectonic Investigations for Proposed and Existing Dams

Consultant services directly commissioned by governmental agencies or by engineering-geological firms involved in dam and damsite investigations. Representative seismotectonic (paleoseismic) investigations include the following existing and proposed dams.

California:	Auburn, Folsom, Potrero, Black Butte, Cottonwood Creek, Anderson, Harvey Place, San Andreas, Crystal Springs, O'Neill, San Luis, Contra Loma, Bradbury, Glenn Reservoirs, New Melones, New Hogan, West Reservoir, Hidden, Buchanan, Pine Flat, Eastside Reservoir east and west dams (Domenigoni/Diamond Valley), Upper Chiquita;
Arizona:	Roosevelt, Stewart, Mountain, Horseshoe, Bartlett;
Colorado:	Two Forks, Twin Lakes;
Montana:	Gold mining tailing dams and ponds;
Utah:	Little Dell, SCS southern Utah embankment dams; Piute;
Washington:	Mud Mountain;
Colombia:	Bettania;
Guatemala:	Chixoy.

Robert (Red) Robinson, LEG | Director of Underground Services

EDUCATION

Graduate Studies, Engineering Geology, University of Illinois
BS, Geology, University of California at Los Angeles

REGISTRATION

Licensed Engineering Geologist – WA
Certified Engineering Geologist – OR
Registered Geologist – OR

Red's technical experience includes subsurface exploration, design, plans and specifications, construction monitoring on projects such as tunnels, slope stabilization bridges, retaining walls, building foundations, and shafts in soil and rock. Much of his work over the last 30 years has dealt with various forms of underground construction on over 300 tunnels, including: drilled and raised bore shafts; horizontal directional drilling, pipe jacking, microtunneling, earth pressure balanced and slurry pressure balanced machines; 10- to 80-foot-diameter tunnels driven by roadheader, tunnel boring machine (TBM), and drill-and-blast methods; chambers up to 70 feet wide by 600 feet long; and solution mining, all in a wide range of soil and rock conditions.

Town of Truckee, "Mousehole" Replacement and Multi-use Pedestrian Tunnel, SR-89, Truckee, CA. Project manager for the conceptual level geotechnical assessment of ground conditions and tunneling construction approaches for twin double-lane highway tunnels and a pedestrian tunnel to replace an existing narrow double lane highway tunnel beneath the mainline Union Pacific Railroad tracks. The existing tunnel, built in 1928 is 25-foot wide and 68-foot long. The new replacement highway tunnels would be 45 feet wide and 85 feet long. Ground conditions consist of gravely sandy fill with cobbles and boulders over similar alluvium deposits. The new twin highway tunnels would likely be constructed by a sequential excavation process, involving sprayed shotcrete and steel rib support. The multi-use pedestrian tunnel would likely be excavated and supported by jacking a 12 to 15-foot pipe beneath the active railroad embankment.

City of Los Angeles, North Outfall Replacement Sewer, Los Angeles, CA. Red served as Project Tunnel Engineering Geologist. He reviewed geotechnical aspects and assisted in the preparation of plans, specifications, and a geotechnical design summary report (GDSR) for the North Outfall Replacement Sewer (NORS) in Los Angeles, California. The project included over 8 miles of main 10 to 15-foot diameter trunkline and diversion tunnel and passes beneath the Los Angeles International Airport, San Diego Freeway, expensive residential areas, and a number of oil fields with abandoned wells. Ground conditions include several major faults, potentially "gassy" conditions, and soils ranging from hard clays to clean, free-flowing dune sands and sections with alluvial soil containing cobbles and boulders. Specified tunneling approaches included earth pressure balance tunneling machines, gasketed segmented linings, and compressed air augmented with compaction grouting and chemical grouting for ground/settlement control.

WSDOT, Alaskan Way Viaduct Replacement SR 99 Bored Tunnel, Seattle, WA. Principal in charge/senior reviewer. Shannon & Wilson implemented geotechnical investigations and design input for 3 alternative alignments for a large tunnel to be driven by a closed-face tunnel boring machine. The tunnel will pass through a range of hard to dense glacially over-consolidated sticky and clogging clays, bouldery till, and abrasive sands and gravels, with up to 210 feet of soil cover, and 140 feet of groundwater head at tunnel crown. The alignment also passes beneath tall buildings, an active railroad tunnel, several sewers, and the existing viaduct. The minimization of ground loss and resulting settlements will be a critical issue.

Sound Transit, Link Light Rail Beacon Hill Section, Seattle, WA. Mr. Robinson served as principal-in-charge for a multi-phased geotechnical exploration program. He provided geotechnical design input for preliminary and final design, prepared and/or reviewed the geotechnical portions of plans and specifications, and assisted with construction management and ground behavior monitoring. The Beacon Hill section consisted of 1 mile of twin 18.9 ft diameter transit tunnels, a deep underground binocular station with twin 550-ft long by 36 ft diameter platform tunnels, one deep main and one deep ancillary ventilation and emergency egress shafts, a headhouse at the top of each shaft, a west portal structure beneath Interstate 5 and opening towards the downtown and an east portal structure that provides access to Rainier Valley. Twin tunnels were constructed with an EPB TBM and precast, gasketed, bolted concrete segments. The shafts are supported with slurry wall panels. The station tunnels were constructed by the sequential excavation method (SEM), with a variety of ground conditioning and support systems to accommodate the complex glacial soils. Explorations occurred over several phases and included 92 borings totaling 13,675 feet of mud rotary, split triple-tube rotary core and vibra-sonic borings, 3 test pits and a test shaft. A wide range of state of the art field tests, including: downhole pressure meter, downhole seismic velocity, and cross-hole tomography were used to define in situ soil properties.

Washington State Department of Transportation, Interstate 90 Mt. Baker Ridge Highway Tunnel, Seattle, WA. Project engineering geologist and project manager during CM phase. Prepared design recommendations, specifications, and developed and implemented a major monitoring program for the 80-foot inside diameter, 1,300-foot-long Mt. Baker Ridge highway tunnel, the world's largest diameter soft ground tunnel. Historically unstable slopes at each portal required special access pit designs including cantilevered cylinder pile walls and cut slope designs. Instrumentation included: inclinometer/sondex casings, multi-position sonic probe borehole extensometers, concrete stress meters, Carlson joint meters and linear potentiometer joint meters that were designed especially for this project, tape extensometers, and strain gages. Due to well written specifications and carefully thought out installation procedures, the instrumentation experienced a 95 percent survival rate after 5 years of construction. The semi-automated data collection systems and rapid computerized data reduction allowed the data from these instruments to be used to guide and control construction procedures and thus greatly reduced the potential for adverse ground behavior and damaging surface settlements.

King County Metro, Downtown Seattle Metro Bus Tunnel (Downtown Seattle Transit Project – DSTP), Seattle, WA. As Project Manager, participated in all phases of design and construction for the DSTP including 1.2 miles of twin 21-foot-diameter tunnel alignment and four cut-and-cover stations in saturated glacial soils and adjacent to up to 50-story buildings. Assessed potential "fatal flaw" for feasibility studies for the DSTP, including a review of geotechnical conditions along alternative alignments and methods for supporting or underpinning the Burlington Northern Railroad tunnel where it crosses the alignment. Assessed ground conditions and their impacts on tunnel construction methods and underpinning requirements for final design of the DSTP. Project Manager for the implementation of a comprehensive construction monitoring program for the DSTP, which included the monitoring and evaluation of ground and soil and water conditions, liner deformations, support stresses, building deformations, and the effectiveness of chemical and compact grouting, jet grouting, and ejector/eductor wells in a variety of glacial soil and water conditions ranging from flowing silts and dense to very hard bouldery clayey silty till. Reviewed submittals, evaluated construction procedures and assessed claims.

Lake Ft. Smith Dam, Ft. Smith, AR. Shannon & Wilson provided geotechnical design services and developed plans, specifications and the engineer's estimate for the construction of a new intake structure and tunnel for the Ft. Smith Dam. The structures consist of an intake tower built in a shaft on the shore of the lake, a 1,300 feet long multi-use tunnel and a portal structure. Lake taps will be performed from the intake shaft utilizing micro-tunneling methods. The tunnel will be used for the water supply pipes and construction phase flood control.

King County Bellevue Pump Station Upgrade Project, Bellevue, WA. Principal-in-Charge for the assessment of alternative alignments during the pre-design phase and for geotechnical recommendations, preparation of the Geotechnical Data and Interpretive Reports, and the development and/or review of geotechnical portions of the plans and specifications during the final design phase. The project will consist of an upgraded pump station and about 5,400 feet of new force main, constructed primarily by Horizontal Directional Drilling (HDD) techniques with trenching between the HDD sections...

King County WTD, Denny/Lake Union CSO, Seattle, WA. As Project Manager, Red directed a team of engineers, geologists and hydrogeologists in a multi-phased exploration program, developing design recommendations, and assisting with CM for a 6,000-foot-long, 15-foot O.D. CSO tunnel, access shafts, outfall pipe into Puget Sound, control facility, and treatment plant from Lake Union to Elliott Bay. The exploration program included: 30 borings, 2 pump tests, 20 slug tests, an in-depth laboratory program, design recommendations for tunnel excavation and support procedures, dewatering requirements, stabilization of liquifiable soils at the control facility, and support and anchoring systems for the subaqueous outfall. The tunnel was successfully constructed through glacial soils with over 200 feet of soil cover and with water heads greater than 100 feet. The tunnel was constructed with an earth-pressure balance tunnel machine (EPBM) and gasketed, bolted concrete segments.

King County WTD, Henderson CSO, Seattle, WA. Project Manager for the evaluation of alternate alignments and final tunnel design for the Henderson CSO. The 2-mile-long alignment included up to seven variations in percentage of tunnel vs. trench, location of pumping and treatment facilities, and variations in alignment. Assisted CM Team in reviewing submittals, assessing construction methods, and analyzing ground behavior of seven access shafts to a 16-foot-diameter, 3,500-foot-long storage tunnel excavated with an earth pressure balance machine, five microtunnels ranging from 48- to 78-inch-diameter and up to 750 feet long, and six horizontal directional drill holes beneath Interstate 5 and mainline UPRR and BNSF railroad tracks.

Baumgartner Sewer Tunnel and Drop Shafts, St. Louis, MO. Staff Tunnel Consultant to review the designer's 90 % bid documents and provide a constructability review for the Construction Management team and owner for 20,000 feet of 8-ft diameter sewer tunnel and six 100 to 150 ft deep drop shafts and a 50 ft diameter pump station shaft constructed through limestone, interbedded with shale, dolomite and chert layers. During initial construction it was found that solutioning along selected joints and bedding planes resulted in localized zones of potentially high groundwatr inflow. The CM team coordinated with the contractor to perform additional explorations and a remedial grouting program to successfully grout these rock features to preclude excessive leakage into the advancing tunnel and shafts.

R. Travis Deane, PE, GE | Senior Associate

EDUCATION

MS, Geotechnical Engineering, University of California, Berkeley, California, 1998
BS, Civil Engineering, University of the Pacific, Stockton, California, 1992

REGISTRATION

Civil Engineer: WA, 37159, 2000
Civil Engineer: CA, C55469, 1996
Geotechnical Engineer: CA: GE2544, 2001

PROFESSIONAL SUMMARY

Travis has provided geotechnical engineering services in Northern and Southern California, the Pacific Northwest, and the Great Plains since 1992. Travis' experience includes geotechnical feasibility, environmental support, preliminary and final design, and construction monitoring for infrastructure and building projects. Infrastructure projects for private and public agencies include new alignments for railroads and roadways and rehabilitation/expansion of existing alignments. Project delivery methods on Travis' projects include design-bid-build and design-bid-build. His work includes identification and recommendations for mitigation of geologic hazards (e.g., liquefaction, landslides, and soft soils), bridge foundations (shallow, driven piles, and drilled shafts), retaining walls (e.g., gravity, cantilever, solider pile, soil nail, and MSE), and earthwork (excavations, embankments, and subgrade). Travis has extensive earthquake engineering experience, including site-specific response analyses, slope stability analyses, liquefaction analyses, and retrofitting and mitigation evaluations. Travis has completed building design and construction services for commercial and residential developments, educational, military, industrial and municipal facilities. In addition, he has completed forensic studies on distressed structures including bridge, embankment/levee, slope, and wall failures. Travis has also completed support for environmental studies, preliminary engineering, and third party reviews for proposed transit projects in the Seattle and Los Angeles metropolitan areas, including evaluating various tunneling methods.

RELEVANT EXPERIENCE

State Route 89, Mousehole Tunnel Replacement Project, Truckee, California. The Town of Truckee and Caltrans have been investigating widening SR-89 to accommodate increasing traffic flows. This segment of roadway includes an 80-year old, 25-foot wide double-lane tunnel, known as the "Mousehole," under a fill embankment supporting mainline Union Pacific Railroad tracks. Because of numerous constraints, we were directed to evaluate tunneling options that could be used to construct twin 40-foot-wide highway tunnels and a 12-foot-wide pedestrian tunnel without disrupting rail traffic. As project engineer, Travis helped prepare an assessment to evaluate tunneling options and worked on the selected final design with the project team. We completed a limited exploration program of the embankment consisting of both horizontal and vertical drilling. We evaluated four options for the highway tunnel replacement, and based on the information collection and project constraints, recommended the sequential excavation method (SEM or also known as the New Austrian Tunneling Method) be considered for two new tunnels and a pipe jacking method for the new multi-use pedestrian tunnel. The final design consisted of pipe jacking in combination with ground freezing to support the tunnel excavation.

Union Pacific Railroad, Los Angeles Transportation Center (LATC), Los Angeles Subdivision, Los Angeles, CA. (Ongoing as of February 2011) Travis is project manager and lead geotechnical engineer for reconfiguration of the intermodal yard adjacent to downtown Los Angeles. New container and chassis stalls and working and tracks will be constructed in the yard. A new maintenance shop, roadability, and flip yards are also proposed. The LATC yard will also be expanded to the south and a 30-foot high retaining wall is proposed along Mission Road. The retaining wall is designed to be soldier pile with tieback anchors or soil nail walls. Geologic hazards typical of the Los Angeles basin that we identified included seismic hazards such as liquefaction and lateral spreading, subsidence, expansive and corrosive soil, oil wells, and methane gas. Our design recommendations included mitigation measures such as ground improvements or deep foundations for the new structures.

Alaskan Way Viaduct & Seawall Replacement, Seattle, WA. Travis assisted in preparation of the Environmental Impact Statement (EIS) for the replacement of a 2.5-mile long section of SR-99 and the adjacent existing seawall located along Seattle's waterfront. The area faces an urgent need to retrofit, rebuild, or replace the Viaduct and the Seawall because of their age, risk to public safety, seismic vulnerability, deteriorated condition, and critical role in the region's transportation system. Travis assisted in the geotechnical engineering recommendations for the Viaduct replacement alternatives, earthquake engineering studies to evaluate the liquefaction and lateral spreading potential of the soils along the alignment, construction dewatering studies, and evaluating potential impacts from contaminated properties along the alignment. Travis also worked on design of the portal and ventilation structures for the tunnel alternative selected for final design of the project.

Mulholland Highway Washout, Hollywood, California

Travis was lead geotechnical engineer and designer of an emergency repair for a washed out roadway below the "Hollywood" sign. This section of Mulholland Highway was closed to general traffic given the steep slopes and narrow width, but was used by the City to access communication towers on top of Mount Lee. The Los Angeles Bureau of Engineering requested we work with Griffith Company (contractor) to develop a "design-build" repair and begin construction within two days after the initial site meeting to review the washout. Travis worked with the City and contractor to review four repair options and explored the washout with the contractor's equipment to determine the most feasible repair option. This repair consisted of excavating into the existing rock cut of the roadway and using the material to fill the washout and buttress the fill side of the road. The road was passable within two weeks and reopened entirely within two months.

Off-Cycle Crew Support Building, United States Coast Guard, Alameda, California

Travis was lead geotechnical engineer and project manager for the TetraTech/Tesoro design-build team for this new building project. The building footprint is approximately 17,700 square feet and is a steel-framed two-story building with an interior concrete slab-on-grade lower floor. The site is fill over San Francisco Bay Mud susceptible to liquefaction and ground settlement from consolidation. The D-B Team selected a deep foundation system consisting of auger-cast in-place piles (ACIPs) with a structural mat slab to support the new building. We observed the installation of the ACIPs, utility backfill, and other minor grading components of the project.

U.S. Forest Service, South Fork Snoqualmie River Bridge, King County, WA. Travis provided geotechnical engineering recommendations and construction observation for replacement of an existing steel truss bridge crossing the South Fork of the Snoqualmie River about 10 miles west of Snoqualmie Pass. The project was developed as design-build project and Shannon & Wilson staff attended several meetings with the USFS, contractor and design team to develop a suitable foundation system for the new bridge. The east abutment is supported on steel pile driven through cobbles and boulders deposited during periods of high runoff from the river. The west abutment was located on bedrock slope. A shallow foundation system with rock bolts was planned for the proposed abutment and wingwall. We observed the pile installation to confirm subsurface conditions were as anticipated and tested the abutment wall backfill. The project was fast-tracked to be completed during the short summer months due to high snowfall.

Dakota, Minnesota & Eastern Railroad, New Track, WY and SD. Project Manager for about 262 miles of new railroad starting from existing tracks east of Rapid City, skirting the south end of the Black Hills, and into the coal fields of the Powder River Basin in east-central Wyoming. Proposed alignment crossed a variety of terrain including landslides, expansive soil, collapsible soil, and mine spoils. To expedite project construction, divided the alignment into geotechnical segments to prioritize our work based on geology, topography, and/or access conditions. Initial field program included geologic mapping and over 150 field exploration sites. Remote locations, environmental concerns, and property requirements necessitated a variety of drilling equipment be used for the field explorations, including all-terrain vehicles and helicopters. Due to property concerns and remoteness of area, we used GPS equipment to locate proposed exploration sites and track features. We prepared project deliverables for the owner including a geotechnical data, characterization, and baseline reports for prospective Design-Build teams pursuing the project.

El Segundo Business Park, Central Park Infiltration, El Segundo, CA. As project manager, prepared the infiltration parameters for design of a dry well system to collect and infiltrate runoff from the business park. Prepared a design report summarizing our findings and recommending the dry well system through the existing, clayey fill and into the underlying native dune sand. During construction of the dry wells, reviewed construction field reports for the dry well installation and associated grading. Also prepared construction reports for agency approvals.

Union Pacific Railroad, East Los Angeles Intermodal Yard, Los Angeles, CA
The East LA Yard is one of a dozen intermodal and automotive yards on the UPRR system that Travis is project manager for to review yard distress and provide repair recommendations. This yard has localized areas of pavement distress and is also looking to redevelop the eastern part of the yard with new pavement sections. We have identified areas of distress at the yard and are planning to do a combination of cores through the pavement sections and soil borings in the proposed redevelopment area. We provided pavement design recommendations to repair and/or replaced the pavement distressed areas.

Dean G. Francuch | Associate Geologist

EDUCATION

BS, Geology, California State University, Northridge, California, 1987
Post-Graduate Work, California State University, Los Angeles, California

REGISTRATION

Professional Geologist (P.G.), No.5789, State of California, 1993
Certified Engineering Geologist (C.E.G.), No.1842, State of California, 1993

PROFESSIONAL SUMMARY

Over the past 23 years, Mr. Francuch has been actively involved from the "ground up", conducting and managing projects involving geotechnical engineering and engineering geology for engineered facilities (landfills, mines, transportation and pipelines) and residential developments. His experience includes working on both private and public funded projects from small single-lot homes to 2000-acre master-planned developments. For many of those projects Mr. Francuch planned and implemented geologic and geotechnical investigations to characterize soil and rock conditions at the sites. He has conducted numerous geotechnical investigations to recognize active faults, landslides and other geologic hazards. Mr. Francuch's professional experience spans the State of California from the southern border to the Bay Area, and includes work within the States of Nevada and Arizona. He has been actively involved in field studies during his career, having conducted extensive geologic mapping projects throughout southern California within various geologic terrains. He has been intimately involved in drilling projects for landfills, large-scale real estate developments, and mining operations. He also has a significant amount of experience with groundwater well installation having worked on groundwater studies for landfills and industrial facilities, gaining valuable knowledge of various drilling techniques and practical well construction methods. Besides his professional geologic background, Mr. Francuch has an extensive knowledge of freight and passenger railroad operations and holds a Class 1 Certified Locomotive Engineer license.

RELEVANT PROJECT EXPERIENCE

Residential Development

Anaverde Development, Empire Land, LLC, Palmdale, California. Senior Engineering Geologist for 2000-acre residential, commercial and recreational master-planned community, including school sites, fire station, multi-lane roads and bridges. Managed geotechnical investigations including active-fault delineation of San Andreas Fault Zone splays, elevated groundwater and liquefaction mitigation, and bedrock slope stability analyses. Project developed over multi-year phased construction.

Alta Vista, Newhall Land, Santa Clarita, California. Senior Engineering Geologist for mass grading construction. Managed geotechnical construction aspects of 83-acre mixed residential development including fill compaction. Geologic hazards included active faults and daylighted slope conditions. Recognized potentially unstable slopes and co-designed buttress remediation. Supervision of soil technicians.

Showcase Homes, Santa Clarita, California. Project Geologist for slope stability and active fault study of 82-acre, 161-lot residential development. Performed subsurface investigation using bucket-auger drilling and trackhoe methods to define active zone of San Gabriel fault.

Foothill Church Assembly Hall, San Dimas, California. Performed field investigation for proposed 300-person Assembly Hall located adjacent to mapped trace of San Antonio fault. Work included fault trenching across site in Pleistocene-age alluvium. Responsible for delineating and identifying activity along faults within proposed expansion.

Landfills

Chiquita Canyon Landfill, Republic Services, Valencia, California. Senior Engineering Geologist for Geologic Hazards and Slope Stability Study. Managed and performed field investigation for proposed 60-acre landfill expansion. Work included fault trenching and landslide exploration using bucket-auger drilling techniques in Plio-Pleistocene sedimentary rock. Responsible for delineating and identifying activity along mapped regional faults within proposed expansion. Professional services and construction completed in 2006.

Barstow Landfill, Norcal/County of San Bernardino, San Bernardino County, California. Engineering Geologist for Geologic Hazards Study: Geologic mapping of Quaternary and Tertiary sedimentary deposits for proposed landfill expansion. Delineation of active fault zone using detailed Quaternary field surficial mapping methods, including desert pavement development and aerial photo-interpretation. Final report preparation for submittal to state oversight agency.

Landers Landfill, Norcal/County of San Bernardino, San Bernardino County, California. Senior Engineering Geologist for active fault study. Determined Holocene activity of previously unstudied fault, using mapping, trenching and soil stratigraphy techniques within Quaternary sediments and underlying Mesozoic granitics and Precambrian gneiss.

Imperial Landfill, Imperial County, California. Engineering Geologist for Imperial fault study. Fault trenching across 1944 and 1977 fault breaks through Pleistocene lake deposits for proposed landfill expansion. Use of aerial photographs as well as offset cattle feedlot "deposits" to determine location of break.

Edom Hill Landfill, County of Riverside Waste Management Department, Riverside County, California. Engineering Geologist for Evaluation Monitoring Program. Installation of deep sedimentary bedrock monitoring wells (up to 400 feet) using mud rotary method and geophysical logging. Geologic mapping and trenching to identify structure adjacent to the San Andreas fault for groundwater modeling within Pleistocene sedimentary deposits. Final analysis was presented to the Riverside County Board of Supervisors for EIR approval.

Tajiguas Landfill, County of Santa Barbara, Santa Barbara County, California. Project Geologist for active fault study. Fault trenching within recent alluvial deposits to delineation and potential setback for proposed expansion. Use of carbon dating techniques to determine offset date.

Slope Stability Study, San Timoteo Landfill, County of San Bernardino, Redlands, San Bernardino County, California. Project Engineering Geologist for subsurface investigation of slope stability study for proposed landfill expansion using bucket-auger drilling techniques within Plio-Pleistocene sedimentary bedrock. Expansion design included slopes as high as 225 within faulted and landslide-prone bedrock. Study included computer stereonet analysis of proposed design and final recommendations regarding slope design relative to geologic constraints. Construction management included overview of geologic mapping program to verify anticipated field conditions.

Golden Valley High School and Golden Valley Road, Phase 1, City of Santa Clarita, Santa Clarita, California. Senior Engineering Geologist for geotechnical investigation. Managed and performed investigation of 160-acre school site and associated 6-lane road. Investigation included fault trenching, landslide delineation and geologic mapping of Plio-Pleistocene sedimentary units.

Co-developed plan to mitigate landslide below critical satellite facility. Four volume report required fast track schedule to meet state funding requirements. Professional services and construction completed in 2002.

Roadways and Transportation

Golden Valley Road, Phase I, City of Santa Clarita, Santa Clarita, California. Senior Engineering Geologist for mass grading construction. Managed geotechnical construction aspects of 8 million yd^3, 160-acre school site and 1.2 mile 6-lane roadway. Included extensive mitigation of over 50 landslides and active fault zone delineation. On-site utilities required relocation or protection including four high-tension lines, twin 30-inch gas mains, four oil wells, and 6-foot diameter aqueduct. Supervision of a staff of field technicians and geologists. Numerous public presentations were given to the Santa Clarita City Council and W.S. Hart school board.

Copperhill Drive, Valencia Company, Valencia, California. Senior Engineering Geologist for mass grading construction. Managed geotechnical construction aspects of 4.5 million yd^3, 500-acre site and 2.2 mile 4-lane roadway. Work included fault mapping, landslide remediation and protection of high-tension lines, groundwater monitoring wells and water distribution line. Supervision of a staff of field geologists and soil technicians.

Commercial and Light Industrial

Gates Development, Newhall, California. Project Geologist for Geologic Hazards Study. Detailed geologic mapping of 450 acres including delineation of potentially active fault for a light industrial development and park site. Major utility corridor including railroad, metropolitan water aqueduct and gas mains feeding the City of Los Angeles.

APPENDIX B

DR. ROY SHLEMON'S REPORT

APPENDIX B

DR. ROY SHLEMON'S REPORT

TABLE OF CONTENTS

FIGURES

ROY J. SHLEMON & ASSOCIATES, INC.
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6 November 2011

Mr. R. Travis Deane, P.E., G.E.
c/o Shannon & Wilson, Inc.
664 West Broadway
Glendale, CA 91204

Re: **Independent Assessment of Fault-Activity Reports, Westside Subway Extension Project: Potential Technical Impacts on the City of Beverly Hills**

Dear Mr. Deane:

As requested, I have reviewed the several fault-activity documents and voluminous appendices prepared by consultants and reviewers in support of the proposed Westside Subway Extension Project. I have particularly focused on the adequacy of these investigations, the technical reasonableness of the conclusions and the potential impact on the City of Beverly Hills by the proposed alternative tunnels and transit stations and by the multiplicity of "active" fault now identified. Additionally, I responded to fault-related, City-raised questions about:

(A) The feasibility an alternative alignment beside that proposed for the Santa Monica and Constellation stations;

(B) The siting of the Santa Monica station along Santa Monica Boulevard between the Santa Monica Fault Zone (SMFZ) and the West Beverly Hills Lineament (WBHL) as presently depicted on the technical report maps;

(C) The potential that one or more so-called active faults could impact location of the Constellation station; and

(D) The precedent for locating a station across a known, regulatory-defined active fault.

The general mapped locations of the consultants' fault zones, whether previously documented or now inferred, ostensibly components of the Santa Monica thrust system (SMFZ), the Newport-Inglewood fault zone (NIFZ), and the so-called West Beverly Hills Lineament (WBHL), are documented on Shannon & Wilson Figure 1. This figure is thus referred to, but not replicated in this report.

My fundamental conclusions and pertinent recommendations were previously discussed and presented to your staff and geotechnical consultants in various electronic communications and conference calls, but are here summarized for more specific documentation.

1. The consultants' technical reports, particularly those investigating the possible presence and relative activity of faults potentially impacting proposed alternative tunnels and transit stations, meet the current professional standard-of-practice. However, uncertainties are inherent in all geological investigations; and professional judgment is therefore always appropriate. By virtue of the investigative techniques employed, and the consultants' expertise and professional standing, I judge that the fundamental conclusions are reasonable, though in some areas, as indicated in following sections, probably too conservative.

2. There are indeed alternative alignments that, from a technical standpoint, may be preferable to those serving the proposed Santa Monica and Constellation stations. But many factors are involved, including technical costs, impact on existing infrastructure and related cultural and economic issues. Any alternative inherently requires site-specific technical investigations, including those to more accurately delimit fault location and to determine relative activity.

3. The technical virtues of relocating the proposed Santa Monica station between the map-depicted (Fig. 1) traces of the SMFZ and the WBHL are very low. In fact, more previously unrecognized faults are likely to be encountered, particularly offsets in the upper plate of the Santa Monica thrust system. Accordingly, an appropriate investigation would likely be costly and time-consuming. Better alternatives are available.

4. Given the regional tectonic framework, there is reasonable probability that a heretofore unrecognized fault does pass through or could affect the proposed Constellation station. Based on existing maps, no obvious faults are recognized, but site-specific investigations are definitely warranted. These would likely include advancement of closely spaced cone penetrometer test lines.

Of geologic concern here is that the NIFZ appears to be "branching" and hence one or more splays may affect the exact site for the proposed station. But the fault investigations are doable, and likely to produce good data for technical decision making.

5. Since enactment of the Alquist-Priolo Act in 1972, no habitable structure has been knowingly placed on a California-defined active fault. The deterministic number traditionally used is about 11,500 years; that is, if there has been ground rupture within that time, then the fault is deemed active, regardless of the amount or recurrence of movement. Accordingly, at present, no structural design or mitigation, other than an appropriate-distance "setback," is permitted for siting a station, here most likely deemed a "habitable structure" by State regulations.

6. The consultants' technical reports now portray the WBHL to be an approximately 600-ft wide zone of faulting. This is not based on direct field observation via trenching and logging, but rather indirectly, based mainly on interpretation of seismic and cone penetrometer test (CPT) data. The conclusions indicate that late Pleistocene strata are likely displaced and, although not physically documented, the myriad of fault comprising this zone are judged to be "active" (Holocene) based on inferred extension of the Newport-Inglewood fault zone with its demonstrably historic movement. The inherently conservative interpretation has many implications for the City of Beverly Hills:

A. The proposed Santa Monica Boulevard (east) station would lie amid these faults, and thus require intensive subsurface investigation to demonstrate that it *would not* be located above a fault;

B. The WBHL faults are branching out to the north as they project into the east-west-trending Santa Monica fault zone. Thus, comparable to the myriad of splays that are now found within a redevelopment area in downtown San Diego (Rose Canyon fault system), some faults may be demonstrably active, whereas other probably had last surface rupture in the late Pleistocene. In essence, regional strain partitioning within the WBHL gives rise to faults with long and "erratic" recurrence. Hence some faults are active according to California regulatory interpretation. Others, however, may not be so. Only laborious, expensive and time-consuming subsurface investigations will likely differentiate between the two; and even then high uncertainty will remain. Accordingly, the probability of diverse, and potentially argumentative, scientific interpretations would be high.

C. The WBHL faults are not presently placed into an "earthquake hazard zone" by the California Geological Survey (CGS). But, given the conclusions of the technical reports and reviewers acceptance thereof, this will likely soon happen. Accordingly, site-specific investigations will be required to demonstrate a fault's relative activity and to establish an appropriate set-back distance.

D. Though probably an unintended consequence, the consultants' designation of faults within the WBHL as active will ultimately negatively impact many commercial and residential structures with the City of Beverly Hills. Specifically, all existing critical (essential) facilities will be affected. This means that construction, expansion or other changes to police and fire stations, to schools, to major water and gas storage facilities, and to all infrastructure will require fault-activity assessments. Further, many property owners will find themselves in a newly designated active fault zone, potentially affecting value and perceived risk from potential ground rupture.

7. The Santa Monica fault zone poses another challenge. According to the consultants' technical reports and acceptance by the reviewers, there are likely to be several thrust (reverse) fault associated with the zone. Other faults with similar characteristics in the Transverse Ranges are typified by upper-plate back thrusts not yet identified given the level of investigations presently carried out in the City of Beverly Hills and adjacent areas. These offsets, however, may be small, but many are likely to be "active." Because current regulatory interpretations fail to allow engineering mitigation, even for offset less than a few inches, the only permissible option is to set-back from the presumed causative fault. But how much setback is appropriate is highly debatable. And, given the urban setting, trenching and other direct geological observation of faults is not likely; and thus only CPT and seismic investigations reasonably offer hope of fault-setback resolution, and even then uncertainty will abound.

8. The "junction" of the SMFZ and the WBHL faults remains uncertain. The boundary, as depicted on Figure 1, is likely to be one or more so-called tear faults. But the tectonic framework here is very complex, and hence subject to a wide variety of academic interpretation. Siting of tunnels and surface stations in this area will thus inherently require extensive and expensive investigation.

9. Owing to the multiplicity of faults and structural complexity in Beverly Hills, including those of the Newport-Inglewood fault zone that give rise to the original "high topography" of the area and the associated hydrocarbon, stratigraphic

traps, inherently required are site-specific investigations to determine fault presence and relative activity. Such studies are obligatory to meet current regulations, to allow engineering design for seismically induced ground accelerations, and ultimately to ensure general public health and safety.

Roy J. Shlemon, Ph.D.

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Economic Geomorphology
Soil Stratigraphy
Geoarchaeology
PG 2867; CPG 1766; CPESC 2167

SUMMARY OF RECONNAISSANCE FIELD OBSERVATIONS, FAULT-TRENCH EXPOSURES FT-1 THROUGH FT-3 (1 FEBRUARY 2012) AND FT-4 (13 FEBRUARY 2012), BEVERLY HILLS HIGH SCHOOL (BHHS), BEVERLY HILLS, CALIFORNIA

BACKGROUND

As requested by Shannon & Wilson (S&W), on behalf of the City of Beverly Hills, this document summarizes my field observations on 1 February 2012 of the initial three fault trenches, and on 13 February 2012 of an additional "gap" trench on the Beverly Hills High School (BHHS) campus. The four trenches were excavated and logged by Leighton & Associates (L&A), Consultants-of-Record for the BHHS.

For chronology: I was formally invited by an L&A Principal Geologist (Phillip Bucharelli) on 24 January to personally visit the site on 1 February 2012 at which time it was understood that I would meet the L&A field geologist (Joseph Roe) and his associate geologists. This was followed by several e-mail and telephone conversations with various L&A personnel regarding exact date, time and place for the observations. Following the initial invitation, I notified S&W, who formally authorized me to undertake the observations and ultimately provide the points following, initially orally, and now in expository form. Also summarized are the observations of 13 February about the likely age of sediments and soils (pedogenic) newly exposed in L&A Trench FT-4.

When arriving at the site on 1 February 2012 (241 S. Moreno Drive, Beverly Hills, CA 90212), I met the following, and to my best recollection provide their names, in whole or part, and their respective affiliations:

Tim ~~Baresh~~ Buresh — BHHS representative and coordinator of the project.

Joe Roe — L&A Senior Geologist and "field chief" and four of his associates who were logging the then-opened trenches.

Glenn Borchardt	L&A consultant from northern California, who was retained to document trench-exposed soil (pedogenic profiles) after my potential "conflict of interest" working with S&W precluded retention by the BHHS district.
Miles Kenney	Geologic consultant to an attorney retained by outside counsel for the BHHS.
Kathyrn Hanson	Geologist for the U.S. Geological Survey, UC Riverside office.
"unknown geologist"	A lady paleoseismologist from the USGS office in Pasadena, presently studying the San Andreas fault system in southern California. She is apparently a former academic, recently employed by the USGS. We were introduced, but – unfortunately – I do not recollect her name.
Janis Hernandez	Geologist for the California Geological Survey (CGS; LA office). Janis works mainly with the with the Jerry Treiman, the Senior CGS geologist in southern California, who reviews all fault investigations where California-defined "active faults" may be present and thus potentially "zoned" for possible inclusion into an "Alquist-Priollo fault hazards zone." Jerry was not present, apparently owing to an illness.
Brian Olson	Another CGS geologist working out of the Sacramento office.
Tim ???	Yet another CGS geologist, who apparently specializes in neotectonics.
Eldon Gath	Principal of Earth Consultants International (ECI), retained by the BHHS (?) or by counsel for the District. A co-owner of ECI is Thomas Rockwell from San Diego State University and a member of the Southern California Earthquake Center (SCEC). Tom is one of several academic reviewers who

commented on faults portrayed in reports of the "Westside Subway Extension Project (WSE)."

Not present during the 1 February 2012 trench observations were other geology and engineering consultants from "Exponent," a forensic firm formerly known as "Failure Analysis," apparently retained by the City of Beverly Hills.

TRENCH OBSERVATIONS AND INITIAL INTERPRETATIONS

As of 1 February 2012, L&A had opened, shored and was in the processes of logging three, on-campus trenches, identified as fault-trenches FT-1, FT-2 and FT-3, respectively. L&A kindly provided me with draft logs. The three trenches were oriented east-west, sited to cross an escarpment that comprises the surface expression of the West Beverly Hills Lineament (WBHL), presumed in the WSE technical reports to be a north-south extension of the Newport-Inglewood fault zone (NIFZ).

In brief, FT-1 some 110-ft long and ~15-ft deep was placed on the crest of the low, north-south-trending hills that mark the campus. The trench was hydraulically shored as appropriate. L&A collected several organic samples for radiocarbon assay. Some near-surface samples were bulk, obtained from organic matter (modern A-horizon); deeper samples were apparently charcoal fragments or even wood according to the L&A field geologist. The dates, as provided by Beta Analytic (Miami, FL), ranged in age from ~1 ka (kilo-annum) near the surface to ~25 ka at the base. Candidly, I reject these numbers owing to the high potential for post-depositional contamination. First, the near-surface samples were bulk organic material and thus yield mean-residence-time ages with an inherent wide range of uncertainty. Further, these sediments are receiving irrigation water from adjacent grassy areas and thus highly susceptible to modern groundwater contamination.

Second, the lower samples, although in proper chronological order (deeper are older), are mainly in expandable clay with high water-holding capacity. Thus, as discussed previously with S&W, one percent of modern contamination yields a date of ~35 ka for a sample truly about 100 ka. Also, the lower-trench samples would also been subject to likely increased gravitational water flux during at least two or three previous epochs of regional pluviality during the Pleistocene.

Third, and an additional “defect” with the L&A radiocarbon chronology, is that the near-surface sediments (below the fill) are capped by an extremely strongly

developed relict paleosol, one ~8-ft + thick with common to many reddish-brown (5YR 4/3-5/3 in Munsell notation) clay films that line ped faces and bridge mineral grains. Based on initial observations, I judge that this soil is at least ~200 ka old! The underlying sediments (parent material) are inherently older. Moreover, this high-surface landform is essentially uneroded, and hence geomorphically stable, thus allowing sufficient time and the vagaries of climatic change to form the strongly developed relict paleosol that caps the surface.

In summary, L&A identifies no faults in this trench, and I observed none as well. If any faults are ultimately identified in FT-1, they are most likely to be substantially pre-Holocene in age and hence “not active” according to present State of California definition.

L&A trench FT-3 was emplaced about 150 ft south of FT-1. This trench was similar in length and depth to FT-1. It, too, was emplaced on the crest of the hills that mark the BHHS campus, and likewise exposed a strongly developed, surface relict paleosol, an estimated ~200 ka old. L&A preliminary logs showed no faults in this trench, and none were observed during the 1 February 2012 reconnaissance.

L&A trench FT-2, the easternmost, was placed on relatively flat terrain immediately adjacent to the general north-south trending escarpment on the campus. FT-2 was 360-ft long, and locally up to ~20-ft deep. The trench walls were also supported by hydraulic shores. The sediments were essentially flat; no eastward “tilting” was apparent that might suggest late Pleistocene or Holocene neotectonic uplift. Unfortunately, however, there was an approximately 15- to 20-ft “gap” between the west end of FT-2 and the east ends of FT-1 and FT-3. This “critical” link extends up the escarpment, a geomorphic position most likely to reflect possible near-surface faults. On the day of the reconnaissance, L&A was attempting to close this gap by excavating FT-4 around water pipes, electrical conduit and other buried infrastructure. But the exposure was not yet cleaned, logged or otherwise ready for observation. Based on the FT-2 observations (below), the FT-4 exposures are critical for the BHHS fault investigations! If no faults are found and if the sediments are demonstrably pre-Holocene in age, then the likelihood of “active faults” affecting the campus is very low.

Based on my soil-stratigraphic reconnaissance (profiles were not yet formally measured, described or otherwise characterized in accordance with current standards of practice), I judge that the FT-2 sediments are substantially younger than those exposed in FT-1. Possible incipient buried paleosols are present, but these are not strongly developed, owing to the lack of significant translocated

clay films. The strong blocky to prismatic structure interpreted by some observers as indicative of soil age most likely stems from inherent expansion and contraction of primary clay minerals (probably smectites), rather than from pedogenic processes.

The L&A draft logs show “soil cracks” on the north wall near station 1+60. But I, and most other observers, identified clay-filled cracks with up to ~1-1/4-inch vertical displacement near the west end of the trench, essentially at the base of the north-south campus escarpment. There are about four or five of these slip surfaces, all with the downslope (east) side up. There is no obvious increase of displacement with depth. Also, whether or not the “cracks” continue to the base of the trench is yet unclear and awaits L&A continued logging and formal documentation. I suggested to L&A that they cut back into the trench wall and log two or possibly three additional faces at these critical localities, as well as log the south side of the trench. The intent is to determine possible horizontal displacement by using local fine-gravel stringers as piercing points and to ascertain the existence of horizontal slickensides, markers of potential right-lateral slip along the NIFZ. Tectonic slickenslides, if present, should be readily visible, for the parent material has a field-estimated clay content of >50 percent.

Frankly, these apparent offsets, minor though they may be, are the heart of the issue. Alternative explanations for their origin are possible (e.g., regional, tectonically driven, downslope “lurching” or less likely soil expansion). I believe, however, that the School District consultants will have to provide overwhelming evidence that the vertical offsets are not tectonic in origin. This may require additional on-site and possible offsite-trenching and documentation. Further, based on “informal trench conversation,” I suspect that some of the invited agency regulators are ready (as of ~5:00 PM on 1 February 2012) to pronounce these offsets as Holocene (active) faults until proven otherwise.

In sum, based on reconnaissance of L&A fault trenches FT-1, FT-2 and FT-3, there are small, but discernible vertical displacement exposed in FT-2 that generally coincide with the strike of WBHL and WSE-presumed NIFZ splays and with the base of the campus escarpment. These vertical slip features may owe their origin to processes other than to neotectonics; but the offset sediments are not yet dated, and only L&A, and perhaps other invitees, have seen the critical exposures in FT-4.

On 12 February 2012 I was advised by S&W that L&A had completed excavating and logging the “gap” trench, FT-4; and that I was requested to communicate with L&A personnel and to arrange field observations. Accordingly, on 13 February I met on-site with L&A (Edward Burrows, Joseph Roe and four other

L&A "loggers"), and with Eldon Gath, Tania Gonzalez and three other geologists from Earth Consultants International (ECI). ECI is apparently retained by BHHS to provide "second-party" review and to otherwise independently document all trench exposures and render their opinion to the School District.

Of particular interest were the new trench, FT-4, ~110-ft long and about 15-ft in depth; and the east part of FT-3 where new sidewall cleaning exposed a heretofore unidentified fault.

FT-4 covers much of the escarpment "gap" between the west end of FT-2 and the east ends of FT-1 and FT-3. A draft log of FT-4 was not available but, from initial observations, there are no obvious faults present, and the soil-stratigraphic column is substantially older than Holocene. In fact, a minimum age for the FT-4 stratigraphy is >~35 ka. Upon departure from the site by ~5:00 PM, L&A personnel were just completing FT-4 logs, and informed me they, too, observed no offsets in the stratigraphy.

The fault exposed in the north wall of FT-3 was apparently previously missed owing to its exposure directly under near-surface ~16-inch diameter pipes. Final hand cleaning shows the fault to be essentially vertical with about 3-4 inches of displacement. Offset decreases slightly with depth suggesting that probably two near-surface tectonic events are recorded in the sediments. Based on the L&A logging, with apparent concurrence from ECI, the fault terminates at the base of fluvial gravels, which are imprinted with the regionally extensive, ~200 ka relict paleosol. Accordingly, last surface displacement of this FT-3 "minor" fault occurred well before about 200-ka years ago; and the fault is therefore not active accordingly to present State of California criteria.

Another gap of ~15-ft occurs in the western or uphill part of FT-2, owing to "cover" by two or more ~6-ft concrete pipes. However, viewing sediments exposed under the pipes, from both the uphill and downhill sides, suggests continuity of sediments. When FT-2 is finally filled, L&A will place a short parallel trench on the present spoil piles in order to confirm apparent lack of displacement. Accordingly to L&A, this task will be completed by about 21 February.

The several ~1 to 2-inch, near-surface offsets, previously logged in FT-2, are now shown to die out at depth. Further, following previous suggestions, L&A cut back "slices" into both trench walls ultimately showing no slickensides in the clayey sediments that might be construed as indicative of faults. Combined, the two lines of evidence indicate that the FT-2 offsets are not tectonic in origin, but

rather more likely owe their origin to downslope lurching. ECI apparently agrees with this interpretation.

Following the site observations of 1 and 13 February 2012, respectively, I summarize my provisional conclusions:

1. There are no Holocene (active) faults exposed in any of the four L&A trenches, FT-1 through FT-4.

2. Sediments in all trenches are substantially older than Holocene based on the presence of relatively datable buried and relict paleosols. The L&A radiocarbon dates, from near-surface bulk samples and from deeper single specimens (non-detrital), are likely contaminated by modern irrigation water and by deeper gravitational water during the late Pleistocene. The contamination by younger organic matter thus provides only very minimal dates for the enclosing sediments. A more reasonable stratigraphy is offered by the paleosols, indicators of regional landscape stability and long-term weathering processes.

3. None of the ~200 ka and younger sediments are visibly or otherwise deformed, indicating that a possibly underlying anticline or monocline is not undergoing active uplift.

4. The capping oldest sediments, particularly well exposed in FT-1 and FT-3, contain remnant channel deposits that generally strike (based on projections of trench-exposed thalweg and channel edges) obliquely to the escarpment (WBHL). This suggests that the escarpment owes its origin to lateral fluvial erosion, rather than to fault truncation, thus supporting the direct observations from the L&A trenches.

5. A reasonable scenario to explain the geomorphically “stable” sediments and their relict capping paleosol is that these are remnants of Pleistocene distal fans emanating from the Santa Monica Mountains to the north. Continued thrusting and tear faults of the Santa Monica fault system most likely isolated the BHHS capping sediments from their source. This reasonable working hypothesis well explains why there is no Holocene or even late Pleistocene faults exposed in the L&A trenches.

Roy J Shlemon, Ph.D.

21 February 2012

APPENDIX C

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

Date: March 8, 2012
To: City of Beverly Hills
Attn: Mr. Aaron Kunz

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors, which were considered in the development of the report, have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based on interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland