APPENDIX F

GEOTECHNICAL ASSESSMENT

MULHOLLAND WATER PIPELINE PROJECT

GEOLOGIC / GEOTECHNICAL SITE ASSESSMENT

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1.1 SCOPE

This report presents the results of a geologic and geotechnical site assessment performed by URS Corporation (URS) for the proposed Mulholland Water Pipeline (Pipeline) along a portion of Mulholland Drive in the Woodland Hills area of the City of Los Angeles, California. The approximate locations of the proposed Pipeline and potential alternatives are shown on the Site Location Map, Figure 1.

The purpose of this report is to provide a reconnaissance-level geologic and geotechnical site assessment for inclusion in this EIR. This assessment involved a literature search and review, site reconnaissance, and evaluation of the geologic conditions for the proposed Pipeline and alternatives.

1.2 PROPOSED DEVELOPMENT

The Department is proposing to construct a connection between two existing water service zones along the southern and western rims of the San Fernando Valley. Specifically, the proposed Pipeline would serve to connect the Corbin Tank service zone, located on Mulholland Drive at approximately Greenbriar Drive, to the Topanga Tank service zone at the west end of project area. The project has been proposed by the LADWP to improve overall water system reliability for current users and approved development in the project vicinity, as well as to provide an additional source of water necessary to protect surrounding communities from potential brush fires and other emergencies.

The proposed Pipeline would consist of approximately15,200 linear feet of water pipe and a regulating station installed along Mulholland Drive, between Picasso Avenue and Greenbriar Drive, in Woodland Hills. About 13,000 linear feet of new 16-inch diameter welded steel pipeline would be installed along the unpaved portion of 'Dirt' Mulholland Drive, between Greenbriar Drive and Saltillo Street. Approximately 2,200 linear feet of 16-inch diameter ductile iron pipeline would be installed along the paved portion of Mulholland Drive between Saltillo Street and Picasso Avenue.

The proposed Pipeline would also include one regulating station and two 16-inch shut-off valves. The regulating station is tentatively located at Mulholland Drive and Saltillo Street. One of the valves would be located close to Greenbriar Drive, and the other close to the regulating station.

In addition to the proposed Pipeline, four project alternatives were identified. Alternative 1 involves locating a segment of the proposed pipeline north of Mulholland Drive, as shown on

Figure 1. Alternative 2 is a longer pipeline along Ellenita Avenue, Rosita Street, Corbin Avenue, Wells Drive, Serrania Avenue, Dumetz Road, Canoga Avenue, and Mulholland Drive, to the north of the proposed Pipeline, as shown on Figure 1. Alternative 3 involves:

1) constructing new water storage tanks to increase the water storage capacity afforded by the existing Topanga Tank service zone to one million gallons,

2) constructing an additional new seven million gallon water storage tank at the Kittridge Tank site,

3) constructing a new small pumping station,

4) upgrading the existing Girard Pumping Station, and

5) upgrading existing pipelines in the area. Alternative 4, No Project, would consist of no improvements to the existing water system.

This report discusses both the proposed Pipeline and Alternatives 1 through 3. Off-site improvements associated with Alternative 3 (i.e., Kittridge Tanks, new pumping station, Girard Pumping Station) were not evaluated for this Alternative.

2.1 REGIONAL GEOLOGIC SETTING

The proposed Pipeline and project alternatives are located on the northern flank of the Santa Monica Mountains in the Woodland Hills area of the City of Los Angeles, California, as shown on Figure 1. The Santa Monica Mountains form the southernmost boundary of the geologically complex and seismically active Transverse Ranges physiographic province of Southern California. East-west trending mountain ranges and valleys characterize the Transverse Ranges physiographic province. This topographic pattern is formed by north-south crustal compression acting across numerous east-west trending active faults. The north-south compression affecting the province is generated by the westward bend in the northwest-trending San Andreas Fault system.

This province is one of California's most seismically active regions and the north-south compressional tectonic forces have lead to active east-west trending folds and reverse, thrust, and left lateral-oblique slip faults. The rocks underlying the Santa Monica Mountains have been folded into a large anticline that has experienced several stages of growth and deformation since the Jurassic geologic time period (136 to 190 million years before present). A consequence of these recurrent episodes of deformation is that the Santa Monica anticline is no longer a simple fold; much of it has been refolded and disrupted by faults.

2.2 SITE TOPOGRAPHIC SETTING

2.2.1 Proposed Pipeline

As shown on the Site Location Map, Figure 1, the proposed Pipeline alignment extends along Mulholland Drive from the intersection with Greenbriar Drive at the eastern end of the project area to Picasso Avenue at the western end of the project area. This section of Mulholland Drive appears to have been constructed primarily as a cut into the slope just below local crests in the north flank of the Santa Monica Mountains. The existing road generally follows the east-west trending topography and crosses several north-south trending ridgelines and drainage channels along its alignment. Elevations along the proposed alignment range from approximately elevation 1575 feet above mean sea level (MSL) at Greenbriar Drive to a low of about elevation 1160 feet above MSL at Picasso Avenue.

Undeveloped slopes are located adjacent to most of the existing Mulholland Drive roadway between Greenbriar Drive and approximately Saltillo Street. Most of this segment of Mulholland Drive is also not paved. The undeveloped slopes have inclinations ranging from about 1:1 (horizontal: vertical) to about 5:1. Locally, slopes with inclinations as steep as about ¾:1 occur, primarily in cut slopes above the roadway. The natural slopes are generally covered with moderate to dense vegetation.

Between approximately Saltillo Street and Picasso Avenue, Mulholland Drive is bordered by residential development.

2.2.2 Proposed Alternative 1

As shown on Figure 1, the Alternative 1 alignment is the same as the proposed Pipeline over about the western one-third of the project alignment and the remainder is located north from the eastern portion of the proposed Pipeline. From its eastern terminus, the Alternative 1 alignment extends downslope and west from Corbin Avenue and Greenbriar Drive at approximately elevation 1300 feet MSL, to Howard Court at approximately elevation 1140 feet MSL, and then upslope to Mulholland Drive, at about elevation 1400 feet above MSL. The remainder of the Alternative 1 alignment then follows Mulholland Drive along the same alignment as the proposed Pipeline to its western terminus at Picasso Avenue at approximately 1160 feet above MSL.

With the exception of the eastern terminus, a segment along the central part of the alignment that is in residential developments and abutting existing cul-de-sacs, and the segment from Blanca Road Street to Picasso Avenue, most of Alternative 1 traverses undeveloped slopes. This alignment crosses several small drainage channels and intervening ridges along its route. The slopes have inclinations ranging from about 1:1 to over 5:1, with the steeper slopes generally in the eastern portion of the proposed alignment. The natural slopes are generally covered with moderate to dense vegetation. There are no existing access roads along the section of the proposed alignment that traverses undeveloped slopes.

2.2.3 Proposed Alternative 2

As shown on the Site Location Map, Figure 1, the proposed Alternative 2 alignment follows existing city streets in residential developments. The Alternative 2 alignment follows Ellenita Avenue from the intersection with Greenbriar Drive at approximately elevation 1100 feet MSL to sections of Rosita Street, Corbin Avenue, Wells Drive (to a low elevation of approximately 900 feet MSL), Serrania Avenue, Dumetz Road, Canoga Avenue, and along Mulholland Drive to its intersection with Picasso Avenue at approximately 1160 feet above MSL. The proposed route is situated in hillside development along most of its alignment, with the exception of sections along Wells Drive, Serrania Avenue, and Dumetz Road, which crosses the southern margin of the San Fernando Valley. Alternative 2 would be constructed within the right-of-way of the existing paved city streets.

2.2.4 Proposed Alternative 3

Alternative 3 consists of supplementing the existing 208,000-gallon Topanga Tank with an additional 800,000-gallon water storage tank, constructing an additional new seven million gallon water storage tank at the Kittridge Tanks site, constructing a new small pumping station, upgrading the existing Girard Pumping Station, and upgrading existing pipelines in the area. The proposed water storage tank would be constructed on a building pad developed to the south of the existing tank pad. Construction of this building pad would likely involve acquiring two or three of the adjacent residential properties and the removal of the homes.

The existing tank site is located at approximately elevation 1300 feet MSL on a cut pad excavated into a north-south trending ridgeline. These slopes have inclinations ranging from about 1:1 (horizontal: vertical) to over 4:1.

2.3 GEOLOGIC SETTING

The main soil and bedrock materials along the proposed Pipeline and alternatives include artificial fill, landslide deposits, alluvium, an unnamed shale, and sedimentary rock of the Monterey Formation. The distribution of these materials along the proposed Pipeline and its alternatives is shown on the Geologic Map, Figure 2, which is excerpted from Dibblee (1992). The following paragraphs provide brief, generalized descriptions of these materials, based primarily on geologic mapping performed by Dibblee (1992).

Artificial Fill [af] - Artificial fill is defined as human-placed material. The local composition varies with source materials. Artificial fill does not appear on Figure 2 along the alignment of the Pipeline or Alternatives 1 and 2. However, it is likely that artificial fill is present in localized areas along the proposed Pipeline, primarily in drainage channel crossings. Artificial fill may also be encountered along the outside edge of Mulholland Drive as a result of material being sidecast during original grading of the roadway. In addition, it is likely that artificial fill would be encountered in the residential developments along Alternatives 1 and 2. Artificial fill did not appear to be present in the area of Alternative 3 at the existing Topanga Tank site, but could not be discounted in the adjacent residential properties.

Landslide Deposits [Qls] - As shown on Figure 2, numerous historic and prehistoric landslides exist along the routes of the proposed Pipeline and Alternative 1. In addition to the landslides mapped by Dibblee (1992) and shown on Figure 2, the City of Los Angeles (1982) has mapped landslides in the area of the proposed Pipeline and Alternative 1, as shown on Figure 3. The City of Los Angeles (1982) also mapped several small landslides along the route of Alternative 2 and on the slopes below the existing Topanga Tank site (Alternative 3). The landslides are Holocene (within about the last 11,000 years) and possibly late Pleistocene (greater than 11,000 years before present) in age, with variable lithology dependent on the nature of the source materials, which may include both bedrock and surficial units.

The larger landslides mapped by the City of Los Angeles (1982) along the proposed Pipeline and Alternative 1 are noted by the City of Los Angeles as being prehistoric or having the appearance of being old landslides. Incised drainage channels through the displaced mass of these landslides suggests that these are old features that likely have not had recent movement. The smaller landslides mapped by the City of Los Angeles (1982) are noted as being historic or having a young appearance, suggesting recent movement. The larger landslides are likely deep-seated features and the smaller landslides shallow surficial features.

In addition to the mapped landslides, recent surficial slumping was observed along Mulholland Drive in the slopes above and below the roadway. The surficial slumps occur primarily in the cut slopes above Mulholland Drive but were also observed at several locations on the natural slopes below the roadway. The location of one of the surficial slumps above the roadway coincides with the location of a landslide mapped by the City of Los Angeles (1982). However, the apparent lateral limits of this surficial slump extend beyond the limits of the landslide mapped by the City of Los Angeles.

Geologic mapping by the City of Los Angeles (1982) indicates the proposed Alternative 2 alignment crosses several landslides and possible landslides (these landslides are beyond the limits of the mapping shown on Figure 3). However, it is likely that some remediation of the landslides along the route of Alternative 2 was performed during grading of the surrounding residential development. There are no known landslides directly underlying the proposed location of Alternative 3. However, geologic mapping by the City of Los Angeles (1982) indicates two possible landslides on the slopes to the west and northeast of the existing tank and a small landslide to the north (these landslides are beyond the limits of the mapping shown on Figure 3).

Young Alluvium [Qa] - Surficial alluvial sediments consisting of gravel, sand, and clay. The materials are Holocene in age (deposited within about the last 11,000 years) and are generally unconsolidated (not cemented) and undissected to slightly dissected by drainage channels. The young alluvium is located primarily in the drainage channels and valley areas, as shown on Figure 2. The alignment of the proposed Pipeline does not cross any mapped deposits of young alluvium. However, young alluvium may be encountered beneath artificial fill in localized deposits at crossings. The alignments of Alternatives 1 and 2 cross deposits of young alluvium, as shown on Figure 2. The young alluvium may be susceptible to liquefaction where it is saturated and also consists of sand. The depths of the alluvium along the alignments of Alternatives 1 and 2 are not known at this time. Alternative 3 is situated on a ridgeline and alluvium is not present.

Older Alluvium [Qoa] - Surficial alluvial sediments consisting of pebble-gravel, sand, and silt-clay. The materials are Late Pleistocene in age (greater than 11,000 years before present) and are generally unconsolidated to weakly consolidated (not cemented to weakly cemented) and dissected (where elevated) by drainage channels. The older alluvial materials were derived from the Santa Monica Mountains. As shown on Figure 2, a mapped deposit of older alluvium underlies the western terminus of the proposed Pipeline and Alternatives 1 and 2. Because this is a developed residential area, artificial fill may locally overlie the older alluvium.

Unnamed Shale (upper member of Modelo Formation of Hoots, 1931) [Tush, Tuss] – Rock generally consisting of claystone and siltstone (Tush) (moderately to vaguely bedded) and diatomaceous clayey shale (Tuss) (thin bedded soft, chalky to somewhat platy, and semi-siliceous). The rock is Late Miocene in age (5.3 to 11.2 million years before present), marine clastic and biogenic (produced by physiological activities of organisms). As shown on Figure 2, this rock would be encountered only along parts of the proposed alignment of Alternative 2.

Monterey Formation (lower member of Modelo Formation of Hoots, 1931) [Tm, Tmss] – Rock generally consisting of siliceous shale (Tm) (platy, moderately hard, locally porcelaneous, and may include thin interbeds of clay shale, siltstone, and silty fine-grained sandstone) and sandstone (Tmss) (semi-friable, bedded, fine- to medium-grained, with some interbedded siltstone and shale). The rock is Middle to late Miocene in age (5.3 to 15.1 million years before present), marine clastic and biogenic. As shown on Figure 2, this rock would be encountered along the proposed Pipeline, Alternatives 1 and 2, and at the site of Alternative 3.

Rock exposed in outcrop along Mulholland Drive appears to be highly weathered and is likely weak. Rock mass discontinuities observed in the rock formations during the field reconnaissance consisted of bedding and fracturing (jointing). As shown on Figure 2, bedding orientations measured in the rock formations in the project area generally strike east-west and dip to the north between about 11 and 30 degrees (Dibblee, 1992). The east-west strike of the bedding in the project area produces bedding that typically dips out-of-slope on north-facing slopes. The fracturing (jointing) observed may be in part the result of near-surface weathering as well as tectonic deformation. Rock strength parameters were not evaluated as part of this field reconnaissance (no laboratory strength testing was performed).

2.4 FAULTS AND SEISMICITY

Southern California is crossed by numerous northwest-trending active, sufficiently active, and well-defined faults and underlain by several "blind" thrust faults (i.e., a low-angle reverse fault with no surface exposure). The locations of the proposed Pipeline and alternatives, the nearest of the known active, sufficiently active, and well-defined faults and epicenters of earthquakes with magnitudes of 3.5 or greater are shown on the Regional Fault and Epicenter Map, Figure 4. The California Division of Mines and Geology (CDMG) (1997) defines an active fault as one that has had surface displacement within Holocene time (about the last 11,000 years), and a sufficiently active fault as one that has evidence of Holocene surface displacement along one or more of its segments or branches. The CDMG considers a fault to be well defined if its trace is clearly detectable as a physical feature at or just below the ground surface.

No known active, sufficiently active, or well-defined faults traces have been recognized as crossing the proposed Pipeline or alternatives, and the CDMG (1997) does not delineate any part of the proposed Pipeline or alternatives as being within an Alquist-Priolo Earthquake Fault Zone. To be zoned under the Alquist-Priolo Act, a fault must be considered active or both sufficiently active and well-defined (CDMG, 1997).

The closest known active faults to the proposed Pipeline and alternatives are segments of the 50-kilometer-long, north-dipping, reverse Santa Monica Mountains fault system. The Santa Monica Mountains fault system, as defined by Dolan, et al. (1995), consists of a series of mapped surface faults individually known as the Malibu Coast, Santa Monica, and Hollywood faults. The Santa Monica Mountains fault system also includes the Santa Monica Mountains thrust fault, a low-angle reverse fault with no surface exposure. The Santa Monica Mountains thrust fault is postulated to dip shallowly, approximately 20 degrees, to the north beneath the Santa Monica Mountains (Dolan, et al., 1995). The activity of the Santa Monica Mountains thrust fault is uncertain (Dolan et al., 2000).

Faults that could contribute to the total seismic shaking hazards at the site are listed below, together with the estimated maximum magnitude earthquakes. The table is based on the requirements of the Uniform Building Code for determination of near-source factors (International

Conference of Building Officials, 1997), but also includes faults mapped within approximately 25 kilometers of the site and the San Andreas fault. At this site, faults located beyond approximately 25 kilometers would not be expected to cause higher levels of shaking than those faults located within 25 kilometers. The approximate distance to each of the seismic sources is estimated from Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada (International Conference of Building Officials, 1998) using the definition of distance given in that publication. The Santa Monica Mountains thrust fault is not included in the table because it was not included as a near-source factor in International Conference of Building Officials (1998).

Fault or Fault Segment	Approx. Distance to Site (km)	UBC Seismic Source Type(1)	Fault Type(2)	Approx. Fault Length (km)(3)	Est. Slip Rate (mm/yr.)(4)	Estimated Maximum Credible Earthquake(5)
Malibu Coast	9	B	R	37	0.3	6.7
Santa Monica	11	B	O/LL, R	28	1	6.6
Hollywood	15	B	O/LL, R	17	1	6.4
Santa Susana	18	B	R	27	5	6.6
Palos Verdes	19	B	O/RL	96	3	7.1
Verdugo-Eagle Rock system	20	B	R	29	0.5	6.7
Sierra Madre system (San Fernando)	20	B	R	57	3	7
Northridge	21	B	BT	31	1.5	6.9
Newport-Inglewood Zone (onshore)	23	B	RL	64	1	6.9
Simi - Santa Rosa	25	B	R	30	1	6.7
San Andreas Fault System	59	A	RL	345	35	7.8

Notes: (1) Defined in International Conference of Building Officials (1998).
(2) RL = Right Lateral Strike-Slip Fault; O/LL = Oblique Left-Lateral Fault; R = Reverse Fault; BT = Blind Thrust
(3) Fault lengths from CDMG (1996).
(4) Slip-Rates from CDMG (1996). Plus and minus factor not included in table.
(5) Maximum credible earthquake values reported as maximum moment magnitude by the CDMG (1996).

The tectonic forces acting on the faults in the Transverse Ranges province are also expressed in the historic seismicity. The most recent earthquake causing significant ground motion in the project area was the 1994 magnitude 6.8 (M_w) Northridge Earthquake generated by the "blind" Northridge thrust fault, which is located north of proposed Pipeline beneath the San Fernando Valley. Prior to the 1994 Northridge earthquake, the largest earthquake to strike the Transverse Ranges region was the 1971 magnitude 6.6 San Fernando earthquake. The earthquake resulted from a 10 mile- (15 kilometer-) long rupture of the San Fernando fault and caused substantial damage in the northern San Fernando Valley (Ziony and Yerkes, 1985) No documented earthquake-induced landslides or damage to Mulholland Drive in the project area were found.

2.5 GROUNDWATER CONDITIONS

The depth to a regional groundwater table beneath the proposed Pipeline and the alternatives is not known. Based on the topography and the stratigraphy at the project site, it is unlikely that there is a near-surface regional groundwater table that would be encountered by the relatively shallow excavation for pipeline construction. However, localized near-surface or perched water could be encountered in an excavation along the proposed Pipeline or the alternative alignments, especially in drainage crossings, in young alluvium, or in artificial fill that has been irrigated.

The nearest groundwater basin to the project area is the San Fernando Basin, located north of the proposed Pipeline (Los Angeles County, undated). The proposed Pipeline and Alternatives 1 and 3 do not lie within this groundwater basin. Several segments of the Alternative 2 alignment cross the southern margin of the San Fernando Basin. The depth to groundwater at the locations where Alternative 2 crosses the basin is approximately 100 feet below the ground surface (Watermaster, 1999) based on small-scale mapping.

3.1 INTRODUCTION

The geology and subsurface conditions of the site have been evaluated in terms of their impact on the proposed Pipeline and alternatives. We have also evaluated the impact of the proposed Pipeline and alternatives on the existing geologic conditions at the site.

It is our opinion that the site is suitable for the proposed Pipeline or alternatives, provided consideration is given to the on-site geologic and geotechnical conditions discussed in this report. It is noted that this is a geologic and geotechnical site assessment; for any given aspect of the project, final geologic and geotechnical recommendations should be provided in a separate report after plans become more finalized and appropriate field investigations have been performed.

3.2 POTENTIAL GEOLOGIC HAZARDS

3.2.1 Seismic Hazards

Hazards associated with seismic activity are described in the following paragraphs.

Ground Shaking

As indicated by the numbers and distribution of recorded earthquake epicenters shown on Figure 4, the proposed Pipeline and alternatives will continue to be subjected to periodic seismic shaking, perhaps of considerable intensity. The degree of shaking that is felt at a given site depends on the distance from the earthquake source, the type of subsurface material on which the project is situated, and topography. Generally, shaking is less severe on rock than on alluvium or fill, but ridge effects and other local phenomena may override this generalization.

Liquefaction

Liquefaction is defined as significant and relatively sudden reduction in stiffness and shear strength of saturated sandy soils caused by a seismically induced increase in pore water pressures. Potential for seismically induced liquefaction exists whenever relatively loose, sandy soils exist with high groundwater level and/or potential for long duration, high seismic shaking. When liquefaction occurs, the site can experience damage induced by permanent ground movements resulting in differential settlement and flotation of structures, tanks and pipelines.

The CDMG (1998) has designated certain areas within California as potential liquefaction hazard zones. These are areas considered at greater risk of liquefaction-related ground failure during a seismic event, based upon mapped surficial deposits and the presence of a relatively shallow water table. As shown on Figure 5, there are no areas delineated by the CDMG (1998) along the proposed Pipeline as having the potential for earthquake-induced liquefaction. Most of the proposed Pipeline is generally located on rock outside of the liquefaction hazard zones, and therefore is not considered at high risk of potential liquefaction during a seismic event. Based on CDMG (1998), liquefaction is not anticipated to present a significant seismic hazard to the proposed Pipeline.

Two small sections along the alignment of Alternative 1 and approximately two-thirds of the alignment of Alternative 2 are delineated by the CDMG (1998) as being in areas having the potential for earthquake-induced liquefaction, as shown on Figure 5. The remaining sections of Alternatives 1 and 2 are generally located on rock, outside of the liquefaction hazard zones, and therefore are not considered at high risk for potential liquefaction during a seismic event. Based on CDMG (1998), liquefaction may present a significant seismic hazard to segments of Alternatives 1 and 2 if localized near-surface or perched water conditions exist, and soil strength loss is a potential risk to segments of the proposed alignments.

The location of Alternative 3 is in an area that is not delineated by the CDMG (1998) as having the potential for earthquake-induced liquefaction. The site of Alternative 3 is generally located on rock, outside of the liquefaction hazard zones, and therefore is not considered at high risk for potential liquefaction during a seismic event.

Ground Lurching

Ground lurching is permanent displacement or shift of the ground in response to seismic shaking. Ground lurching occurs in areas with high topographic relief, and usually occurs near the source of an earthquake, where shaking and permanent ground displacements are highest. These displacements can result in permanent cracks in the ground surface, which are sometimes confused with surface fault ruptures. Cracks from lurching do not extend to great depths, usually only several feet to tens of feet below the ground surface, depending on specific site conditions. At the project site, ground lurching may represent a potential hazard to the proposed Pipeline and Alternatives 1 and 3, most likely as a result of an earthquake on the underlying Santa Monica Mountains blind thrust.

Surface Fault Rupture

There are no known active or potentially active surface fault traces that have been recognized as crossing the proposed Pipeline or the alternatives and the CDMG (1997) does not delineate any part of the surrounding area as being within an Alquist-Priolo Earthquake Fault Zone. Therefore, the potential for surface fault rupture is not considered a significant seismic hazard to the proposed Pipeline or any of the alternatives.

Tsunami

A tsunami is a great sea wave (commonly called a tidal wave) produced by a significant undersea disturbance, such as tectonic displacement of the sea floor associated with large, shallow earthquakes. Other processes that may generate tsunamis include sea-floor landslides, large rock falls into the ocean, and exploding volcanoes. Tsunamis are not a potential seismic hazard to the proposed Pipeline or any of the alternatives due to the alignments' elevation and distance from the Pacific Ocean.

Seiche

A seiche is an oscillation of a body of water in an enclosed or semi-enclosed basin, such as a reservoir, harbor, lake, or storage tank, resulting from earthquakes or other large environmental disturbances. No such bodies of water that would be subjected to failure due to seiche lie directly upstream of the proposed Pipeline or Alternatives 1 and 2; therefore, seiches are not a potential seismic hazard to the proposed Pipeline or to Alternatives 1 and 2. However, seiche is a potential seismic hazard to Alternative 3 because this alternative is an enclosed reservoir.

Differential Seismic Settlement

Differential seismic settlement occurs when seismic shaking causes one type of soil or rock to settle more than another type. It may also occur within a soil deposit with relatively homogeneous properties if the seismic shaking is uneven, which could occur due to variable geometry, for example, variable depth of the soil deposit. Differential seismic settlement is most likely to occur in areas that transition between rock formations and more recently deposited alluvial soils or human-placed artificial fill. Along the alignment of the proposed Pipeline and Alternatives 1 and 2, transition zones between rock and artificial fill or alluvium occur at drainage channel crossings. There is also the potential for variable soil depths in the alluvium along the alignment for Alternative 2. Alternative 3 appears to be situated entirely upon rock, which would not be prone to differential settlement. Therefore, differential settlement represents a potential seismic hazard to the proposed Pipeline and Alternatives 1 and 2.

Seismically-Induced Landslides

The Seismic Hazards Zone maps for the Canoga Park quadrangle (CDMG, 1998) indicate that all of the slopes within the proposed project area have the potential for earthquake-induced landsliding. These are areas where previous occurrence of landslide movement, or local topographic, geologic, geotechnical and subsurface water conditions indicate a potential for permanent ground displacement.

The potential for landslides induced by seismic shaking is high along the alignments of the proposed Pipeline and Alternatives 1, and at the location of Alternative 3, mostly based on apparent previous occurrence of landslide movement, site topography and the geologic conditions (out-of-slope dipping rock). Alternative 2 is less likely to be impacted by a seismically induced landslide, based on portions of the alignment being within the San Fernando Valley and the alignment following previously graded and well-established developments. However, the potential for a seismically induced landslide to impact Alternative 2 does exist if the landslide is large enough.

Landslides from other sources are discussed in Section 4.2.2.

Seismically Induced Flooding

Seismically induced flooding is not considered a significant hazard for the proposed Pipeline or Alternatives 1 and 2 because no dams, rivers, water tanks or other significant water retention structures lie within the drainage basin occupied by the project. Seismically induced flooding could impact Alternative 3 if the existing Topanga Tank were to rupture.

3.2.2 Other Hazards

Subsidence

The extraction of water or petroleum from sedimentary source rocks can cause the permanent collapse of the pore space previously occupied by the removed fluid. The compaction of subsurface sediment caused by fluid withdrawal will cause subsidence of the ground surface overlying a pumped reservoir. If the volume of water or petroleum removed is sufficiently great, the amount of resulting subsidence may be sufficient to damage nearby engineered structures. Significant quantities of water or petroleum are not being extracted in the area occupied by the proposed Pipeline or the alternatives. Subsidence is therefore not anticipated to pose a significant hazard to the project site, barring such extraction in the future.

Volcanic Hazards

No centers of potential volcanic activity occur within hundreds of miles of the proposed Pipeline or the alternatives. Volcanic hazards such as lava flows and ash falls are therefore not anticipated to present a hazard to the project.

Landslides

Landslides are common in the slopes surrounding the proposed Pipeline and alternatives. The landslides are generally associated with high rainfall or a rise in groundwater and involve slopes underlain by both surficial deposits (generally colluvium) and bedrock. There are numerous landslides mapped within the project area, as shown on Figures 2 and 3.

Many of the existing landslides in the vicinity of the proposed Pipeline and alternatives, including most of the largest landslides, appear to be relatively ancient and inactive under contemporary climatic conditions. Some of the smaller landslides, generally associated with steep cut slopes or steep slopes incised in the terrain by erosion, are more recent and probably developed under climatic conditions similar to contemporary ones. It is these smaller landslides that are more likely to be affected by, or to affect, the proposed project.

No landslides have damaged an existing 12-inch diameter oil pipeline belonging to the Tosco Refining Company (Tosco) that follows the route of the proposed Pipeline (Tosco Refining Company, 2001, personnel communication with Steve Van Winkle). This pipeline was constructed along Mulholland Drive in the mid-1950's (Tosco Refining Company, 2001, personnel communication) and has not required repairs or maintenance as a result of landslide movement. However, the same site conditions that are conducive to seismically induced landslides are also conducive to landslides associated with high rainfall or a rise in groundwater. Therefore, the potential for a landslide induced by rainfall or a rise in groundwater (through irrigation) is high along the alignments of the proposed Pipeline and Alternative 1, and at the location of Alternative 3 and is less likely to impact Alternative 2 because the area is more flat in topography.

Erosion

As mentioned above, Tosco operates a 12-inch diameter oil pipeline that follows the route of the proposed Pipeline. According to Tosco (Tosco Refining Company, 2001, personnel communication with Steve Van Winkle), the winter rainy seasons have caused erosion of the unpaved roadbed overlying their pipeline. The erosion most commonly results in partial removal of the cover material, but the pipeline has been exposed in the past. Soil loss along Dirt Mulholland is also attributable to periodic grading conducted by the City of Los Angeles Bureau of Street Services. Because Mulholland Drive is not paved along most of the length of the proposed Pipeline, erosion could affect the pipeline during heavy rain events. Erosion could also affect sections of Alternative 1 where the alignment crosses the undeveloped slopes. Erosion is not likely to affect Alternative 2 because the alignment follows paved roadways. The affects of erosion on Alternative 3 could not be evaluated because the details of proposed site layout are unknown at this time.

Corrosion

As mentioned above, Tosco operates a 12-inch diameter oil pipeline that follows the route of the proposed Pipeline. According to Tosco (Tosco Refining Company, 2001, personnel communication), they have had to provide protection against corrosion resulting from the chemical composition of the soils native along the pipeline alignment. It is probable that any metallic pipeline buried along the Pipeline or alternative alignments would also require measures to counteract the corrosive nature of the soils. The proposed project would include cathodic protection to mitigate against adverse interaction with the existing Tosco pipeline in an anode/cathode type of phenomenon.

For Alternative 3, the corrosive nature of the soils is not likely to be an impact becuase the tank would be above ground. However, connecting pipe(s) may need protection from corrosive soils.

Collapsible Soils

Collapsible soils are soils, generally deposited in an arid environment, that undergo settlement upon wetting, even without the application of additional load. The Pipeline and Alternatives 1 and 3 would be founded primarily in bedrock or landslide deposits derived from bedrock and are unlikely to be affected by collapsible soils. Collapsible soils could be anticipated along Alternative 2 where the alignment crosses the alluvial soils. However, in developed areas any collapse that could occur in the soil has likely already taken place. Therefore, collapsible soils are not likely to affect the Alternative 2 alignment but should be addressed in the preliminary geotechnical report should this alternative be selected.

Expansive Soils

Expansive soils are fine-grained soils (clay) that can undergo a significant increase in volume with an increase in water content and a significant decrease in volume with a decrease in water content. Changes in the water content of an expansive soil can result in severe distress to structures constructed upon the soil. Soils derived from claystone or clay shale bedrock in the project area, or the clayey bedrock itself, may be susceptible to expansion and, if so, could affect the Pipeline and the alternatives.

3.3 POTENTIAL ENVIRONMENTAL IMPACTS

3.3.1 Slope Stability and Erosion

As discussed in Section 3.2.2, many of the existing landslides in the vicinity of the proposed Pipeline and alternatives, including most of the largest landslides, appear to be relatively ancient and inactive under existing climatic conditions. Some of the smaller landslides, generally associated with steep cut slopes or steep slopes incised in the terrain by erosion, are more recent and probably developed under existing climatic conditions. It is these smaller landslides that are more likely to be affected by the project.

For the proposed pipeline and alternatives, after the pipeline has been buried in the ground, it should have essentially no influence on the stability of adjacent terrain or on erosion. The most likely mechanism by which the pipeline could have an effect on slope stability is by the pipe trench backfill acting as a conduit for infiltration of surface water. This significance of this mechanism can be minimized by use of trench backfill that is relatively impervious, such as the existing native materials.

During construction, the open trench could have some effect on slope stability. The effect, whether stabilizing or destabilizing, would depend on the location and dimensions of the trench relative to the topography of the area within which it lies. If there were potentially any destabilizing effects, these could be reduced by limiting the length of trench that is open at any time and backfilling the trench at the end of every workday.

For Alternative 3, the effect on stability will depend greatly on the details of design, which are unknown. An evaluation of potential impacts on slope stability should be conducted if this alternative is selected..

3.3.2 Groundwater Conditions

The impacts of the proposed development to existing site groundwater conditions are anticipated to be minimal. In particular, the following is noted:

- The proposed project would not significantly alter the ability of precipitation to infiltrate the subsurface; consequently, infiltration would not decrease significantly.
- There are no groundwater wells or well fields present within 1-mile of the site. As such, the project would not affect the yields of adjacent wells or well fields.
- The proposed project would not impact potable groundwater sources (i.e., quality and quantity.
- The proposed project would not involve emissions or contamination that would negatively affect groundwater quality. No mitigative measures relative to groundwater quality are required assuming standard care is taken during construction to control leaks, etc., from construction equipment.
- The proposed project will not involve removal of water from the ground.

3.3.3 Impacts to Mineral Resources

The proposed project is located in areas designated as "existing urbanized areas" and "urbanizing areas" by the CDMG (CDMG, 1979). The central Santa Monica Mountains are designated an MRZ-3 area, corresponding to "areas containing mineral deposits the significance of which cannot be evaluated from available data." Four oil wells appear to have been drilled in the vicinity of the proposed project (Munger Map Book, 1999). These wells were constructed between 1921 and 1954 and are noted by Munger Map Book (1999) as being uncompleted and abandoned. There are no known mineral resources in the project area. Therefore, the proposed project would not likely have an adverse impact on the mineral resources of the State of California.

3.4 DESIGN AND CONSTRUCTION CONSIDERATIONS

The sites appear suitable for the proposed Pipeline or alternatives provided that the considerations discussed in this section are followed.

3.4.1 Differential Settlement

Differential settlements could occur where the proposed pipeline or tank foundations cross the daylight contact lines between artificial fill/alluvium/landslide and bedrock. Differential settlements could damage facilities that cross these boundaries. If the potential for negative impacts is found at these locations or at other artificial fill/alluvium/landslide/bedrock contact lines, possible remediation includes:

- Relocate the pipeline or structure away from these contact lines;
- (2) Construct transition zones between the bedrock and the fill/alluvium/landslide contacts. A transition zone involves overexcavating some of the bedrock material and replacing it with engineered fill in order to provide a gradual transition from the stiffer rock to the less stiff soils, thereby evenly distributing potential settlement along the pipeline.
- (3) Design the pipeline to accommodate the anticipated differential settlement. Structural design modifications for the tank site may include changes to the foundation location, elevations, or types.

3.4.2 Seismic Shaking

As discussed in Section 2.4, the Pipeline and alternatives would be subjected to periodic seismic shaking. Normal design and construction standards, delineated in the Los Angeles Building Code (City of Los Angeles, 1999), which is based on the California Building Code (State of California, 1998) and the Uniform Building Code (International Conference of Building Officials, 1997) and regulated by the design review, permitting, and construction inspection procedures enforced by the City of Los Angeles, result in the reduction of hazards from potential seismic shaking, seismic lurching, and foundation settlement to standard design levels. Therefore, no other specific mitigation measures are proposed at this time.

3.4.3 Liquefaction

Liquefaction is unlikely to affect the proposed Pipeline or Alternative 3 due to the generally deep groundwater table and the predominance of bedrock foundation materials. Liquefaction may present a significant seismic hazard to segments of Alternatives 1 and 2 where localized near-surface or perched water conditions exist. The potential for liquefaction should be evaluated in a Preliminary Geotechnical Investigation to support engineering design.

3.4.4 Slope Stability

The possibility of landslides occurring in the future at the project area is likely, based on the topography and subsurface conditions. This potential exists primarily along the north facing slopes, as the geologic conditions on these slopes appear conducive to landslides. High rainfall or seismic shaking could induce landslides on these slopes in their present condition. The landslides would most likely consist of shallow surficial type failures but could also consist of a deep-seated failure.

It is not likely that the proposed Pipeline would increase the potential for a landslide to occur. However, an excavation at the toe of a slope may temporarily create a less stable condition until the excavation is backfilled or otherwise stabilized. It is possible that Mulholland Drive was built by a combination of excavation on the high side of the roadway and fill on the low side. It is possible that the fill was not controlled. Uncontrolled fill materials would make a relatively poor foundation for the pipeline and be more susceptible to landsliding, relative to the native bedrock. This concern may be mitigated by constructing the pipeline on the high side of the roadway where the thickness of fill would be least, and preferably burying it in the bedrock. However, the existing petroleum pipeline may limit the option for placing the pipe on the high side of the roadway.

If it is necessary to place the pipeline across an area of fill, consideration should be given to deepening the trench to have a bedrock foundation. Although the pipeline would not likely increase the potential for landslide, protection of the pipeline from potential landslides in areas of fill is considered a prudent design measure, and would supplement the protection provided by planned isolation/shut-off valves.

The occurrence of a landslide following the construction and during the operation of the pipeline could damage or rupture the pipeline. A rupture of the pipeline would add water into the slope, potentially increasing the impact of the landslide on the slope and pipeline. To limit the discharge of a significant amount of water into the slope following a pipeline rupture, the installation of automated shut-off valves should be considered along the pipeline alignment.

Regulating station and valves should be placed outside the limits of a mapped landslide and along the high side of the roadway where artificial fill is less likely to be encountered.

3.4.5 Expansive soils

As discussed above, expansive soils may be encountered. In this case, it may be necessary to design the pipeline for these conditions. Expansive soils should be addressed in a Preliminary Geotechnical Investigation.

3.4.6 Other Construction Considerations

- Backfill materials – Sand bedding and fill immediately adjacent to the pipe (sidefill) will likely have to be imported. Native materials can likely be used to backfill the trench above the sidefill.
- Seismically induced flooding - For Alternative 3, sloshing of water in either the new or existing Topanga Tank should be considered during design.

- Groundwater - Groundwater, mostly likely seeps, may be intercepted by the trench during construction of the proposed Pipeline or Alternatives 1 or 2. This may be either beneficial or detrimental.
- Surface erosion/maintenance - Limited wind and water erosion might occur locally during the construction of the proposed facilities. However, measures commonly employed during construction, such as spraying water to control dust, use of sandbags to control siltation, and drainage control measures such as the covering of soil stockpiles with plastic sheeting during wet weather, should limit the potential for significant wind and water erosion impacts.
- Construction of excavations, foundations, or grading on site slopes may impact site slope stability. Potential site slope instabilities should be mitigated by normal construction procedures, which includes monitoring of construction activities by the geotechnical engineer of record or his representatives.

This report presents our conclusions and recommendations pertaining to the subject site, based on the assumption that the geologic and subsurface conditions do not deviate appreciably from those described in this report. The purpose of this report is to provide a reconnaissance-level geologic and geotechnical site assessment for inclusion in this EIR.

Professional judgments presented in this report are based on evaluations of the technical information gathered, on our understanding of the proposed construction, and on our general experience in the geotechnical engineering field. We have no way of knowing the successful bidder's capabilities, experience, choice of crew and equipment, choice of bidding and operating strategies, or limitations that may be imposed on him by the Owner or the designer. Therefore, we cannot guarantee the performance of the project in any respect, only that URS's engineering work and judgments rendered meet the standard of care of our profession at this time.

This report has been prepared for the Department solely for their use in assessing the feasibility of constructing the proposed Pipeline or its alternatives. This report has not been prepared for use by other parties or for other uses, and may not contain sufficient information for purposes of other parties.

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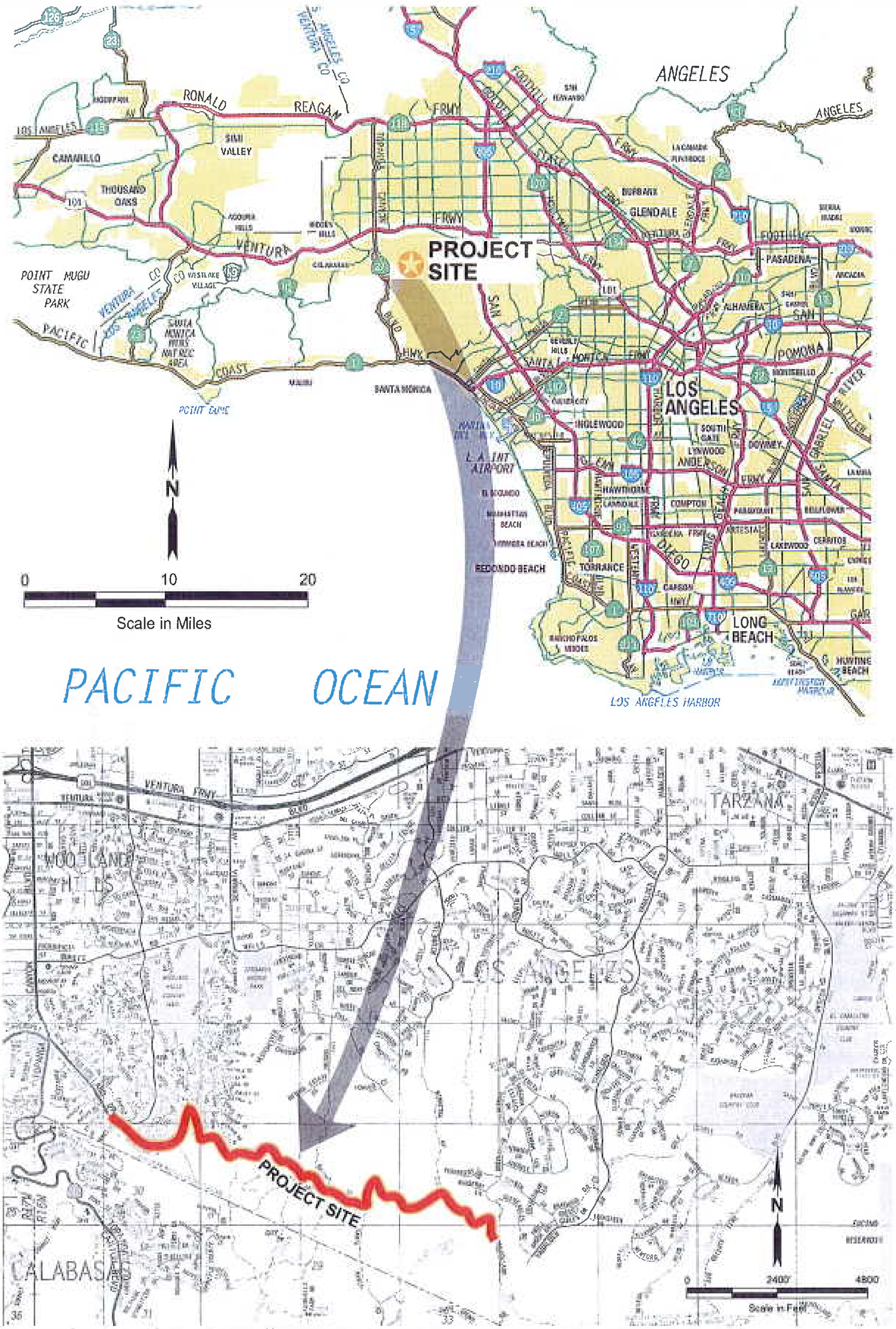

REGIONAL AND SITE LOCATION MAP

Project No.: 5700170019.02	Date: APRIL 2001	Project: MULHOLLAND WATER PIPELINE	Figure 1

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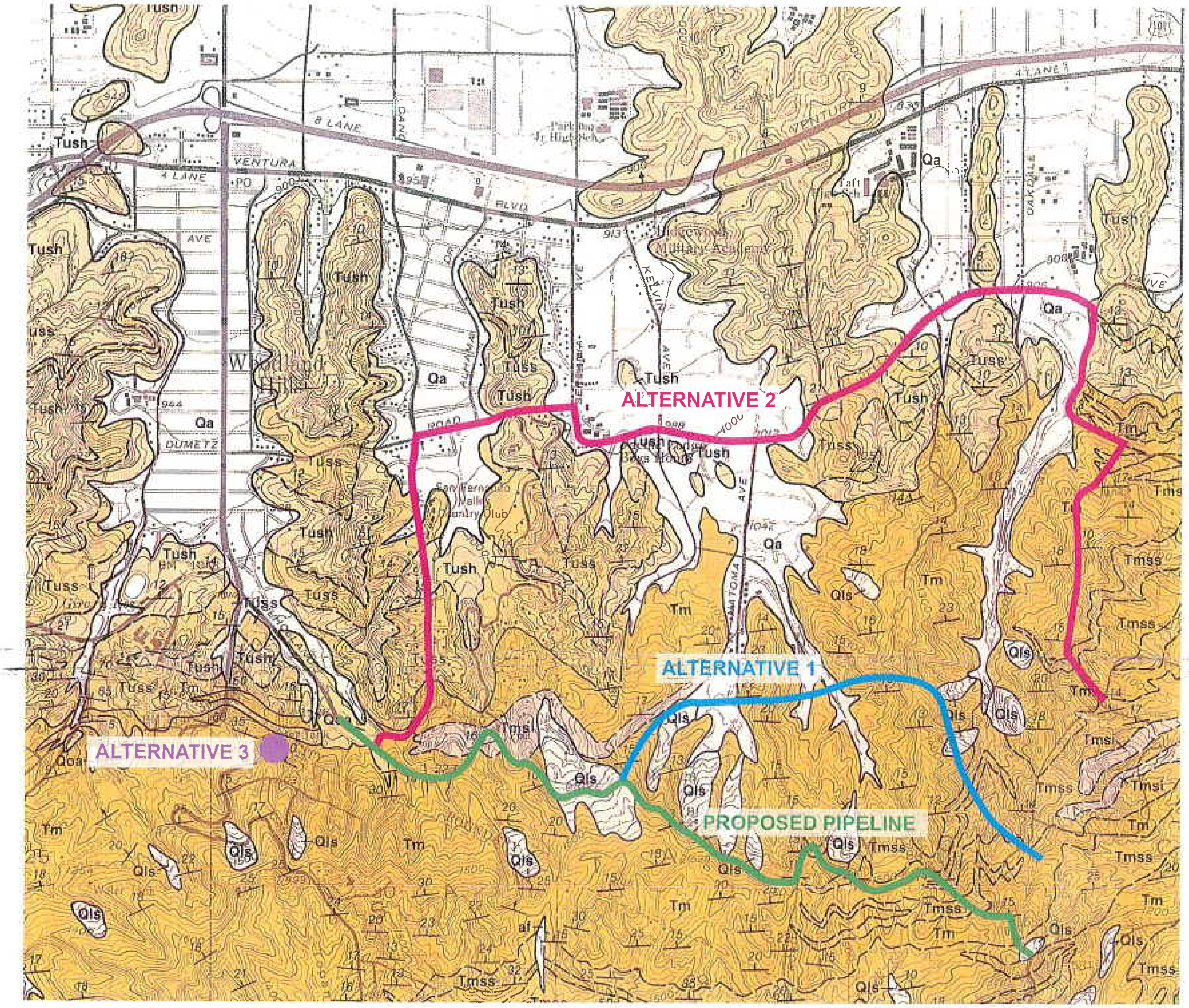

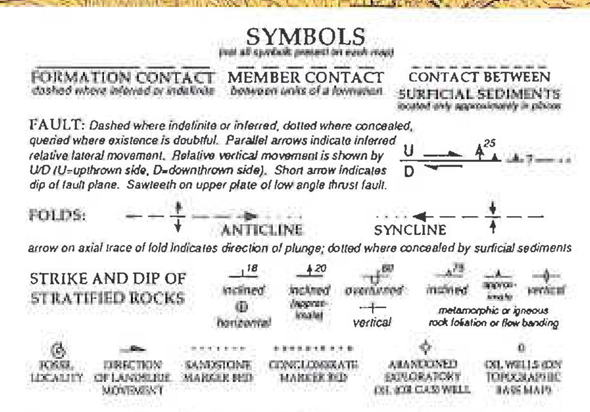

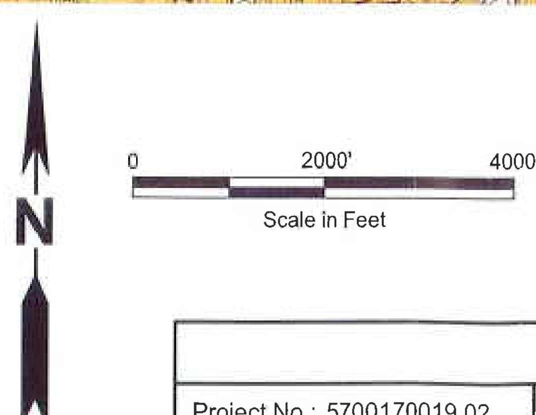

af | Qs | Qg | Qa | Qls

SURFICIAL SEDIMENTS

unconsolidated detrital sediments; undissected to slightly dissected

af *artificial cut and fill* **Qs** *beach sand*
Qg *gravel, sand and silt of major stream channels*
Qa *alluvial gravel, sand, and clay of valley areas*
Qls *landslide debris; some may be of late Pleistocene age*

Qoa

OLDER SURFICIAL SEDIMENTS

unconsolidated to weakly consolidated alluvial sediments, dissected where elevated; late Pleistocene age

Qoa *older alluvium of gray to light brown pebble-gravel, sand and silt-clay derived from Santa Monica Mountains; includes thin basal layer of marine fossiliferous sand in and near sea cliffs (McGill 1989)*

Tush | Tuss | Tud

UNNAMED SHALE

(upper member of Modelo Formation of Hoots 1931; Upper Modelo Formation of Durrell 1954; and A.E.G. maps, 1982; Santa Margarita Formation of Truex and Hall 1969, Truex 1976; equivalent to Sisquoc Formation of Dibblee 1989, in Ventura basin)
marine clastic and biogenic; late Miocene age
("Delmontian" and late Mohnian Stages)

Tush *light gray claystone and siltstone, moderately to vaguely bedded; crumbly where weathered*
Tud *white-weathering diatomaceous clayey shale, thin bedded, soft, chalky to somewhat platy, semi-siliceous*
Tuss *light gray sandstone, soft, friable, fine to medium grained*

Tm | Tmsl | Tmcg | Tmss

MONTEREY FORMATION

(lower member of Modelo Formation of Hoots 1931; Lower Modelo Formation of Durrell 1954; A.E.G. maps 1982; Modelo-Monterey Formation of Truex and Hall 1969, Truex 1976; Modelo Formation of Yerkes and Campbell 1979; equivalent to Monterey Formation of Dibblee 1989, in Ventura basin)
marine biogenic and clastic; middle(?) and late Miocene age
(Mohnian, possibly latest Luisian Stages)

Tm *white-weathering, thin bedded, platy siliceous shale, dark brown where fresh; moderately hard; locally porcelaneous, brittle; in many places includes thin interbeds of clay shale, siltstone and of light gray silty to fine grained sandstone; platy siliceous shale at Will Rogers State Park*
Tmsl *similar to* **Tm**, *but includes nearly equal amounts of interbedded clay shale, siltstone and sandstone*
Tmss *light gray to tan semi-friable bedded sandstone, fine to medium grained; includes some interbedded siltstone and shale; deposited as deep sea fans (Tarzana Fan of Sullwold 1960); at base locally includes hard graywacke on Santa Monica Slate* (**sms**) *with dark grains and fragments of slate*
Tmcg *light gray conglomerate of poorly sorted subrounded pebbles, cobbles and small boulders of mostly granitic rocks, some of metaporphyry, quartzite, and of Tertiary volcanic rocks (Conejo Volcanics?); near Santa Maria Road (where mapped as older alluvium by Hoots 1931) includes large, subrounded clasts of Miocene(?) white to tan dolomite; at lower Temescal Canyon contains pebbles and cobbles of white tuff*

Source: Geology from "Geologic Map of the Topanga and Canoga Park (south half) Quadrangles, Los Angeles County, CA" by Thomas W. Dibblee, Jr. 1992

Note: The Kittridge Tanks are located approximately 3.75 miles to the NW of Topanga Tank at the end of Victory Boulevard which is beyond the limits of this map.

GEOLOGIC MAP

Project No.: 5700170019.02	Date: APRIL 2001	Project: MULHOLLAND WATER PIPELINE	Figure 2

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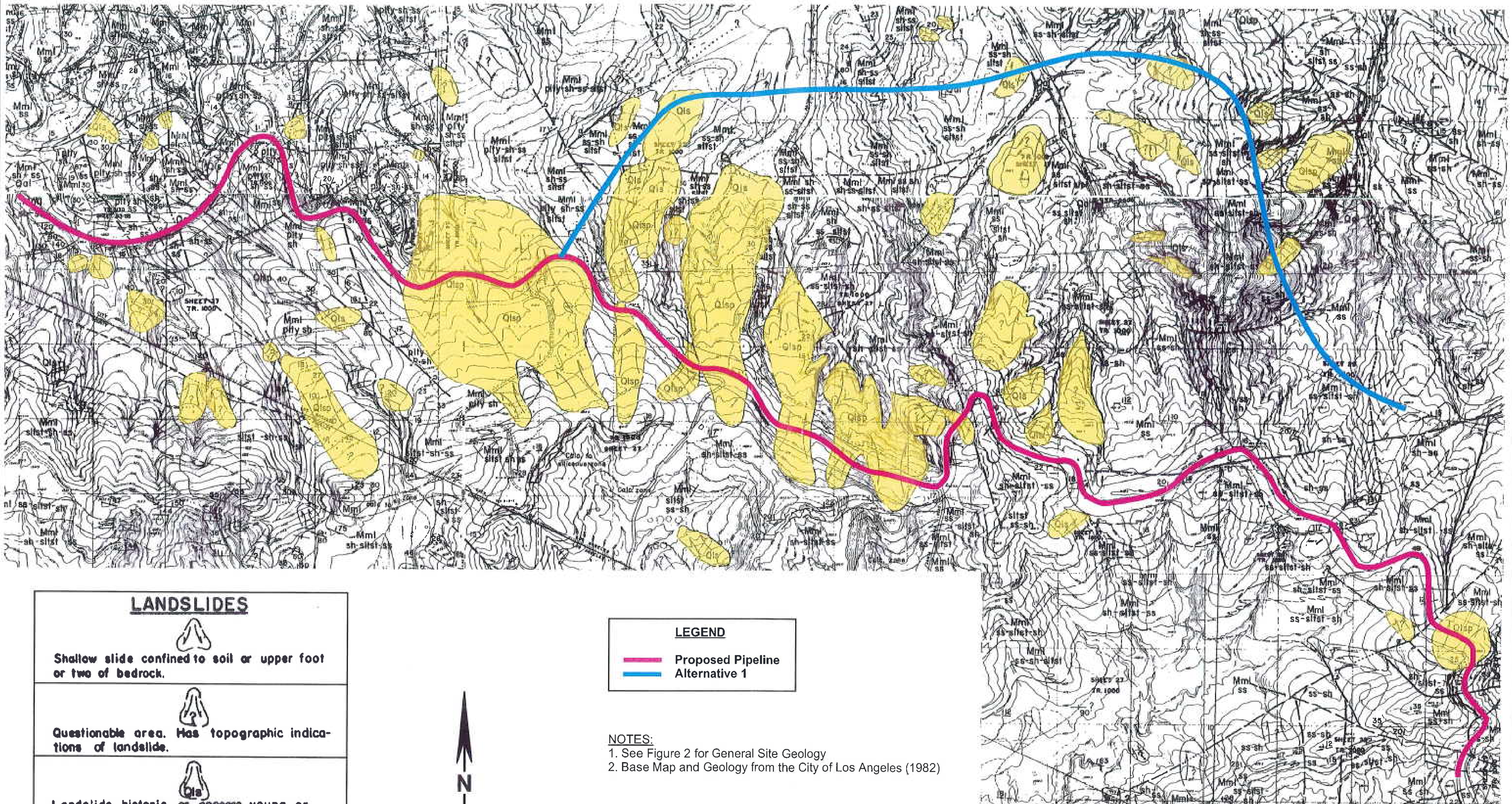


LANDSLIDES

Shallow slide confined to soil or upper foot or two of bedrock.

Questionable area. Has topographic indications of landslide.

Landslide, historic, or appears young or recent.

Landslide, prehistoric, or appears old.

LEGEND

Proposed Pipeline

Alternative 1

N

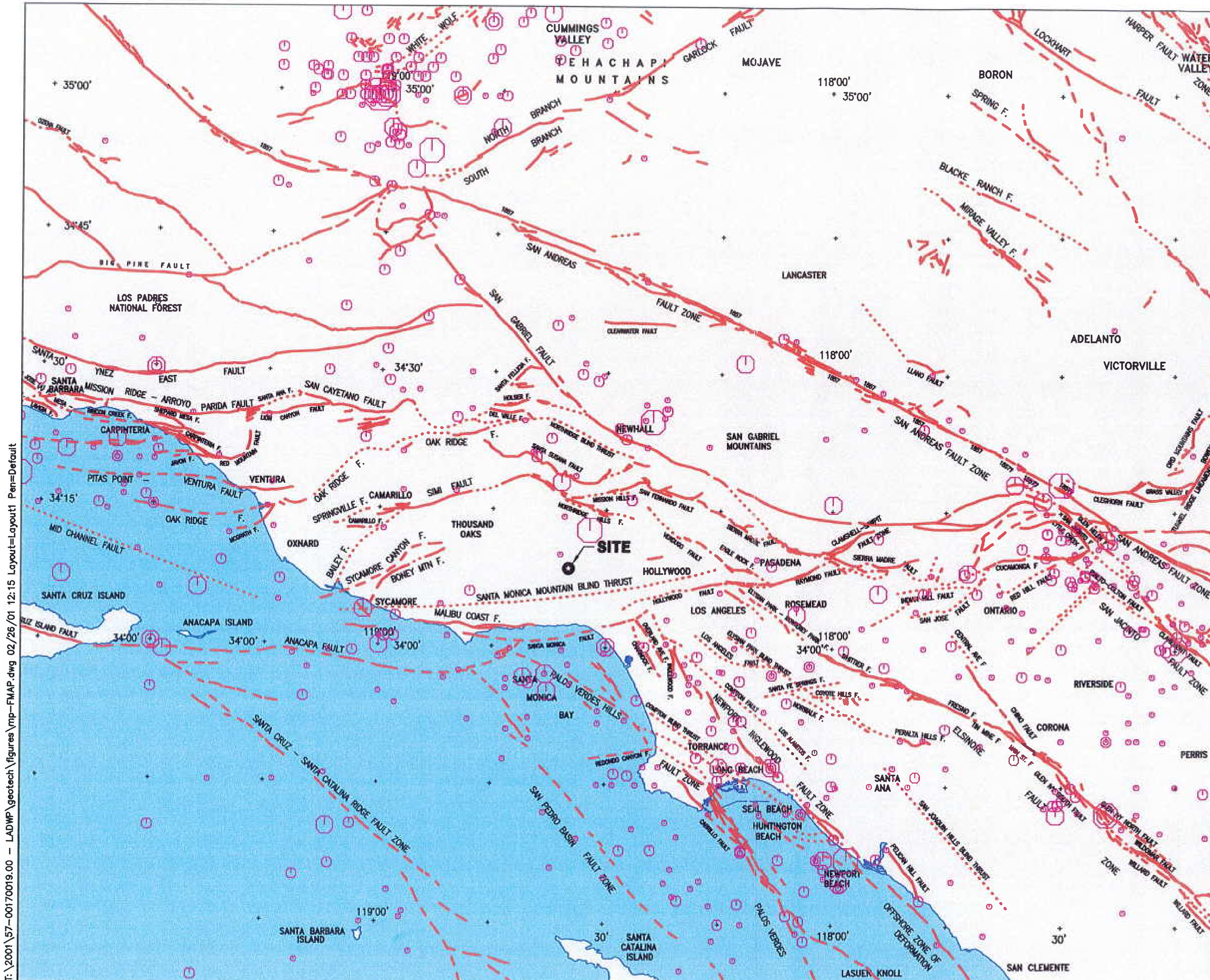
0 400 800

Scale in Feet

NOTES:

1. See Figure 2 for General Site Geology
2. Base Map and Geology from the City of Los Angeles (1982)

CITY OF L.A. GEOLOGIC MAP - LANDSLIDE LOCATIONS			
Project No.: 5700170019.02	Date: APRIL 2001	Project: MULHOLLAND WATER PIPELINE	Figure 3



DRAFT SUBJECT TO CHANGE

N

0 20 40

APPROXIMATE SCALE, kilometers

LEGEND

REPORTED EARTHQUAKE MAGNITUDES.

- 3.5 TO 3.9
- 4.0 TO 4.9
- 5.0 TO 5.9
- 6.0 TO 6.9
- 7.0 AND GREATER

SOUTH OF LATITUDE 35°N, EPICENTER AND MAGNITUDE DATA ARE FROM THE CALTECH EARTHQUAKE CATALOG FOR THE PERIOD FROM 1800 TO JUNE 1994. ONLY EARTHQUAKES OF MAGNITUDE 3.5 AND LARGER ARE SHOWN. AFTERSHOCKS ARE NOT INCLUDED.
NORTH OF LATITUDE 35°N, DATA ARE FROM THE CNSS EARTHQUAKE CATALOG (UC BERKELEY) FOR THE PERIOD FROM 1932 TO DECEMBER, 1998. ONLY EARTHQUAKES OF MAGNITUDE 4.0 AND LARGER ARE SHOWN. SIGNIFICANT AFTERSHOCKS OF THE 1952 KERN COUNTY EARTHQUAKE ARE INCLUDED.

? ? ?

APPROXIMATE LOCATION OF HOLOCENE AND PLEISTOCENE FAULTS, DOTTED WHERE CONCEALED, QUERIED WHERE CONJECTURAL. FAULT LOCATIONS BASED ON: ZIONY AND JONES, 1989; CDMG GEOLOGIC MAP SERIES OF CALIFORNIA, 1977–1986 (1:250,000 SCALE); CDMG GEOLOGIC MAP SERIES, CALIFORNIA CONTINENTAL MARGIN, 1987 (1:250,000 SCALE); HAUKSSON, 1990; SHAW AND SHEARER, 1999; WRIGHT, 1991; AND DOLAN, ET AL., 1995.

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REGIONAL FAULT AND EPICENTER MAP

Proj. No.: 5700170019.02	Date: APRIL 2001
Project: MULHOLLAND WATER PIPELINE	Figure 4

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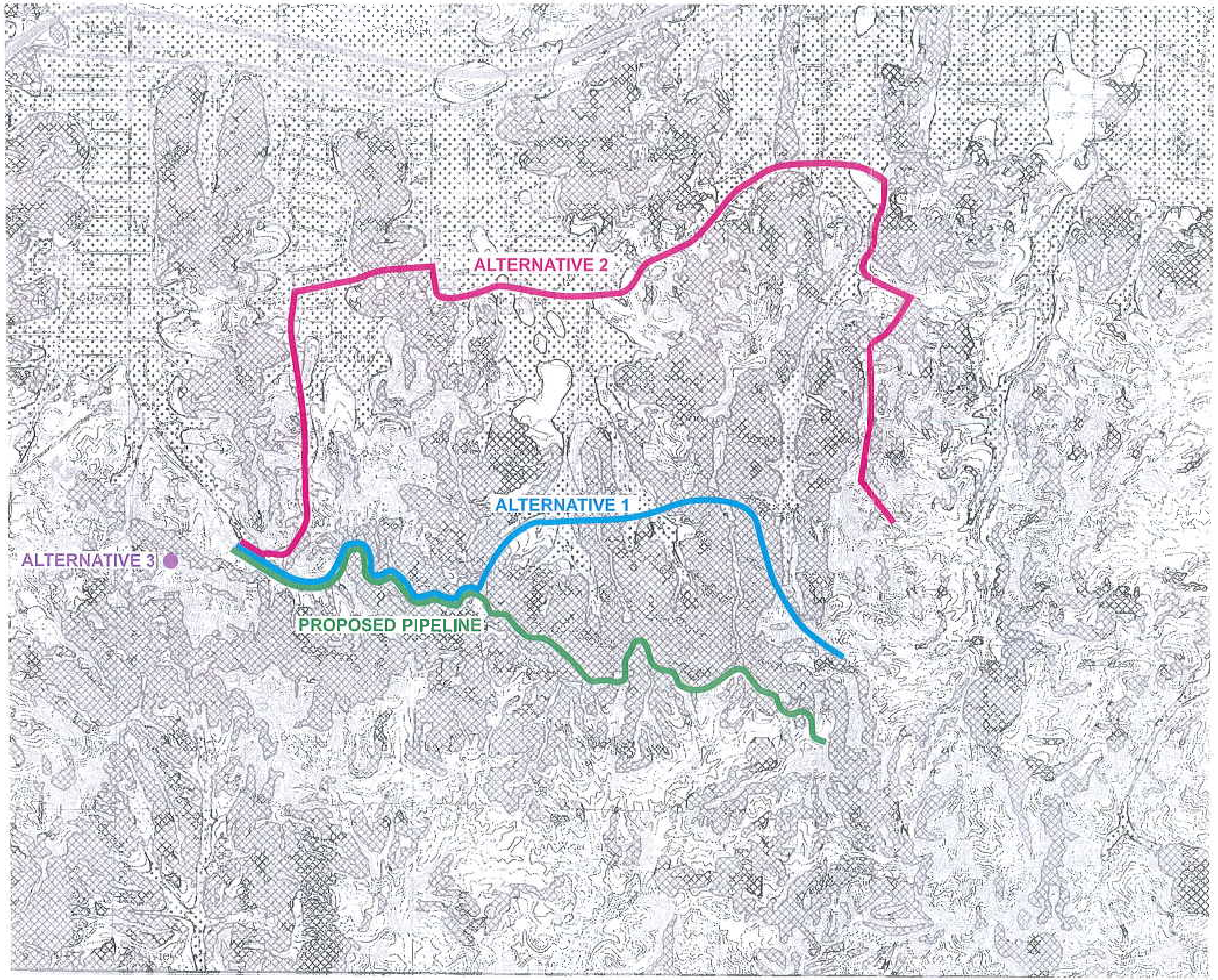

LEGEND

LIQUEFACTION

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

EARTHQUAKE-INDUCED LANDSLIDES

Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

N

0 2000' 4000'

Scale in Feet

NOTE:
Base map taken from State of California, Seismic Hazards Zones, Canoga Park Quadrangle. Official map released Feb. 1, 1998.

The Kittridge Tanks are located approximately 3.75 miles to the NW of Topanga Tank at the end of Victory Boulevard which is beyond the limits of this map.

SEISMIC HAZARD ZONES MAP			
Project No.: 5700170019.02	Date: APRIL 2001	Project: MULHOLLAND WATER PIPELINE	Figure 5

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APPENDIX G

GROWTH INDUCEMENT DATA

MULHOLLAND WATER PIPELINE PROJECT
MAXIMUM BUILD-OUT CALCULATIONS PER DWP SERVICE ZONES

	ZONE	REGION	AREA (SF)	ACRES	PERIMETER	A PER DU (SF)	MAXIMUM DU
	R1	1337	19046949.893	437.258	57089.137	5000	3809
	RE15	1337	5747010.645	131.933	20984.357	15000	383
	RA	1337	1217805.427	27.957	6355.456	17500	69
	RE40	1337	8277469.537	190.025	24125.212	40000	206
Topanga Tank			**34289235.502**	**787.173**		**0**	**0**
	UNDEVELOP	1337	2889835.454	66.341	32522.907		4467
	RE40	1677	17334616.852	397.948	42887.096	40000	433
	RA	1677	43850547.144	1006.670	110732.881	17500	2505
	RE15	1677	3197289.133	73.400	9193.501	15000	213
Corbin Tank			**64382453.129**	**1478.018**		**0**	**3151**
	UNDEVELOP	1677	52509776.318	1205.459	113926.343		
TOTAL							**7618**

Note: Topanga Tank Acreage provided by DWP is 610
Corbin Tank Acreage provided by DWP is 1,392