July 19, 1990

Mr. Mehdi Khailaizadeh  
City of Corona  
Department of Public Works  
815 West Sixth Street  
Corona, CA 91718-0090

Dear Mr. Khailaizadeh:

This is to acknowledge receipt of geologic/seismic reports for the following sites:

2. Tentative Tract No. 20966, Corona; by Richard-Mills Assoc.; 2/25/86.
3. Tentative Tract 9850, Corona; by S.E. Medall & Assoc.; 10/5/78 and 1/24/80.

Please note that Plate A to report 3, which shows the locations of trenches, is missing from the copy. If possible, we would appreciate a copy of that plate to complete our file.

These reports contain information (mainly trench data) on the Chino fault which may assist us in planning future fault evaluations under the Alquist-Priolo Act. Receipt of these reports is very much appreciated.

Sincerely,

Earl W. Hart  
Senior Geologist & Program Manager

EWH: hk

cc: A-P file (3)
ENVIRONMENTAL IMPACT REPORT

On

Tentative Tract Map 4873
The 294 Acre Village Grove Planned Development Amendment Easterly Of Border Avenue

Submitted To
The City of Corona

Prepared By
COMMUNITY SCIENCE TECHNOLOGY, INC.
Ralph E. Bolles, CE
Vice President

Dated: June 29, 1973
The terrace slope along the west side of Mabel Creek contains a slightly different habitat than that of the wild lands adjacent. The habitat is too limited to provide significant shelter for larger animals, but ground animals, insects and birds are present in great numbers.

The reservoir barranca is unique among the wildlands in that it is totally isolated by man-made objects and cultivation from the Santa Ana Mountains. It provides, therefore, a localized habitat for animals and an island for birds.

The orange and lemon groves provide a habitat for birds, insects, reptiles and rodents.

To the knowledge of the consultants there are no plants or animals of endangered species on the project site.

F. Geology, seismicity and groundwater: The following geological data has been abstracted from the investigations of C. Michael Scullin, Registered Engineering Geologist as incorporated in the previously cited report by Kammeyer, Hogan and Lynch. This material is supplemented

by additional seismic hazard information on the project reported June 13, 1973, by F. Beach Leighton, Engineering Geologist.

The region of the project consists of alluviated valleys separated by narrow mountain ranges, which trend northwestward. The mountains rise sharply above the alluvial plains to summits 3,000 to 5,000 feet above sea level. The Santa Ana Mountains have been uplifted along the Elsinore Fault Zone or Elsinore Rift, which is within approximately 2000 feet of the southwesterly border of the project site. Three branches of the Chino Fault cut diagonally across the property. Other than ground surface form, no apparent or obvious indications of the faults are exposed at the surface within the project site.

The citrus area within the project are developed on a surface of an alluvium of a generally buff to dark brown color containing clay and silt mixed with sand, gravel and cobbles. The Department of Water Resources Bulletin 104-3 indicates the thickness of this alluvium varies from approximately 80 feet at the northerly boundary of the project to approximately 350 feet within the southerly portion of the site. There are surface exposures of sedimentary bedrock in the southerly portion of the site adjacent to Mabey Canyon.
The site is within 1/2 mile of the Elsinore Fault Zone and 23 miles from the San Jacinto Fault Zone. The San Andreas Fault Zone is located within 32 miles of the site. These zones have all experienced magnitude 6.0 or greater earthquakes during the past historical record. A magnitude 7 to 8 event should be anticipated along the San Andreas system within the next 50+ years. Utilizing data from the San Fernando earthquake: "Distance versus Acceleration (g)" chart by Jennings, 1971, and the "Duration of Strong Shaking versus Magnitude" chart by Seed and Idriss, 1971, the following peak ground accelerations (g) and durations may be anticipated at the site:

<table>
<thead>
<tr>
<th>Fault Zone</th>
<th>Magnitude</th>
<th>Distance</th>
<th>Accelerations (g)</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elsinore</td>
<td>6.0</td>
<td>1/2 Mile</td>
<td>0.6 (g)</td>
<td>20-30 Sec.</td>
</tr>
<tr>
<td></td>
<td>7.0</td>
<td>1/2 Mile</td>
<td>0.6 to 0.8 (g)</td>
<td>20-30 Sec.</td>
</tr>
<tr>
<td>San Jacinto</td>
<td>7.0</td>
<td>23 Miles</td>
<td>0.4 to 0.45 (g)</td>
<td>10-20 Sec.</td>
</tr>
<tr>
<td>San Andreas</td>
<td>8.0</td>
<td>32 Miles</td>
<td>0.4 to 0.5 (g)</td>
<td>20-50 Sec.</td>
</tr>
</tbody>
</table>

Potential geotechnical hazards which should be considered in the planning and construction of the project are seismicity, active faulting, locally steep terrain, fill and slope erosion and down slope sedimentation, cut slope failure and mass movements, and rock disposal.
The project area is underlain by the Temescal groundwater basin, a major source of water for the Temescal Water Company, supplying irrigation water to the region, and the City of Corona Water Department the supplier of domestic water. Although this groundwater basin is ample in terms of its water volume yield capacity, and recharge rate, the water quality is unacceptable as potable water unless it is blended with waters from other sources. The Temescal water has a high hardness and a high total dissolved minerals content; but the principal detrimental characteristic is its high concentration of dissolved compounds of nitrates, which exceeds considerably the allowable concentration of 45 parts per million established by the United States Public Health Service. Perliter and Ingalsbee (2) indicate that the nitrates concentration tends to increase with time. The depth to the groundwater surface within the site varies from 235 feet at the northerly end to 475 feet at the southerly end. The aquifer thickness varies from approximately 225 feet to 445 feet.

G. Water Supply: A serious water supply problem exists presently in the city, which is aggravated by any increase in water demand. This problem is threefold: the unacceptably low quality of the principal source of water, the wells pumping from the Temescal groundwater basin; the

(2) Perliter and Ingalsbee, "Master Plan Municipal Water System, City of Corona," 1968
estimated that 5 additional employees will be required. Sewer and water
maintenance, and sewage and water treatment operations will have in-
creased requirements, but of an amount difficult to quantify until detailed
planning of direction is undertaken.

A need for expansion of library facilities and personnel to maintain the
present level of service with the increased population is evident. The
construction of a new library on the site being dedicated by the developer
and the staffing of the library will fulfill this need. It is noted, however,
that the proposed library site is in the area subject to flood hazard until
the Oak Avenue channel is improved.

Certain capital projects and expenditures by the City, which are related
to the project, but for which the full impact of the need is not necessarily
attributable to the project are listed as follows:

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire station</td>
<td>$150,000</td>
</tr>
<tr>
<td>Library</td>
<td>300,000</td>
</tr>
<tr>
<td>Park construction</td>
<td>900,000</td>
</tr>
<tr>
<td>Traffic signalization</td>
<td>100,000</td>
</tr>
</tbody>
</table>

D. Seismic hazard: The immediate impact of the seismic hazard to
the project is the risk that planned land uses may not be compatible with
subsequently discovered earthquake damage potential. Leighton

(5) F. Beach Leighton, "Geologic Review of the Geology Study for Envir-
onmental Impact of Village Grove, Tract 4873, Corona, California,"
recommends that a thorough analysis of the location, extent and magnitude of the seismicly induced ground rupture potential should be completed prior to final determination of land uses along potentially active fault branches. Subsurface exploration, infra-red photography and early-morning oblique photography along with stereoscopic analysis of existing vertical aerial photography will aid materially in defining fault traces through the property.

The undertaking of such an analysis is beyond the scope of this report. The commitment to a sufficiently cautious plan which will be compatible with the extent of available data might turn out to be an unbearable constraint to the project.

E. Flood Hazard: Acceptance of the recommended conditions of the Tentative Tract Map will result in all of the project, except for the portion between the Oak Avenue and Mangular Channels, being reasonably free from flood hazard. There is no existing public program for improving the Oak Avenue Channel, as is required by the Riverside County Flood Control District, to relieve the flood hazard to the remaining property. Consequently the timing of the completion of the project and all of the planned facilities for the enjoyment of the buyers is indefinite, unless
1. Three drainage courses affect the project, some areas of which
now suffer extensive erosion damage. Lots along Oak Street
Channel will be raised to protect the project from flooding.

2. The Riverside County Flood Control District proposes to construct
a debris basin south of the project. This will keep debris from
Mabey Canyon from plugging the drainage channel.

3. A natural drainage course crosses the project in an area designated
as a park. This will be left untouched except for possible planting
to curb erosion.

B. Geology

1. Specific tract development plans should be reviewed prior to con-
struction to take advantage of possible opportunity for enhancing
the environment or mitigating any negative geotechnical impacts
which may arise.

2. Detailed soils engineering and geological investigation should be
conducted to evaluate the specific design criteria for slopes and
embankments.

3. Further investigation should be made of the Chino Faults through
4. Evaluation should be made of natural slopes for local instability and specific needs for slope stability.

5. Additional studies are recommended to confirm the presence, location and state of activity of the major faults in the area. These studies should be done prior to each successive stage of development.

6. Based on detailed data and inspection during grading, specific slopes should be geologically reviewed.

C. Landscape Architecture

1. A well thought out street scene for the entire development should be implemented now as required by City Code. This should consist of street trees of a limited pallet, consistent throughout a sub-area and planted to make the most of curves in streets, intersections, and entrances to schools, parks, and the recreation areas and relate to the scale for its desired use. It also includes contour grading, sidewalk placement, off-street parking, curb height, street profile, open spaces and restrictions on private residences design, setbacks and colors which are all formulated.
GEOLOGICAL AND SEISMIC ANALYSIS

OF
TENTATIVE TRACT 4873
CORONA LAND COMPANY
CORONA, CALIFORNIA
SEPTEMBER 4, 1973

Prepared for
Corona Land Company
Leighton-Yen & Associates, Inc.
in association with F. Beach Leighton & Associates, Inc.

September 4, 1973

TO: Corona Land Company
Attention: Mr. James C. Cashman, President


SUBJECT: Geotechnical and Seismic Analysis of Tentative Tract 4873, Corona Land Company, Corona, California

INTRODUCTION

Introductory Statement

This investigation was undertaken for Corona Land Company in order to determine the geotechnical and seismic conditions pertinent to residential development of approximately 300 acres within Tentative Tract No. 4873, Corona, California.

Principals

Subdivider: Corona Land Company
Corner of Chase and Taylor
P. O. Box 970
Corona, California 91720  (714) 735-7770

Planner and Design Engineer: McCutchan and Associates, Inc.
2100 East Foothill Blvd.
Pasadena, California 91107  (213) 681-2373

Soil Engineer: Leighton-Yen & Associates
300 South Beach Boulevard  (714) 526-1337
La Habra, California 90631  (213) 694-1826

Geologist: F. Beach Leighton & Associates
300 South Beach Boulevard  (714) 526-1337
La Habra, California 90631  (213) 694-1826
Index Map
of
Tentative Tract 4873
for
Corona Land Company
(subject area shown in blue)
(Base Map from CDMC Bulletin 178 - Plate I)
Scale: 1" = 2000'

Leighton-Yen & Associates, Inc.
Maps and Illustrations

Index Map on Page 2

Geologic Map (SCALE 1" = 100')
Geologic Logs of Trenches
Tables I and II; Figure 1

Appendix

List of Geologic Reports Referenced
List of Aerial Photos Studied

Proposed Development

Total Acreage: 300± acres
Number of Lots: 422
Zoning: Single-family dwellings, multiple dwellings; planned development, school, library, recreation, lake, park and reservoir site.
Dwellings: 1568 total dwelling units
Sewage Disposal: Sanitary sewers
Access to Tract: Smith Avenue to Border Street along westerly property line. Easterly boundary is Oak Avenue, Ontario and Habey Canyon Road.

Scope of Investigation

Detailed geologic mapping began on July 24, 1973 and was completed on August 20, 1973. The base map for the field studies was the 100-Scale Tentative Tract Map dated September, 1972, by McCutchan & Associates, Inc.

The sequence of geologic steps in this investigation was as follows:

1. Review and synthesis of all previous geologic reports as shown in the Bibliography in the Appendix. These reports included reports prepared by this office for other investigations conducted in the general area.

3. Geologic mapping with emphasis on delineating those problem areas that must be explored by subsurface means.

4. Excavation of backhoe trenches beginning on July 24, 1973. This work continued into August and was intermittent due to irrigating of the citrus grove and to changes in contractors. A total of 16 backhoe trenches were excavated and a bulldozer trench was excavated on August 20, 1973 by 46A-D8 dozer.

5. Geologic logging of the artificial exposures concurrent with the excavation. In addition, surficial geologic mapping utilizing these data and previously obtained information continued during the period of subsurface exploration.

6. Ground rupture evaluations and feasibility determinations.

7. Ground shaking analysis.

8. Laboratory testing and analysis.

9. Preparation of this report.
Tract 4873 is located southwest of the City of Corona within the city limits. The southwesterly one-third of the tract is located within the foothills of the eastern flank of the Santa Ana Mountains. The northeasterly two-thirds of the tract is located on the compound alluvial fan that extends down into the City of Corona. The Santa Ana Mountains rise sharply above the tract to the south-southwest with summits 3,000 - 5,000 feet above sea level. The Santa Ana Mountains extend northwestward toward Santa Ana Canyon.

The majority of the tract is located within the Habey Canyon Outwash which drains northerly through the tract toward the Santa Ana River. Semi-improved channels conduct the Habey Canyon drainage down Mangular Avenue to Border Avenue. The area southeast of the development drains out of Tin Mine Canyon and down Oak Avenue along the easterly perimeter of Tract 4873 to Border Avenue, thence northerly to the Santa Ana River.

The climatic conditions within the tract generally consist of long and warm summers and moderate winters. The air is dry, and precipitation is mainly rain. The average mean annual temperature is reported to be 62.7°F at Corona, and the annual rainfall averages 13.3 inches. The average rainfall along the northerly boundary of the site is approximately 14 inches, and the higher elevations along the southerly boundary receive approximately 17 inches annually.

**Materials**

The site is underlain by recent alluvium, older alluvium, terrace deposits, Paleocene Silverado Formation and Cretaceous Ladd Formation undifferentiated. The approximate percentages of the acreage mapped is underlain by different earth materials as follows:
Topographic Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Existing Natural Topography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest and Highest Elevations:</td>
<td>High: 1240(^{\circ}) feet elevation at southeasterly corner and 1210(^{\circ}) feet along the southerly property line, reservoir Lot 412 and Lot 15.</td>
</tr>
<tr>
<td></td>
<td>Low: 756 feet along Border Avenue adjacent to the recreation site at the northerly end of the property.</td>
</tr>
<tr>
<td>Maximum Relief for Entire Tract:</td>
<td>454(^{\circ}) feet from north to south within the tract.</td>
</tr>
<tr>
<td>Maximum Relief for Highest Entire Slope:</td>
<td>90(^{\circ}) feet at the southerly property line adjacent to the proposed debris basin dam.</td>
</tr>
<tr>
<td>Steepest Overall Natural Slope:</td>
<td>40-45(^{\circ}) at the easterly side of the proposed desilting basin dam.</td>
</tr>
<tr>
<td>Average Natural Slope Angle:</td>
<td>2:1</td>
</tr>
<tr>
<td>Areas of Artificial Fill:</td>
<td>Northerly of the reservoir and tennis courts on Border Avenue; City of Corona water line excavation at Ontario Avenue and Border and at the intersection of Kirkwood and Border.</td>
</tr>
<tr>
<td>Thicknesses of Major Canyon Fills:</td>
<td>40(^{\circ}) feet at the easterly end of the debris basin dam along southerly property line.</td>
</tr>
</tbody>
</table>
The subject property is located on an old compound alluvial fan which has been elevated and channeled as a result of combined relative uplift and erosion to form foothills and a preserved upland surface of low relief.

**Bedrock**

The southeasterly and southwesterly corners of the tract are underlain by the Cretaceous Ladd Formation, undifferentiated. The Ladd Formation within this site is a buff or yellow-brown to light tan conglomerate with interbeds of sandstone. The conglomerate consists of clasts of hard volcanic rocks up to 8 inches in diameter, and occasionally a boulder set in a coarse-grained matrix. The sandstone beds are medium to coarse-grained, well cemented and very hard.

Overlying the Ladd Formation and generally in fault contact with it is the upper member of the Paleocene Silverado Formation. The Silverado Formation on this site is characterized by a light gray and light yellow fine-grained silty sandstone, and a white to gray and yellow-brown siltstone. The sandstone is sometimes pinkish in color. The sandstone unit is micaceous, massive and friable. In Trench 15, a coquina bed was found. It was well cemented and very dense.

**Terrace Deposits**

A thin veneer of terrace deposits are located on the side slopes of a ridge at the southwest corner of the site. A very thick section of terrace deposits is located on the prolonged ridge that extends outward from along the southeasterly portion of the site. These ridges form the side slopes for the Hacy Canyon drainage that passes through the center of the southerly portion of the site.
The terrace deposits consist of unconsolidated gravels and cobbles set in a reddish brown to light brown matrix of silty or clayey sand. Angular to rounded fragments of volcanic, granitic, metamorphic and sedimentary rocks generally on the order of 4 inches in diameter are found throughout. Materials exposed in the exploratory trenches were generally friable and massive. Outside the subject area, the terrace deposits include cobble and boulder size materials.

Where bedding attitudes were recognized, the terrace deposits generally trended southeast-northwest and dipped 5-13° to the north-northeast. The terrace deposits are similar in characteristics and depositional environment to the older alluvium. They are older, have been subjected to oxidation longer (hence the reddish color), and the clasts are generally larger than those found in the alluvium. Contacts between the two units are very subtle.

Older Alluvium

A majority of the proposed tract consists of a gently sloping surface composed of older alluvium. The surface is a part of the Corona compound alluvial fan. The alluvium is generally buff to dark brown in color with more reddish brown coloring near the higher elevations. The older alluvium contains smaller clasts than the terrace deposits and generally contains more clay and silt in association with the sand, gravel and cobbles. It has a thicker top soil section. Older alluvium is considered to be of Recent age with the possibility that some will be as old as late Pleistocene. Published data indicates that the thickness varies from 80° feet at the northerly boundary of the site to as thick as 350° feet in the foothill area within the southerly portion of the site.

Recent Alluvium

The lower reaches of Habey Canyon Creek and the smaller creekbeds are filled with a mixture of unconsolidated sand pebbles, cobbles and boulders. They are derived from the nearby granitic metamorphic and sedimentary rocks of the Santa Ana Mountains. Generally, the recent alluvium ranges from a very
thin veneer in the minor creeks to over 40 feet thick in Mabey Canyon Creek along the easterly portion of the proposed debris basin dam.

Topsoil

Topsoil throughout the site generally varies from 1 foot thick on the ridge tops to 42 feet thick along the drainage ravines. It is typically reddish brown to dark brown, clayey or silty sand with cobble size angular fragments of the bedrock included in the soil matrix. In the older alluvium, the topsoil generally contains gravel and cobble size material derived from the underlying alluvium.

The topsoil is generally well desiccated with cracks extending into and terminating within the underlying material. It contains numerous worm borings and roots, and is sometimes mottled. The topsoil is generally massive and firm.

Colluvium

Most of the drainage reentrants and heads of ravines contain thick deposits of slopewash materials termed colluvium. These materials range in thickness from 42 feet to 102 feet and are generally located within the southerly portion of the tract. The colluvium is formed by a combination of slopewash, deep weathering, creep and local mass movements, chiefly soil flowage. It is generally structureless, adobe-like, clayey silt and sand and possibly expansive where derived from siltstone.

Groundwater

The groundwater of the area has been studied extensively by the State of California, Department of Water Resources. Their publication, "Meeting Water Demands in the Chino-Riverside Area", Bulletin #104-3 and Appendix A: Water Supply, September, 1970, covers the site. The effective base of groundwater reservoir below the site is at the approximate 300-foot elevation. The water level in October, 1960 varied from 725-foot elevation at the southerly boundary to 525-foot elevation at the northerly end of the property. The depth to the ground water
groundwater surface within the site varies from 235 feet at the northerly end to 475 feet at the southerly end. The aquifer thickness varies from approximately 225 feet to 445 feet. Their well log Section C-C' indicates a gradual water surface without breaks due to faulting. The area exhibits a low infiltration rate of less than 1.0 inch per hour. During the next 50 years the quality of water is expected to remain satisfactory to meet most requirements. The groundwater storage is continually being replenished by deep percolation of water from delivered water, precipitation and stream flow and subsurface inflow from outside the boundaries of the State study. No pollution of the groundwater basin is anticipated from development of Tract 4873.

Near surface groundwater, seeps and springs were not found during this investigation. The ravines extending from Fraser Way to Carolwood Drive contained a continuous flow of surface irrigation water during the time of the field study.

Geologic Structure

The subject site is located in the foothills, the northeastern flank of the Santa Ana Mountains and extends down onto the Corona compound alluvial fan that becomes part of the Corona Basin. The Corona Basin is part of the Corona-Chino Valley block that is located on the northeast side of the Chino Fault. Santa Ana Mountains are an anticline in which the apparent crest coincides with the crest of the mountains. The mountains are uplifted along the major fault called the Elsinore Fault Zone or the Elsinore Rift. The Elsinore Fault Zone occupies a trough-like depression along the northeastern front of the Santa Ana Mountains. The faults of the Elsinore Zone dip vertical or steeply to the southwest and are considered a reverse dip separation. The Elsinore Fault is approximately 4,000 feet southerly of the site and the rift zone is within 2,000 feet of the southerly border of the site.
Three major structural blocks can be distinguished in the Corona-Santa Ana Narrows Region.

1. The Santa Ana Mountain block bounded on the northeast by the Elsinore and Whittier Faults, which are considered to be related.

2. The Puente-Chino Hills block bounded on the northeast by the Chino Fault. Three mapped branches of the Chino Fault pass through the subject site.

3. The Corona-Chino Valley block on the northeast side of the Chino Fault which includes the northerly portion of the subject site.

The Lamar studies indicated that the distribution of thicknesses and facies within the upper Cretaceous, Paleocene, middle-Eocene and upper Miocene and middle Miocene volcanics on opposite sides of the faults suggests 20 miles of right-slip from Lake Elsinore to the Santa Monica Mountains.

Offset of the Paleocene Silverado Formation has been interpreted as an indication that approximately 19 miles of post-Paleocene movement has occurred on the Whittier-Elsinore Fault System. The recency of movement along the Elsinore-Whittier Fault Zones are indicated by: (1) a northwest-trending scarp which cuts old alluvium and a straight section of Wardlow wash parallel the northeast edge of the Santa Ana Mountains directly southwest of Corona and northwest of Corona Land property, (2) major drainage lines are offset in a right lateral sense by the Elsinore-Whittier Fault from Tin Mine Canyon to the western end of the Puente Hills. Maximum offset averages 1-1/2 miles. Stream offset generally has shifted downslope from the surface trace of the fault, and (3) young appearing features such as a very steep northeast flank of the Santa Ana Mountains and the graben or depression of the Elsinore Rift Zone.

Three mapped branches of the Chino Fault cut diagonally across the property. They strike N35-45°W and dip vertically to 55°SW. The Chino Fault is considered a reverse fault with nearly 8 miles of strike separation in a right lateral sense. This lateral displacement is suggested by the offsetting of the Vaqueros and Sespe Formations. Topographic features such as scarps

Leighton-Yen & Associates, Inc.
and anomalous drainage lines, scars, and trenches, strongly suggest that the fault borders the lower margin of the Santa Ana Mountains under the older alluvium. No apparent or obvious indications of the faults are expressed at the surface within the property studied. The USGS report study indicated that the most recent known or inferred displacement along the Chino Fault took place within the last 300,000 to 500,000 years. It has not moved since about 3,000 to 11,000 years ago, according to that study.

The sedimentary rocks adjacent to the site generally trend N50-70°W parallel to the faults, and dip 30-90° toward the northeast. Some overturned beds and drag along the faults make a difference in this general trend. It is part of the northeasterly dipping limb of the Santa Ana Mountains anticline that dips toward the axis of the Arena Blanco syncline that is inferred beneath the older alluvium northeast of the site.

Within the site, the terrace deposits located on the ridge in the southeasterly portion of the site generally trend N10-55°W and dip 5-10° northeasterly. The terrace deposits located adjacent to the site and to the west of the site trend N20°W and dip 10-15° to the north-northeast.

Except where influenced by faulting, the general trend of the Ladd Formation sediments is N20-55°W and dip 15-25°NE. The small area of the Silverado Formation exposures in the southeast corner of the site indicated a north-south or near north-south trend with 30-35° dips to the east.

Some jointing noted along Habey Canyon Road indicated dips of 45-70° to the east and west. Some minor shears within the Ladd and Silverado Formations generally trend N15°N to N40°E and dip 65-70° to the east-northeast.

Seismicity

The entire greater Los Angeles area is subject to strong shaking from earthquakes originating on nearby active faults such as the San Andreas, San Jacinto and Elsinore Fault Zones. Ten or more earthquakes of magnitude 7 or greater have occurred in California during the past 150 years. Five earthquakes of this magnitude have occurred in the past 50 years. Statistics suggest that
Southern California has been and probably will be subjected to at least a 6.0 to 6.5 magnitude earthquake every 4 to 5 years. Magnitude 7 to 8 earthquakes are anticipated in California every 10 to 15 years and one of a magnitude 8 or approximately every 50 years. A seismic table summarizing historical maximum quake magnitudes within 40 miles distance of the site, together with evidence of activities is included in this report. It should be emphasized that recorded data is not sufficient to provide precise recurrence intervals of the "maximum probable" quake. "Maximum Probable" earthquake is a term used by the Atomic Energy Commission to describe a seismic event which might occur with a fairly high probability and the mechanisms for triggering it are well understood. From an engineering design viewpoint all essential functions of utilities in the structure should be operational under such a postulated probable event, i.e., to be designed based on such an operational base earthquake.

It should be pointed out that the consequences of strong shaking are of greater significance over a far wider area than are the consequences of local surface faulting. Evidence provided by the earthquakes of the last 100 years has shown that the great preponderance of damage is primarily caused by the strong ground shaking rather than by local surface faulting. For instance, damages directly attributable to surface faulting in the 1971 San Fernando earthquake were estimated at probably less than 1% of the total damages (according to the Earthquake Commission Report, 1971).

For the Corona Land Company Tract 4873, the two most significant possible earthquake sources are the San Andreas Fault Zone, located 32 to 42 miles from the site and the San Jacinto Fault Zone, located 23 to 25 miles from the site. Each of these two sources and other potentially active faults such as the Elsinore Fault Zone adjacent to the site could generate ground shaking in the area with different frequencies, accelerations, velocities and duration. The intensity of ground shaking is a function of a magnitude of the quake, hypocentral distance and the dynamic properties along the transmission path of the seismic waves. The maximum probable or operational base earthquakes will be discussed and shown in the engineering portion of this report. Seismic considerations
Evidence of geologically Recent movement along the Plummer-Whittier Fault System and the related Chino Fault have been reported by other investigators. Evidence of past activity has been discussed in the previous section. Additional considerations, derived from oral communication with the investigators, were oil well and water well data from locations to the northwest and southeast of the Corona Land Company Tract 4673. Investigation of Tract 3347 in 1969 located northwesterly of the subject tract noted a fault contact between terrace deposits and the bedrock, but it could not be followed laterally for more than 200 feet. The projection of this trend as well as those trends established by published reports was investigated and evaluated during this study.

The Chino Fault is considered potentially active. However, the observed evidence suggests that the probability of activity is low. Because it is presumed that ground rupture is more likely to occur where it has previously occurred, we looked for evidence of recent ground rupture along those alignments that appear on published and unpublished maps. We did not find any evidence of recent ground rupture within the site, either as a surface expression, in aerial photography and infrared photography, or in exploratory trenches.

This study does not disprove the presence of faults in the deep subsurface or at other locations. It does permit us to say:

1. There is no recognized evidence of recent ground rupture in the vicinity of those fault lines shown on published and unpublished maps reviewed, and

2. In the absence of such evidence, it is reasonable to conclude that surface rupture is not likely to occur along those lines.

Leighton-Yen & Associates, Inc.
The property is gently sloping and near level at the northerly end, gently sloping at the southerly end and very conducive to development without large slopes (high slopes).

Summary of Unfavorable Geologic Conditions

1. The property is crossed by mapped traces of the Chino Fault Zone that is considered of low potential for activity. However, the site is adjacent to the Elsinore-Whittier Fault Zone which is considered active, currently.

2. Boulder disposal may locally be a problem; however, it should not be too significant a problem in the rough grading stage.

3. The southerly portion of the property contains bedrock that could possibly require support if excavations are made facing the east-northeasterly direction.

4. Utility trenches in the recent alluvial deposits of Mabey Canyon may require safety supports during construction of the utilities (placement of the utilities in the trenches).
Soil Density - Significance

Densities representative of the in-place surficial materials were obtained mainly to evaluate 1) compressibility of the near surface materials and 2) the approximate magnitude of shrinkage that might be expected in site grading. The samples were obtained by the drive-cylinder method using steel cylinders 2.87 inches in diameter by 2.8 inches. Disturbed bag samples of the soils were also obtained.

A summary of the in-place densities and moistures is presented in tabular form in the Test Data. The optimum moisture content and maximum dry density of two of the typical materials were also determined and are included as a means of evaluating certain aspects of compressibility and shrinkage.

In-place dry densities of near surface materials at the site ranged from a low of 72.7 pcf to a high of 113.5 pcf. The range of apparent relative compaction for these densities is from 60% to 90%. This spread is not considered unusual for alluvium where much of the more recent alluvium may have been rapidly deposited in a desert environment. The low densities and relative compactions, i.e., less than approximately 75% relative compaction, suggest that consideration of the consolidation properties (soil compression) of the material is warranted in construction. The northerly portion of the property is of concern because of porous soils and the attendant low relative compaction at depths greater than one foot. Mitigation measures for those potentially compressive soil zones are discussed in the Conclusions and Recommendations section.

An estimate of the shrinkage that will occur as a result of compaction of the natural soils can be made assuming an average of 97% relative compaction for compacted fill. The shrinkage is thus estimated as follows - using the average relative compaction obtained through testing.
In addition, some loss of grade can be expected as a result of clearing and grubing operations and operations of the grading equipment. This loss is estimated to result in a general site reduction in grade of approximately 2 to 3 inches.

Soil Moisture

Most of the soils are moist as a result of retention of irrigation waters. Soil moisture could decrease significantly if irrigation of the citrus was terminated. The present soil moisture is close to the optimum moisture content in most cases. Hence, little construction water would be needed for compaction under current moisture conditions.

Expansive Soils - Classification and Distribution

Typical surficial materials were subjected to standard laboratory determinations of their expansive properties. A summary of the results of index tests on these materials is included in the Test Data.

In general, the near surface materials are somewhat more clayey and more plastic than the materials at depth. The primary concern is therefore with the shallow soils within approximately 2 to 3 feet of the present surface.

Four swell tests performed indicate a non-expansive soil condition (less than 3% volumetric swell) for most of the area. Lowly expansive soils exist locally, as suggested by the one test exhibiting 5.1% volumetric swell.

No unusual construction precautions or significant problems are anticipated when normal construction precautions for lowly expansive conditions are observed in construction. Subgrade for slabs and footings should be adequately moist when concrete pours are made, and minimal reinforcing of both slabs and footings is considered essential.
CONCLUSIONS AND RECOMMENDATIONS

General Conclusion

No unusual soils conditions exist that will require the implementation of expensive or unusual construction techniques. Site conditions deserving special attention that can be treated by usual measures to produce safe and stable building sites include:

1) Potentially compressible soils, particularly those soils deeper than one foot below the surface at the north end of the tract.
2) Expansive soils (in the lowly expansive range).
3) Compressible alluvium in the bottoms of drainage courses.

A detailed lot-by-lot analysis of soil conditions was beyond the scope of this study.

The recommendations presented below, therefore, are of a general nature and should be verified or modified by additional subsurface exploration and further testing and engineering analyses once more firm grades are established. A section entitled, "GENERAL GRADING AND EARTHWORK SPECIFICATIONS," is provided in the Appendix as a guide for construction involving earthwork. Recommendations for footings, slabs, and the site conditions listed above are presented below.

Clearing and Grubbing

Special care shall be given to removal of the roots of trees. Rootballs shall be completely removed and the resulting cavities should be inspected and backfilled under the inspection of the soils engineer.

Irrigation pipes and other abandoned substructures shall be completely removed or thoroughly crushed and mixed with adequate quantities of soil.

Preparation of Compressible Soil Areas

Compressible soil at the northerly end of the tract, in the general area of Trenches S1 and S2, shall be removed down to stable subgrade. Depth of removal will depend on the grading involved (cut or fill depth), depth of...
APPENDIX

GEOLOGIC REPORTS REFERENCED

F. Beach Leighton & Associates

"Preliminary Geologic Assessment of Seismic Hazards, Tentative Tract 3347, Corona Area", 1/10/69.

"Preliminary Engineering Geological Investigation and Assessment of Seismic Hazards, Tracts 3368 and 3374, Corona", 12/8/69.

"Geological Review, Tract 3375, (Tentative Tract 3347), Corona", 1/2/73.

"Geological Examination and Assessment of Seismic Hazards, Tract 4391, Corona", 4/7/72.

"Safety Element & Seismic Safety Element, Rancho California", 7/30/75.

USGS


State of California, Division of Oil & Gas


State of California, Division of Water Resources

"South Coastal Basin Investigation", Bulletin #45, 1934


Leighton-Ven & Associates, Inc
State of California, Division of Mines and Geology

U. S. Department of Agriculture, Soil Conservation Service
"Soil Survey of the Riverside Area, California", 1937.

C. Michael Scullin, Engineering Geologist (EG 170)

Other
Schmable, P. H. and Seed, H. B., 1972, "Accelerations in Rock for Earthquakes in the Western United States": Earthquake Engineering Research Center, University of California.


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Leighton-Yen & Associates, Inc.
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<td>2) N 30° W, 50'</td>
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**Graphic Representation**

- **Pit Trend**: [Diagram showing geological layers and features]
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<td>3) S N55E, 10N (partly buried)</td>
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<td>4) N55E, 2 SN</td>
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See Sheet 1 for lithologic descriptions.

Scale - 1" = 5'
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SCALE: 1" = 10'

GRAPHIC REPRESENTATION

Pit Trend = N8E