ENVIRONMENTAL IMPACT REPORT
FOR THE
PALMDALE BUSINESS PARK
CENTER SPECIFIC PLAN

VOLUME II:
TECHNICAL APPENDICES

Prepared for

City of Palmdale
Planning Department
Palmdale, California

Prepared by

URS Consultants, Inc.
San Bernardino, California

May 1995

ENVIRONMENTAL IMPACT REPORT

FOR THE

PALMDALE BUSINESS PARK CENTER SPECIFIC PLAN

VOLUME II: TECHNICAL APPENDICES

State Clearinghouse #93061074

Prepared for:

CITY OF PALMDALE
Planning Department
38306 Ninth Street East
Palmdale, California 93550

Prepared by:

URS CONSULTANTS, INC.
164 W. Hospitality Lane, Suite 6
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May 1995

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NOTICE OF PREPARATION

Notice of Preparation *Supplementary Document M*

Mail to: State Clearinghouse, 1400 Tenth Street, Sacramento, CA 95814 916/445-0613

SCH # 93061074

Project Title: Palmdale Business Park Center Specific Plan EIR

Lead Agency: City of Palmdale — **Contact Person:** Tara Hullinger

Street Address: 38306 9th Street East — **Phone:** (805)267-5200

City: Palmdale — **Zip:** 93550 — **County:** Los Angeles

Project Location

County: Los Angeles — **City/Nearest Community:** Palmdale

Cross Streets: Ave. M/Sierra Highway — **Zip Code:** 93550 — **Total Acres:** 632.40

Assessor's Parcel No.: _____ — **Section:** _____ **Twp.:** _____ **Range:** _____ **Base:** _____

Within 2 Miles: **State Hwy #:** 14,138 — **Waterways:** _____

Airports: Plant 42 — **Railways:** SPRR — **Schools:** Various

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Document Type

CEQA: ☒ NOP ☐ Supplement/Subsequent ☐ Early Cons ☐ EIR (Prior SCH No.) _____ ☐ Neg Dec ☐ Other _____ ☐ Draft EIR

NEPA: ☐ NOI ☐ EA ☐ Draft EIS ☐ FONSI

Other: ☐ Joint Document ☐ Final Document ☐ Other _____

Local Action Type

☐ General Plan Update ☒ Specific Plan ☒ Rezone ☐ Annexation
☐ General Plan Amendment ☐ Master Plan ☐ Prezone ☐ Redevelopment
☐ General Plan Element ☐ Planned Unit Development ☐ Use Permit ☐ Coastal Permit
☐ Community Plan ☐ Site Plan ☐ Land Division (Subdivision, Parcel Map, Tract Map, etc.) ☐ Other _____

Development Type

☐ Residential: Units _____ Acres _____
☒ Office: Sq.ft. _____ Acres 26.43 Employees _____
☒ Commercial: Sq.ft. _____ Acres 55.52 Employees _____
☒ Industrial: Sq.ft. _____ Acres 254.48 Employees _____
☐ Educational _____
☒ Recreational 27-hole golf course 236.30 acres

☐ Water Facilities: Type _____ MGD _____
☐ Transportation: Type _____
☐ Mining: Mineral _____
☐ Power: Type _____ Watts _____
☐ Waste Treatment: Type _____
☐ Hazardous Waste: Type _____
☐ Other _____

Project Issues Discussed in Document:

☒ Aesthetic/Visual
☐ Agricultural Land
☒ Air Quality
☒ Archeological/Historical
☐ Coastal Zone
☒ Drainage/Absorption
☐ Economic/Jobs
☒ Fiscal
☐ Flood Plain/Flooding
☐ Forest Land/Fire Hazard
☐ Geologic/Seismic
☐ Minerals
☒ Noise
☐ Population/Housing Balance
☒ Public Services/Facilities
☐ Recreation/Parks
☐ Schools/Universities
☐ Septic Systems
☒ Sewer Capacity
☒ Soil Erosion/Compaction/Grading
☐ Solid Waste
☐ Toxic/Hazardous
☒ Traffic/Circulation
☒ Vegetation
☐ Water Quality
☐ Water Supply/Groundwater
☐ Wetland/Riparian
☐ Wildlife
☒ Growth Inducing
☒ Landuse
☒ Cumulative Effects
☐ Other _____

Present Land Use/Zoning/General Plan Use The project site is vacant. The General Pla designation is Palmdale Business Park Center Specific Plan. The zoning is M

Project Description This project proposes commercial, business park, light indust airport-related, open space, and recreational land uses.

NOTE: Clearinghouse will assign identification numbers for all new projects. If a SCH number already exists for a project (e.g. from a Notice of Preparation or previous draft document) please fill it in.

Revised October 1989

NOP Distribution List

SCH# 1994101 4

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OTHER: _____

OTHER: _____

APPENDIX B

BIOLOGICAL SURVEY AND DESERT VEGETATION PRESENTATION PLAN

DRAFT

BIOLOGICAL SURVEY
SPECIFIC PLAN 92-2
(PALMDALE BUSINESS PARK CENTER)
PALMDALE, CALIFORNIA

PREPARED FOR:

CITY OF PALMDALE
38306 9TH. STREET EAST
PALMDALE, CALIFORNIA 93550

PREPARED BY:

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JUNE 1993

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1.0 INTRODUCTION

Comprehensive biological surveys were conducted on a 632.4 acre site in the City of Palmdale, Los Angeles County. The site (Specific Plan 92-2) has been proposed as the location for the Palmdale Business Park Center. The surveys were performed to evaluate the biological resources occurring on the property with special emphasis placed on determining if the desert tortoise (*Xerobates agassizii*) is present on the site, and if the existing habitat is suitable for the Mohave ground squirrel (*Spermophilus mohavensis*). Surveys were also conducted throughout the project site for other sensitive animals, as well as sensitive plant species. Sensitive species are defined as plants and animals which are California or federal threatened or endangered species, federal candidate species, California Species of Special Concern, or species placed on a "watch list." Results of the biological surveys, which are presented in this report, are part of the baseline data necessary for consideration of the proposed project by the City and other concerned regulatory agencies.

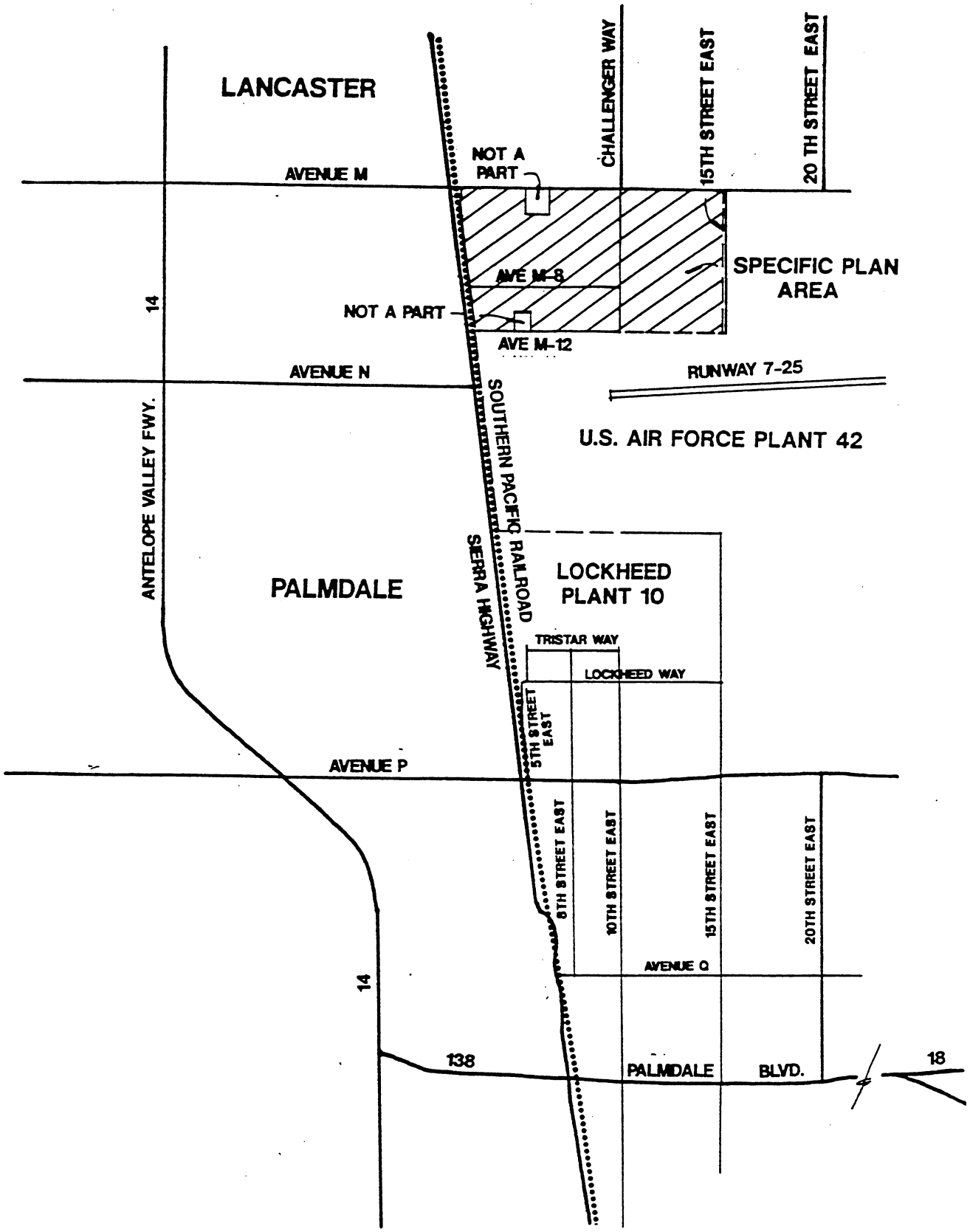
2.0 PROJECT LOCATION AND DESCRIPTION

The property, which is owned by Lockheed Corporation, consists of 632.4 acres of undeveloped land located within the City of Palmdale. The property is bordered on the north by Avenue M; by Air Force Plant 42 on the east and south; and by Southern Pacific Railroad Right-of-Way and Sierra Highway on the west (Exhibit 1). The proposed Palmdale Business Park Center will be a combination of commercial and industrial complexes with a 27-hole golf facility.

The site is relatively flat with no prominent ridges or valleys. Elevation ranges from 2490 feet in the northeastern corner to 2550 feet in the southwest (Exhibit 2). The property is relatively undisturbed, although it has received some disturbance from various human activities. There are several dirt roads and dump sites scattered throughout the property. Several commercial buildings are located along the north side of Avenue M, although, some areas remain undeveloped. A few single-family residences are also located to the northeast of the site. A chainlink fence surrounds the property on the east and south, separating the site from Air Force Plant 42.

3.0 METHODOLOGIES

A comprehensive literature review was performed prior to the commencement of field surveys. Data sources which were reviewed included, but were not limited to, environmental documents (e.g. Environmental Impact Reports and Statements, Environmental Assessments, etc.), California Natural Diversity Data Base (CNDDB), state and federal regulatory documents, scientific articles, field



FEBRUARY 15, 1993

Source of Exhibit:
David A. Price
ASSOCIATES

NORTH

PALMDALE BUSINESS PARK CENTER

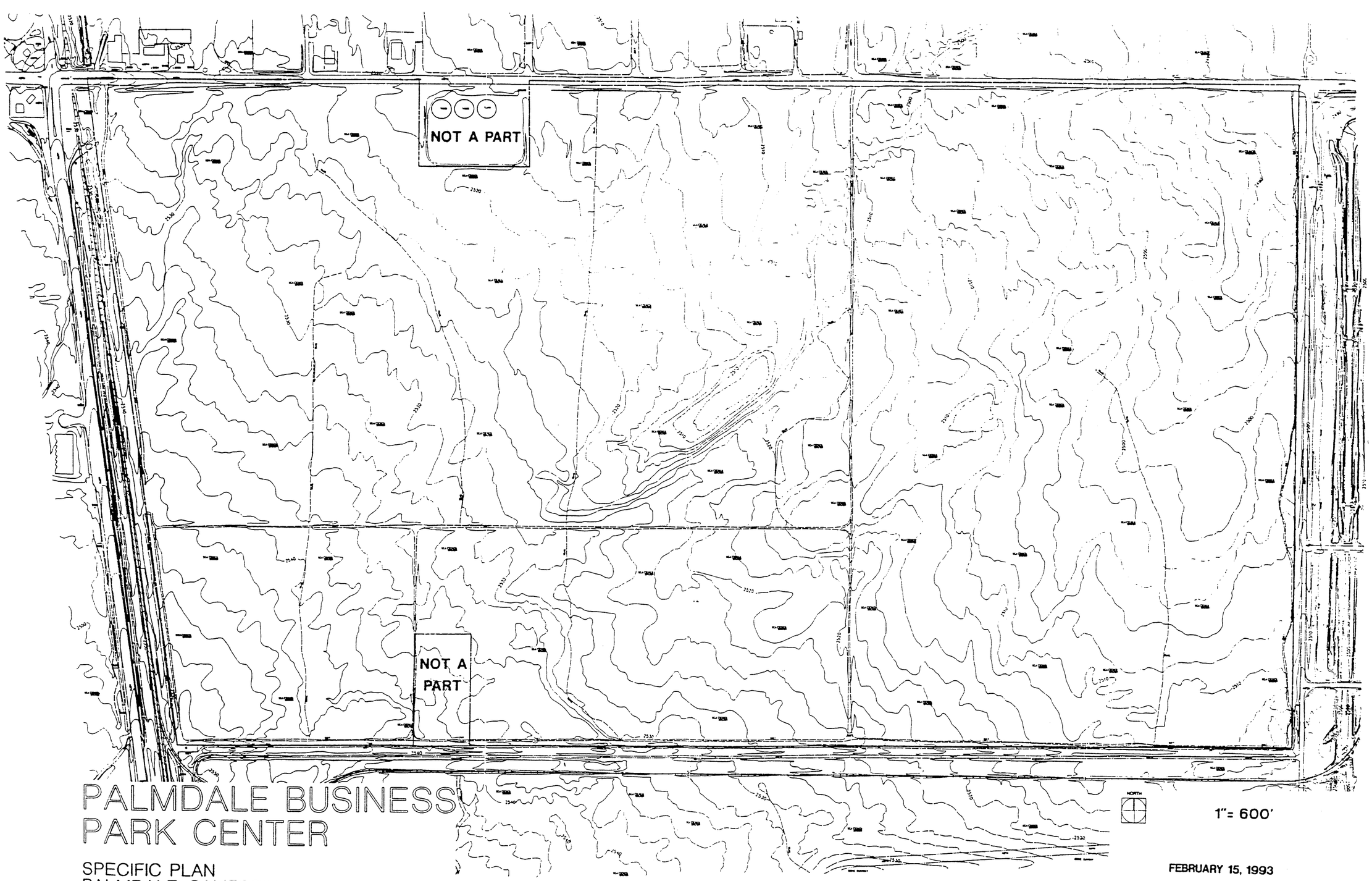
SPECIFIC PLAN
PALMDALE, CALIFORNIA

LOCKHEED CORPORATION

EXHIBIT I

Not To Scale

PROJECT LOCATION MAP



PALMDALE BUSINESS PARK CENTER

SPECIFIC PLAN
PALMDALE, CALIFORINA

LOCKHEED CORPORATION
4500 PARK GRANADA BLVD
CALABASSAS CA. 91339-0220
(818) 876-2212

1"= 600'

FEBRUARY 15, 1993

Source of Exhibit:

David A. Price
ASSOCIATES

Exhibit II

EXISTING TOPOGRAPHY

guides, and local experts. These data sources were utilized in producing a general description of the biological resources occurring in the region surrounding the project site. Surveys were conducted between April 22 and May 14, 1993 to determine the specific biological resources existing on the site. A total of 21 man days were spent in the field. In addition to determining the biological resources present on the site, specific surveys were conducted for the desert tortoise and Mohave ground squirrel. Surveys were also conducted for other sensitive wildlife species and various sensitive plants (See Sections 3.4 and 3.5 for list of sensitive wildlife and plant species.). The various survey methodologies utilized during the field work are outlined below.

3.1 GENERAL VEGETATION AND WILDLIFE

Evaluations of the existing biological resources on the site were conducted in conjunction with surveys performed for the desert tortoise and Mohave ground squirrel since tortoise and ground squirrels surveys require comprehensive coverage. Plants were primarily identified in the field; however, some species were returned to the lab for positive identification. Wildlife species were identified using several methods. Birds were identified by visual observation and by vocalizations. Visual observations were also used to determine the mammals and reptiles present on the site, along with tracks, scats, and animal carcasses.

3.2 DESERT TORTOISE

Recent documentation prepared by the U.S. Bureau of Land Management and U.S. Fish & Wildlife Service was consulted prior to initiation of field surveys to determine to what extent tortoises have been observed in the general area. In addition, survey reports prepared for other developments in the region were reviewed. Following the literature review, the site was surveyed during the months of April and May 1993. The biologists conducting the surveys included Randall Arnold and Patti Moore (See Appendix D).

Surveys for desert tortoises require the use of parallel transects (10-yards wide), which will result in 100 percent coverage of the project site. Survey markers (12 feet in height) were located at the ends of each transect and were used to facilitate surveys along the transects. Transects ranged between 0.25 and 0.5 miles in length. Shorter transects were utilized in those areas where Joshua tree densities inhibited visibility along the length of the transects. Transects were walked in a north-south direction in the northwestern portion of the site; whereas east-west transects were used in the eastern portion. During surveys the site was thoroughly checked for tortoises, tortoise burrows, and other tortoise sign (i.e tracks, scats, carcasses, etc.).

Survey protocol also requires the implementation of "Zone of Influence" surveys to determine the presence or absence of

tortoises within the immediate area surrounding a site. However, the subject property, as previously mentioned in Section 2.0, is surrounded by existing commercial developments, Lockheed facilities, and a major highway (i.e. Sierra Highway) which prevented the conduct of transects within the "Zone of Influence".

While conducting the tortoise survey, particular emphasis was given to viewing the bases of bushes and other perennial plants, since tortoises tend to burrow into small hills and banks such as those at the base of woody plants. Any depressions or suspect burrows were closely scrutinized. Additionally, field notes were taken regarding native plant assemblages on the site, and the presence or absence of suitable tortoise foraging habitat was identified. To further document the biological setting of the property several photographs were taken and are included in this report (see Appendix A).

The tortoise survey was conducted during a time (i.e. March 25 - May 31) when tortoises are most active. Therefore, a methodical search by qualified biologists will reveal evidence of the presence or absence of tortoises on a site. A survey combined with identification of the habitat on and surrounding a property will further reveal the status of the tortoise on a site and give a good indication of the potential for future habitation.

3.2.1 Background Information

The desert tortoise is the largest reptile in the arid southwest United States. It historically occupied a range that included a variety of desert communities in southeastern California, southern Nevada, western and southern Arizona, southwestern Utah, and through Sonora and northern Sinoloa, Mexico. Today populations are largely fragmented and studies indicate a steady and dramatic decline over most of its former range. Additionally, because tortoises have long been prized as pets, collecting of wild tortoises has further reduced the population. Wildlife biologists estimate that between 1880 and 1970, five to eight million tortoises were taken from the desert by collectors.

Recently, a highly contagious respiratory disease has infected tortoise populations, primarily in the western Mojave Desert region. While the disease seems to be most widespread in the western Mojave, cases have been documented in numerous widely scattered areas throughout the wider Mojave range of the tortoise. In one area of the western Mojave, the infection rate among individual tortoises increased from 9 to 52 percent based on surveys conducted between 1988 and 1989. Isolated cases are believed to have the potential to cause widespread infection over a short time period.

Given the continued habitat loss and the rapid decline in numbers of tortoises brought about by the disease, the U.S. Fish and

Wildlife Service exercised its emergency authority and determined tortoise populations north and west of the Colorado River to be an endangered species under the Endangered Species Act of 1973, as amended. The emergency rule was published in the Federal Register on August 4, 1989, and remained in effect until April 1, 1990. On April 2, 1990, the U.S. Fish and Wildlife Service officially listed the desert tortoise as a threatened species under the Endangered Species Act of 1973, as amended.

3.3 MOHAVE GROUND SQUIRREL

The property site was also evaluated for the Mohave ground squirrel using the most recently accepted survey methodology. California Department of Fish & Game has developed a system which evaluates and ranks existing human disturbance on a site and in adjacent areas. The system was developed to help standardize mitigation requirements for loss or disturbance of Mohave ground squirrel habitat (Clark, D. 1991).

In addition to the transects utilized for the tortoise survey, several meandering transects were walked throughout the property during which ten land use disturbance categories were evaluated for the property site. These categories included OHV use, roads through the area, horse or foot traffic, dog activity, urbanization, garbage dumping, mining activity, utilities, grazing, and shrub disturbance. Each of these disturbances was ranked on a scale of 0 to 4, with 0 indicating no disturbance and 4 indicating a significant disturbance. Following evaluation of these disturbance categories, the five highest numbers were added together and multiplied by two to determine the Cumulative Impact Rating number (CIR). The evaluation was performed by Randall C. Arnold, Jr. who was trained in the procedure by P. Woodman (1991) and C. Uptain (1992).

Information was also gathered on the habitat occurring throughout the site. Data gathered as part of the Mohave ground squirrel analysis included shrub density, species list, soil description, presence of desert pavement, rocks, and boulders, slope and aspect, and elevation.

3.3.1 Background Information

The Mohave ground squirrel was listed by the California Department of Fish & Game in 1991 as a threatened species, thereby giving the animal protection under the California Endangered Species Act. However, the Fish and Game Commission recently voted to delist the species. This action will go into affect in October 1993. The species is known to occur in the western Mojave Desert in portions of four counties including Inyo, Kern, San Bernardino, and Los Angeles.

The distribution of the Mojave ground squirrel is quite limited as

compared to the distributions of other ground squirrel species. The Mohave ground squirrel is found in several habitat types throughout the Mojave Desert including creosote bush scrub, saltbush scrub, and Joshua tree woodland communities. Degradation and destruction of the species' habitat and isolation of small individual populations appear to be the primary factors in the species' decline.

3.4 OTHER SENSITIVE WILDLIFE SPECIES

There are several other wildlife species occurring in the general region which are provided protection or given special recognition by local, state, or federal agencies. Many of these species are declining in numbers or have limited populations due to habitat reduction, increasing predation by domesticated animals, human induced mortality, and/or disease. Discussed below are the various sensitive wildlife species which occur in the general region and which may be found on the project site. Surveys for these species were conducted in conjunction with the tortoise and Mohave ground squirrel surveys. Sensitive wildlife observed during the field surveys were noted.

Coast horned lizard *(Phrynosoma coronatum)*: Two subspecies of the horned lizard occur in southern California and include the San Diego horned lizard (*P. c. blainvillei*) and the California horned lizard (*P. c. frontale*). The San Diego horned lizard is listed as a federal candidate species (category 2) and a California Species of Special Concern, whereas the California horned lizard is only listed as a Species of Special Concern. The coast horned lizard is found throughout the desert where it's primary food, the harvester ant (*Pogonomyrmerx* sp.), is abundant. Populations have been decline rapidly over the last several years due to a variety of factors including habitat loss, mortality from domesticated pets and motorized vehicles, and collection of the species for pets.

Le Conte's thrasher *(Toxostoma lecontei)*: This bird species is listed as a Species of Special Concern and is rather local in its distribution throughout the Mojave Desert. It inhabits sparse desert scrub areas, Joshua tree woodlands, and desert washes.

Black-shouldered kite *(Elanus caeruleus)*: The black-shouldered kite, which is fully protected by the State of California, is considered to be a rare species with a very restricted range. The species is known to utilize undisturbed areas within the Palmdale area as wintering habitat; however, it is not known if the species nests in the area.

Northern harrier *(Circus cyaneus)*: The Northern harrier is a Species of Special Concern and is primarily associated with marshes and grassland areas. These particular habitats are limited within the Palmdale area, although the Northern harrier may occasionally

occur on the project site during foraging activities. The species may not nest within the area, although, the Palmdale area is probably utilized by the Northern harrier during the winter months.

Burrowing owl *(Athene cunicularia)*: Burrowing owls inhabit open areas in California where abandoned ground squirrel burrows are available. This species is a Species of Special Concern.

Long-eared owl *(Asio otus)*: This Species of Special Concern was once abundant throughout California; however, the species has experienced a significant decline over the last few decades. It is found primarily in riparian habitats and may occasionally occur within the Palmdale area, although, suitable riparian areas are relatively limited in the region.

Loggerhead shrike *(Lanius ludovicianus)*: The loggerhead shrike is a federal candidate species (category 2) and is found in open areas with scattered shrubs and trees. The species is occasionally observed in Joshua tree woodland areas and is known to nest within the Palmdale area.

California horned lark *(Eremophila alpestris actia)*: This federal candidate species (category 2) occurs in association with grasslands, fields, and similar open habitat. It is known to nest within the Palmdale area.

Pale big-eared bat *(Plecotus townsendii pallescens)*: The big-eared bat is listed as a Species of Special Concern and occurs in desert scrub habitats in the Mojave Desert.

American badger *(Taxidea taxus)*: The badger, which is,listed as a Species of Special Concern, inhabits desert scrub habitat and pinyon-juniper woodlands within the Mojave Desert. Populations levels have declined over the last few decades due in large part to urbanization, agricultural activities, and human induced mortality.

Swainson's hawk *(Buteo swainsoni)*: The Swainson's hawk, which is listed as a State threatened species, occurs throughout the arid regions of the western United States. It occurs primarily in open habitats where it forages for small mammals, birds, and reptiles.

Sharp-shinned hawk *(Accipiter striatus)*: This species is found in southern California in mixed woodlands primarily during the winter months, and may be an infrequent visitor to the Antelope Valley area. It is listed as a Species of Special Concern.

Cooper's hawk *(Accipiter cooperii)*: The Cooper's hawk is a Species of Special Concern and, like the Sharp-shinned hawk, is found primarily in woodland habitats. It may also be an infrequent visitor to the western Mojave Desert.

Prairie falcon *(Falco mexicanus)*: The Prairie falcon inhabits dry,

open habitats and is a Species of Special Concern. It is uncommon throughout California and may occasionally be seen in the Antelope Valley.

3.5 SENSITIVE PLANT SPECIES

Several sensitive plants are known to occur in the Mojave Desert and may occur in the Palmdale area. The plants most likely to be found in the region are discussed below. Surveys for sensitive plants were conducted in conjunction with the desert tortoise and Mohave ground squirrel surveys.

Peirson's morning glory *(Calystegia peirsonii)*: Peirson's morning glory is a federal candidate species (category 2) which has been recorded in the area. It occurs primarily on dry slopes in desert scrub habitat normally between elevations of 3000 to 4500 feet.

Desert cymopterus *(Cymopterus deserticola)*: This plant is a federal candidate species (category 2) occurring in desert scrub and Joshua tree woodland habitats and is considered to be very rare.

Alkali mariposa lily *(Calochortus striatus)*: This lily is found in undisturbed meadows where alkali soils are present, and is listed as a federal candidate species (category 2). It normally occurs at elevations of between 2500 to 4500 feet.

Mohave spineflower *(Chorizanthe spinosa)*: The Mohave spineflower has a limited distribution in California and has been placed on the "watch list" by the California Native Plant Society. This species occurs in creosote bush scrub communities on dry/gravelly slopes between 2500 and 3500 feet elevation.

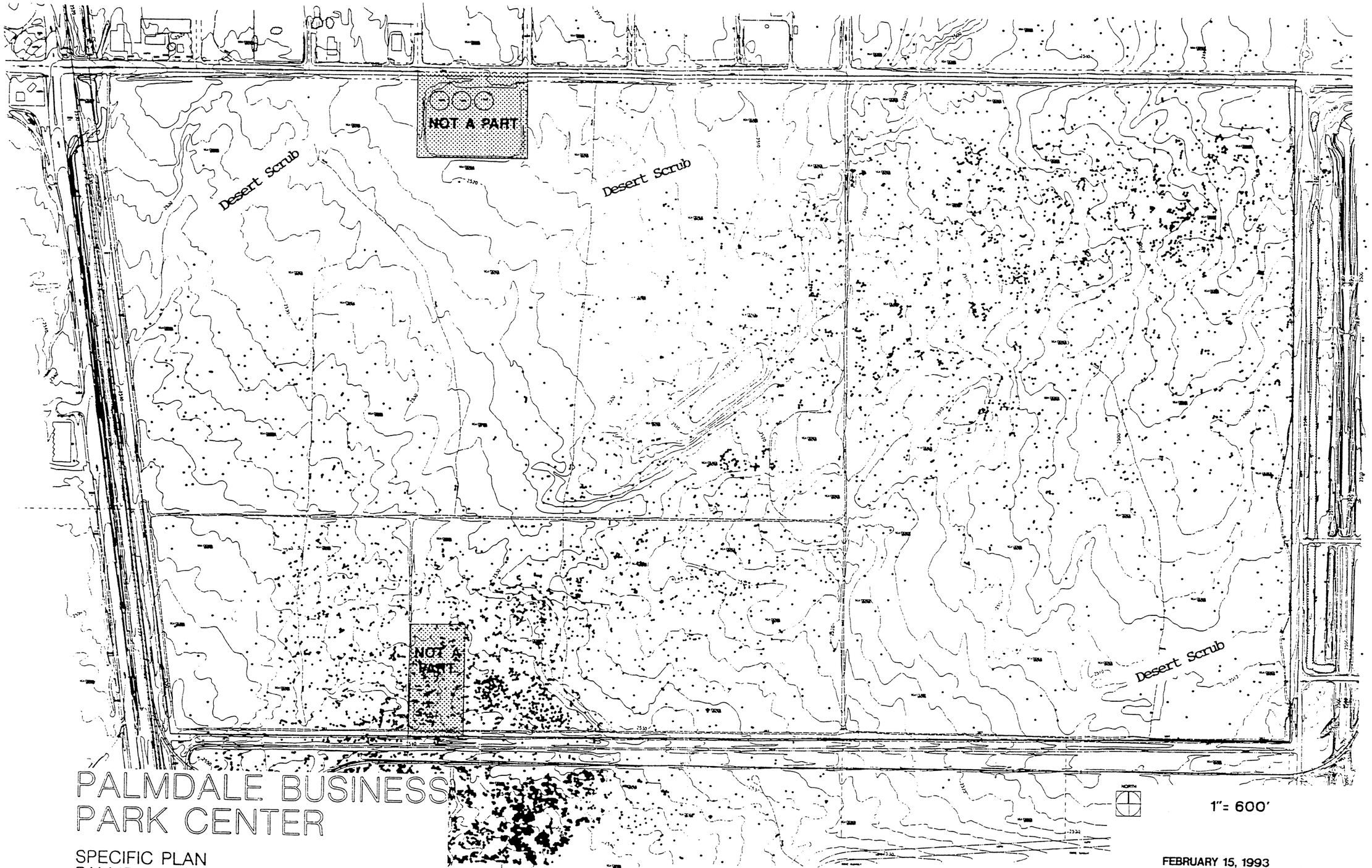
Joshua tree *(Yucca brevifolia)*: Joshua trees occur throughout the Mojave Desert and are protected by the City of Palmdale Native Vegetation Ordinance. The Joshua trees present on the project site will be addressed in more detail in a separate document (i.e. Desert Vegetation Protection Plan).

4.0 RESULTS

Descriptions of the vegetation and wildlife resources observed on the project site during the fields surveys are provided below. Photos of the site, species lists, and field notes are also included in Appendices A, B, and C.

4.1 VEGETATION

There are two plant communities occurring on the site. These include high quality desert scrub and Joshua tree woodland. There is a considerable amount of intermixing of the two communities;



PALMDALE BUSINESS PARK CENTER

SPECIFIC PLAN
PALMDALE, CALIFORINA

LOCKHEED CORPORATION
4500 PARK GRANADA BLVD
CALABASSAS CA 91339-0220
(818) 876-2212

FEBRUARY 15, 1993

LEGEND

* INDICATES EXISTING JOSHUA TREE
TOTAL: 4592 EXISTING TREES ON-SITE

Source of Exhibit:
David A. Price
ASSOCIATES

Exhibit III
EXISTING VEGETATION

however, the Joshua tree woodland is particularly prominent in the southwestern and northeastern portion of the site. Joshua trees within the woodland areas range from moderate to very high densities. Distinct areas of desert scrub occur in the northwestern, northcentral, and southeastern portions (Exhibit 3). A "blueline" stream is also located in the extreme northwest corner of the property; however, no riparian vegetation occurs anywhere along the channel.

4.1.1 Desert Scrub

Desert scrub is one of the most common communities in the western Mojave Desert, and is found throughout the project site and in the surrounding region (Exhibit 3). A wide variety of plant species are found in this community. The most common plants observed on the project site during field surveys included rabbitbush (*Chrysothamnus nauseosus*), creosote bush (*Larrea tridentata*), saltbush (*Atriplex canescens*), ephedra (*Ephedra* sp.), boxthorne (*Lycium* sp.), hopsage (*Grayia spinosa*), and burrobush (*Ambrosia dumosa*). The ratio of these dominant species is apparently dependent upon various local physical factors such as slope, soil type, and the amount of past human disturbance.

A wide variety of other plants occur on the site interspersed among the dominant species. Some of these include goldenbush (*Haplopappus* sp.), buckwheat (*Eriogonum fasciculatum*), cholla (*Opuntia* sp.), and mustard (*Brassica* sp.). Other species observed included filaree (*Erodium* sp.), desert primrose (*Oenothera brevipes*), downey chess (*Bromus tectorum*), winterfat (*Eurotia lanata*), rice grass (*Oryzopsis hymenoides*), and needlegrass (*Stipa speciosa*). A comprehensive list of plants observed on the project site and/or known to occur in the general area are provided in Appendix B.

4.1.2 Joshua Tree Woodland

Joshua trees are found throughout the project site; however, the most dense woodland areas are in the southwestern and northeastern portion of the property (Exhibit 3). The Joshua trees in these areas have densities as great as 75 to 100 trees per acre. There are a total of 4592 Joshua Tress on the project site as determined by computer analysis. Joshua trees are protected under the City of Palmdale Native Vegetation Ordinance, which requires the preparation of a "Desert Vegetation Protection Plan". A "Protection Plan" has been prepared as a separate document for the project site and discusses the use of the existing Joshua trees as part of the proposed project site landscaping.

Plant species common to the desert scrub community are also well represented within the Joshua tree woodland areas with rabbitbush, creosote bush, and saltbush co-dominants with the Joshua trees. No discernable difference was noticed between the desert scrub and

Joshua tree woodland communities with annual and perennial species diversity virtually identical.

4.2 WILDLIFE

4.2.1 General Wildlife

The habitats occurring on the site support a diverse assemblage of wildlife species typical of the western Mojave Desert. The wildlife species observed during the field surveys and which are known to occur in the area are discussed below. A comprehensive list of wildlife species is provided in Appendix B.

Birds are the most abundant group of vertebrates, with numerous species migrating throughout the area during the spring and fall months. Numerous resident species are also common to the area including the house sparrow (*Carpodacus mexicanus*), morning dove (*Zenaida macroura*), greater roadrunner (*Geococcyx californianus*), song sparrow (*Melospiza melodia*), common raven (*Corvus corax*), California thrasher (*Toxostoma redivivum*), cactus wren (*Campylorhynchus brunneicapillus*), and northern mockingbird (*Mimus polyglottus*). Raptors such as the red-tailed hawk (*Buteo jamaicensis*) and American kestrel (*Falco sparverius*) are also frequently observed in the area.

Several species of small mammals inhabit the western Mojave Desert and are expected to occur on the project site, although, no live-trapping surveys were conducted on the property. Some of the more common species in the region include the western harvest mouse (*Reithrodontomys megalotis*), desert woodrat (*Neotoma lepida*), little pocket mouse (*Perognathus longimembris*), antelope ground squirrel (*Ammospermophilus leucurus*), California ground squirrel (*Spermophilus beecheyi*), and various mice species (*Peromyscus* sp.). Large mammals observed on the site and which are common in the region include the black-tailed jack rabbit (*Lepus californicus*), desert cottontail (*Sylvilagus auduboni*), kit fox (*Vulpes macrotis*), and coyote (*Canis latrans*).

Reptile populations are not as diverse in the region as are birds and mammals; however, several species do occur on the site and were seen on the site during field surveys. Some of the reptiles more commonly observed included the side-blotched lizard (*Uta stansburiana*), western whiptail lizard (*Cnemidophorus tigris*), western fence lizard (*Sceloporus occidentalis*), desert spiny lizard (*Sceloporus magister*), coachwhip (*Masticophis flagellum*), and Mojave rattlesnake (*Crotalus cerastes*). Two additional snake species inhabit the Mojave Desert and include the gopher snake (*Pituophis melanoleucus*) and sidewinder (*C. cerastes*). Neither the gopher snake or sidewinder were observed on the site.

4.2.2 Desert Tortoise

The project site lies within the southwestern part of the tortoises range and current data indicates the species still occurs in the region, although population levels are quite low. U.S. Bureau of Land Management has ranked the area as a Category 3 area indicating a very low population density.

No live tortoises were encountered on the subject property during the field surveys, and no active or inactive burrows were observed. However, one tortoise scat (greater than 12 months old) and one scute (i.e. part of a tortoise shell) were found in the northeastern part of the project site. The absence of any other tortoise sign from the rest of the project site indicates that the scat and scute may have come from a captive tortoise which was released on the site during the last few years and which eventually died.

4.2.3 Mohave Ground Squirrel

The habitat on the project site was evaluated as per California Fish and Game regulation to determine if suitable habitat is present. The species is known to occur in the general area. The most recent sighting was in 1984 approximately 2.5 miles north of the project site (Lancaster East Quadrangle, T7N, R12W, Section 23). A mohave ground squirrel was also observed in 1973 4.5 miles east of the site (Lancaster East, T7N, R11W, Section 3). Exhibit-4 shows the existing disturbance on the site which has resulted from various human activities (e.g. garbage dumping, etc.).

A Cumulative Human Impact Evaluation (AN) was performed for the property site, which included an evaluation of ten disturbance categories (i.e. OHV use, roads on-site, horse/foot traffic, dog activity, urbanization, presence of dump sites, mining activity, utilities, grazing, and existing shrub disturbance). As previously mentioned in Section 3.3, each of these categories was evaluated as per the existing conditions on the project site and in the surrounding area, and were utilized in calculating the Cumulative Impact Rating (CIR) number. The CIR was calculated to be 30 for the project site indicating a low to moderate level of human disturbance. The rating for each individual category is also discussed below and is provided in Appendix C.

(1) OHV Use was rated a 3 due to the presence of several tracks and established trails observed throughout the site. The property appears to be frequently utilized by local residents for OHV activities.

(2) Roads Through The Area was rated a 3 primarily due to the presence of Sierra Highway along the western boundary and Avenue M along the northern boundaries. Both of these thoroughfares are heavily used on a daily basis.

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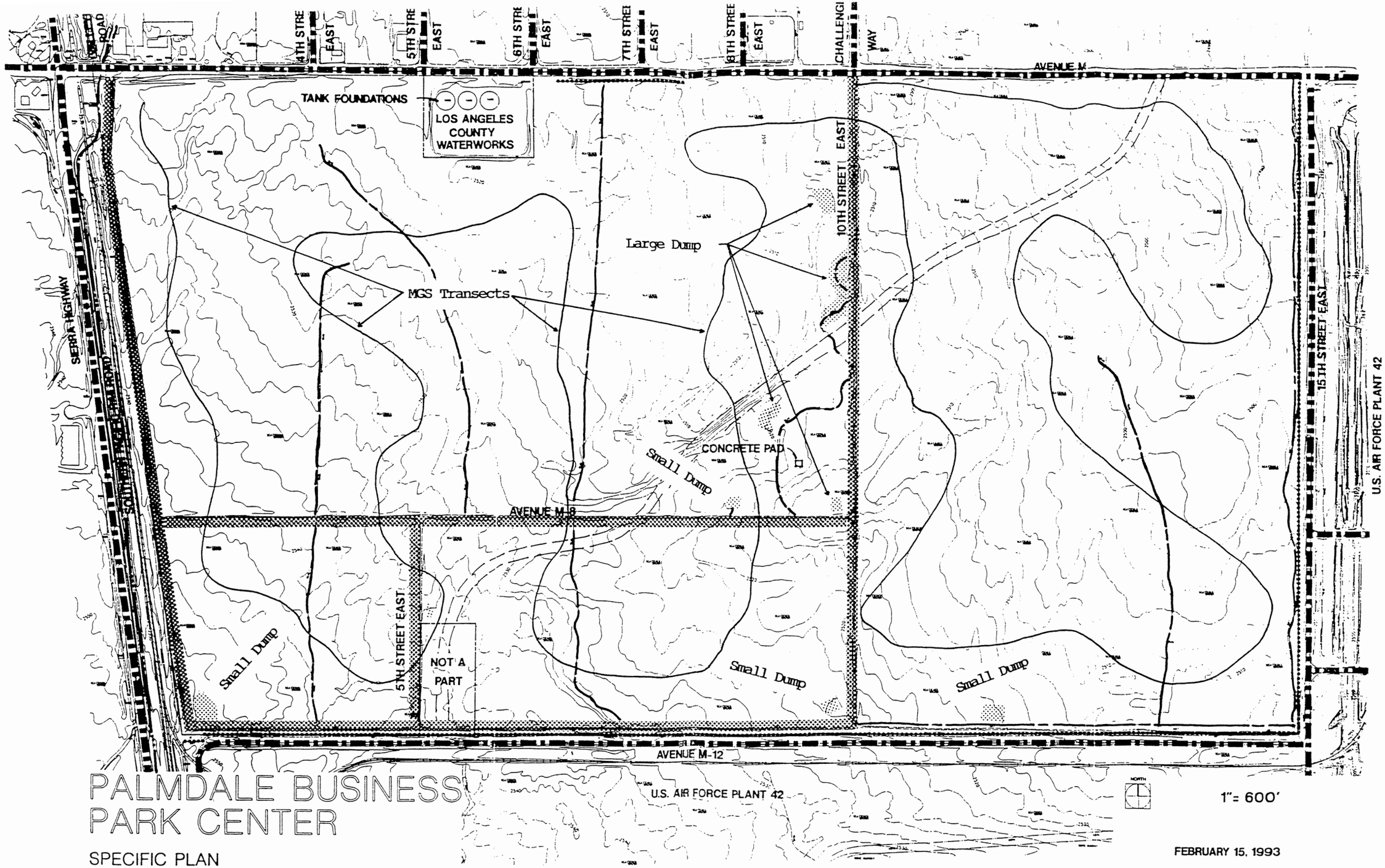

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PALMDALE, CALIFORINA

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FEBRUARY 15, 1993

LEGEND

- PAVED ROAD
- MAJOR DIRT ROAD
- MINOR DIRT ROAD
- EXISTING SITE DRAINAGE
- CHAIN LINK FENCE
- DRAINAGE CHANNEL
- DUMP AREA

Source of Exhibit:
David A. Price ASSOCIATES

Exhibit IV
EXISTING SITE CONDITIONS

(3) Horse or Foot Traffic was rated a 1 since very little horse sign (i.e. tracks or scats) was found on the site. No established horse or foot trails were observed; however, the existing dirt roads are probably used on a frequent basis by local residents.

(4) Dog Activity was rated a 1. Only a few dog tracks and scats were observed on the site during the field surveys.

(5) Urbanization was rated a 3 due to the presence of numerous commercial and light industrial buildings along Avenue M and Sierra Highway. Additional structures associated with the U.S. Air Force Plant 42 are also located to the east and south.

(6) Garbage dumping was rated a 4, which was the highest rating given any of the ten disturbance factors. There are several small and large dump sites scattered throughout the property, and local residents frequently used the site for dumping purposes.

(7) Mining Activity was rated a 0 since there was no evidence of recent or past mining activities anywhere on the site.

(8) Utilities was rated a 2 due to the presence of utility lines along Avenue M and Sierra Highway.

(9) Grazing was rated a 0 since there was no evidence of any recent or past grazing activities.

(10) Shrub disturbance was rated a 1 since only a few shrubs along the roads and around the dump sites showed any signs of disturbance.

4.2.4 Other Sensitive Wildlife Species

As previously mentioned, several other sensitive wildlife species occur in the region as residents or as transitory species. The loggerhead shrike and horned lark, which are federal candidate (category 2) species, were observed during the field surveys. Both species are year-round residents of the Antelope Valley and may nest on the project site, although no confirmation of this was obtained during the field surveys.

The coast horned lizard has also been observed in the immediate area according to the California Natural Diversity Data Base (CNDDB). A specimen was collected in the 1980's immediately northwest of the site (Lancaster West Quadrangle, T7N, R12W, Section 34). The relatively recent sighting of the coast horned lizard in the area indicates the species may occur on the project site, although none were observed.

Some of the transitory and/or resident raptors (i.e. Black-shouldered kite, Northern harrier, Long-eared owl, Swainson's hawk, Cooper's hawk, Sharp-shinned hawk, and Prairie falcon) may occasionally utilize the project site for foraging purposes. Some of the larger Joshua trees may also serve as roosting and/or nest sites. One potential raptor nest was observed in the southwestern portion of the site.

5.0 SENSITIVE PLANT SPECIES

No sensitive plant species, other than the Joshua tree, where observed on the project site. However, the Alkali mariposa lily was observed in the general area in 1982, according to the CNDDB. Over 1000 plants were identified immediately west of Sierra Highway approximately six (6) miles north of the property site (Lancaster West Quadrangle, 7N, 12W, Section 3). The species is found primarily on alkaline soils; no alkaline soils are known to occur on the project site.

6.0 SUMMARY AND CONCLUSIONS

The vegetation and wildlife species found on the project site are typical of the western Mohave Desert. The high quality desert scrub community is relatively undisturbed; however, some human disturbance is present along the existing dirt roads and dump sites. The desert scrub community is integrated with the Joshua tree woodland areas, which also represent excellent habitat. Some of the woodland areas support Joshua tree densities between 75 and 100 per acre. No other sensitive plant species were observed on the site.

Wildlife species observed throughout the project site are typical of those found within desert scrub and Joshua tree communities; however, some sensitive wildlife species were observed on the site. The loggerhead shrike and horned lark, both of which are federal candidate species (category 2), were observed during field surveys. These species are known to nest within the Palmdale area and may nest on the project site. Some of the transitory species (e.g. raptors) may also occasionally traverse the site during foraging activities.

One desert tortoise scat and one scute (ie. shell fragment) were found in the northeastern portion of the site, and may have come from a captive tortoise recently released on the project site. No other tortoise sign (e.g. burrows, tracks, etc.) were observed, and the site does not currently support any tortoise populations.

The Mohave ground squirrel was not observed on the project site; however, the species does occur within the general area surrounding the property. As previously mentioned, the vegetation communities

represent high quality habitat and the Mohave ground squirrel may inhabit the property. The Cumulative Human Impact Evaluation performed for the site indicates a low to moderate level of past human impact with most impacts confined to areas immediately adjacent to the roads and dump sites.

The proposed plan calls for construction of numerous commercial buildings, roads, parking lots and golf course. Construction activities will impact biological resources causing the loss of the majority of high quality native vegetation, numerous Joshua trees, and potential sensitive species habitat. Vegetation loss will also directly affect the wildlife species inhabiting the site including increased mortality for less mobile species and displacement of mobile species into surrounding habitats. Some displaced wildlife may experienced increased mortality or forced into wider dispersal if adjacent habitats are at carrying capacity and unable to support additional individuals.

The presence of tortoise sign and the potential use of the site by Mohave ground squirrels may require the project proponent to apply for a Federal Section 10a permit and a State 2081 permit prior to development of the site. These permits are required when threatened and endangered species will be affected by a proposed project. Following review of the Biological Survey Report and other environmental documentation, California Department of Fish and Game (CFG) and U.S. Fish and Wildlife Service (USFWS) will determine if the permits and associated mitigations are required. If the permits are deemed necessary by the agencies, the project proponent will enter into consultation with CFG and USFWS. During consultations, specific mitigations will be proposed by the agencies which will help to offset potential impacts to the desert tortoise and Mohave ground squirrel. The various mitigations will be incorporated as part of the Section 10a and 2081 permits.

Other general mitigations which should be considered prior to development of the site include:

(1) Retain as many Joshua trees on the site as possible (see Desert Vegetation Protection Plan for additional information);

(2) Retain large areas of existing vegetation in order to maintain the integrity of the plant communities; and

(3) Encourage the planting of drought resistant native shrubs and trees around the proposed buildings and golf course in order to provide quality wildlife habitat.

In summary, overall impacts to the biological resources are rated as significant. The significant rating is based on the loss of high quality desert scrub and Joshua tree woodlands, and the loss of potential Mohave ground squirrel habitat. In addition, there was limit desert tortoise sign observed on the site; however, no

active or potentially active burrows were found during the surveys. Development of the site is not expected to generate significant cumulative impacts to biological resources in the general region.

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APPENDIX A

PHOTOGRAPHS OF THE PROJECT SITE

VIEW FROM THE NORTHWEST CORNER LOOKING SOUTHEAST

VIEW FROM THE SOUTHWEST CORNER LOOKING NORTHEAST

VIEW FROM THE NORTHEAST CORNER LOOKING SOUTHWEST

VIEW FROM THE SOUTHEAST CORNER LOOKING NORTHWEST

APPENDIX B

LISTS OF PLANT AND ANIMAL SPECIES OCCURRING ON THE PROJECT SITE AND/OR IN THE GENERAL REGION

PLANT SPECIES OBSERVED ON THE PROJECT SITE AND/OR KNOWN TO OCCUR IN THE REGION.

Commom Name	Scientific Name
EPHEDRACEAE	
Ephedra	Ephedra sp.
ASTERACEAE	
Annual Bur-ragweed	Ambrosia acanthicarpa
Burrobush	Ambrosia dumosa
Western ragweed	Ambrosia psilostachya
Great Basin sagebrush	Artemisia tridentata
Mulefat	Baccharis glutinosa
Rabbitbush	Chrysothamnus nauseosus
Horseweed	Conyza canadensis
California bush sunflower	Encelia farinosa
Narrow-leaved goldenbush	Ericameria linearifolia
Pine goldenbush	Ericameria pinifolia
Long-leaved goldenbush	Haplopappus longifolius
Common sunflower	Helianthus annuus
Telegraph weed	Heterotheca grandiflora
Scale-broom	Lepidospartum squamatum
Lemmon's lessingia	Lessingia Lemmoni var ramulosissima
Cocklebur	Xanthium strumarium
BORAGINACEAE	
Salt heliotrope	Heliotropium curassavicum
BRASSICACEAE	
Black mustard	Brassica nigra
CACTACEAE	
Silver cholla	Opuntia echinocarpa
CHENOPODIACEAE	
Four-winged saltbush	Atriplex canescens
Russian thistle	Salsola australis
EUPHORBIACEAE	
Dove weed	Eremocarpus setigerus
FABACEAE	
Bird's-foot lotus	Lotus corniculatus
LAMIACEAE	
Great basin blue sage	Salvia dorri
Vinegar weed	Trichostema lanceolatum
POLYGONACEAE	
California buckwheat	Eriogonum fasciculatum
Yellow turban	Eriogonum pusillum
Buckwheat	Eriogonum spp.

SOLANACEAE	
Western jimsonweed	Datura innoxia
TAMARICACEAE	
Small-flowered tamarisk	Tamarix parviflora
ZYGOPHYLLACEAE	
Creosote bush	Larrea tridentata
AGAVACEAE	
Joshua tree	Yucca brevifolia
Spanish bayonet	Yucca whipplei
LILIACEAE	
Blue dicks	Dichelostemma pulchellum
POACEAE	
Ripgut grass	Bromus diandrus
Red brome	Bromus rubens
Downy chess	Bromus tectorum
Bermuda grass	Cynodon dactylon
Desert needlegrass	Stipa speciosa

WILDIFE SPECIES OBSERVED ON THE PROJECT SITE AND/OR KNOWN TO OCCUR IN THE REGION.

Common Name	Scientific Name
REPTILES	
TESTUDINIDAE	
Desert tortoise	Xerobates agassizi
GEKKONIDAE	
Banded gecko	Coleonyx variegatus
IGUANIDAE	
Common leopard lizard	Gambelia wislizenii
Coast horned lizard	Phrynosoma coronatum
Desert spiny lizard	Sceloporus magister
Side-blotched lizard	Uta stansburiana
TEIDAE	
Western whiptail	Cnemidophorus tigris
COLUBRIDAE	
Glossy snake	Arizona elegans
Western shovel-nosed snake	Chionactis occipitalis
Night snake	Hypsiglena torquata
Common kingsnake	Lampropeltis getulus
Coachwhip	Masticophis flagellum
Spotted leaf-nosed snake	Phyllorhynchus decurtatus
Gopher snake	Pituophis melanoleucus
Long-nosed snake	Rhinocheilus lecontel
Western patch-nosed snake	Salvadora hexalepis
VIPERIDAE	
Sidewinder	Crotalus cerastes
Mojave rattlesnake	Crotalus scutulatus
BIRDS	
ANATIDAE	
Mallard	Anas platyrhynchos
CATHARTIDAE	
Turkey vulture	Cathartes aura
ACCIPITRIDAE	
Sharp-shinned hawk	Accipiter striatus
Cooper's hawk	Accipiter cooperii
Red-tailed hawk	Buteo jamaicensis
FALCONIDAE	
American kestrel	Falco sparverius

PHASLANIDAE	
California quail	Callipepla callifornica
RALLIDAE	
American coot	Fulica americana
CHARADRIDAE	
Killdeer	Charadrius vociferus
LARIDAE	
California gull	Larus californicus
COLUMBIDAE	
Rock dove	Columbia livia
Mourning dove	Zenaida macroura
CUCULIDAE	
Greater roadrunner	Geococcyx californianus
TYTONIDAE	
Common barn-owl	Tyto alba
STRIGIDAE	
Great horned owl	Bubo virginianus
Burrowing owl	Athene cunicularia
APODIDAE	
White-throated swift	Aeronautes saxatalis
TROCHILIDAE	
Costa's hummingbird	Calypte costae
TYRANNIDAE	
Say's phoebe	Sayornis saya
Ash-throated flycatcher	Myiarchus cinerascens
HIRUNDINIDAE	
Northern rough-winged swallow	Stelgidopteryx serripennis
Cliff swallow	Hirundo pyrrhonota
Barn swallow	Hirundo rustica
CORVIDAE	
Scrub jay	Aphelocoma coerulescens
Common raven	Corvus corax
PARIDAE	
Plain titmouse	Parus inornatus
REMIZIDAE	
Verdin	Auriparus flaviceps
AEGITHALIDAE	
Bushtit	Psaltriparus minimus

TROGLODYTIDAE	
Cactus wren	Campylorhynchus brunneicapillus
Rock wren	Salpinctes obsoletus
MUSCICAPIDAE	
Ruby-crowned kinglet	Regulus calendula
Western bluebird	Sialia mexicana
Wrentit	Chamaea fasciata
MIMIDAE	
Northern mockingbird	Mimus polyglottos
Sage thrasher	Oreoscoptes montanus
California thrasher	Toxostoma redivivum
Le Conte's thrasher	Toxostoma lecontei
BOMBYCILLIDAE	
Cedar waxwing	Bombycilla cedrorum
PTILOGONATIDAE	
Phainopepla	Phainopepla nitens
LANIDAE	
Loggerhead shrike	Lanius ludovicianus
STURNIDAE	
European starling	Sturnus vulgaris
VIREONIDAE	
Warbling vireo	Vireo gilvus
EMBERIZIDAE	
Orange-crowned warbler	Vermivora celata
Yellow-rumped warbler	Dendroica coronata
Townsend's warbler	Dendroica townsendi
Black-chinned sparrow	Spizella atrogularis
Song sparrow	Melospiza melodia
White-crowned sparrow	Zonotrichia leucophrys
Dark-eyed junco	Junco hyemalis
Western meadowlark	Sturnella neglecta
Brewer's blackbird	Euphagus cyanocephalus
Hooded oriole	Icterus cucullatus
FRINGILLIDAE	
House finch	Carpodacus mexicanus
Lesser goldfinch	Carduelis psaltria
PASSERIDAE	
House sparrow	Passer domesticus

MAMMALS

VESPERTILIONIDAE	
Yuma myotis	Myotis yumanensis
California myotis	Myotis californicus
Western pipistrelle	Pipistrellus hesperus
Hoary bat	Lasiurus cinereus
Townsend's big-eared bat	Plecotus townsendii
Pallid bat	Antrozous pallidus
MOLOSSIDAE	
Brazilian free-tailed bat	Tadarida brasiliensis
LEPORIDAE	
Brush rabbit	Sylvilagus bachmani
Desert cottontail	Sylvilagus audubonii
Black-tailed jackrabbit	Lepus californicus
SCIURIDAE	
White-tailed antelope squirrel	Ammospermophilus leucurus
Mohave ground squirrel	Spermophilus mohavensis
Western gray squirrel	Sciurus griseus
GEOMYIDAE	
Botta's pocket gopher	Thomomys bottae
HETEROMYIDAE	
Little pocket mouse	Perognathus longimembris
Desert pocket mouse	Perognathus penicillatus
San Diego pocket mouse	Perognathus fallax
Merriam's kangaroo rat	Dipodomys merriami
CRICETIDAE	
Western harvest mouse	Reitrodontomys megalotis
Cactus mouse	Peromyscus eremicus
California mouse	Peromyscus californicus
Deer mouse	Peromyscus maniculatus
Canyon mouse	Peromyscus crinitus
Brush mouse	Peromyscus boylii
Pinon mouse	Peromyscus truei
Southern grasshopper mouse	Onychomys torridus
Desert woodrat	Neotoma lepida
Dusky-footed woodrat	Neotoma fuscipes
MURIDAE	
Black rat	Rattus rattus
Norway rat	Rattus norvegicus
House mouse	Mus musculus
CANIDAE	
Coyote	Canis latrans
Red fox	Vulpes vulpes
Kit fox	Vulpes macrotis

Gray fox	*Urocyon cinereoargenteus*
PROCYONIDAE	
Raccoon	*Procyon lotor*
Long-tailed weasel	*Mustela frenata*
Badger	*Taxidea taxus*
Western spotted skunk	*Spilogale gracilis*
Striped skunk	*Mephitis mephitis*

APPENDIX C

MOHAVE GROUND SQUIRREL FIELD SURVEY FORMS

CUMULATIVE HUMAN IMPACT EVALUATION FORM

PART I

PROJECT ID# Palmdale Business Park DATE: May 20, 1993

EVALUATION CONDUCTED BY: Randall C. Arnold, Jr.

PHONE NUMBER: (619) 955-8971 TRAINED BY: 1991 - P. Woodman 1992 - C. Uptain

LOCATION: T 6N S/N; R 12W E/W; -- 1/4 SEC 1 & 2 SITE: --

QUAD MAP/SERIES: Lancaster East 7.5" X 15"

ACREAGE OF PROJECT: 632 TOTAL ACREAGE SURVEYED: 632

CIR OF PROJECT AREA: 30 CIR OF TOTAL ACREAGE: 30

Acreage of non-compensable habitat (if any): none

Acreage of agriculture field (if present on parcel): none

==========

PART II LAND USE IMPACTS (0 = none, 4 = heavily impacted)

	COMMENTS	RATING
1. OHV use		3
2. Roads through area		3
3. Horse or foot traffic		1
4. Dog activity		1
5. Urbanization		3
6. Garbage Dumping		4
7. Mining activity		0
8. Utilities		2
9. Grazing		0
10. Shrub disturbance		1

Add the five highest rated disturbances and multiply by 2. Enter in Part I.

OHV Use..... 3
Roads Through Area..... 3
Urbanization..... 3
Garbage Dumping..... 4
Utilities..... 2

15

CIR = 15 x 2 = 30

PART III **GENERAL HABITAT DESCRIPTION**

1. Shrub coverage estimate, (including sub-shrubs):
   A. acres of dense shrub coverage: 475
   average height of creosote: 6-7 ft., other shrubs: 2-4 ft.

   B. acres of moderate shrub coverage: 157
   average height of creosote: 6-7 ft., other shrubs: 1-3 ft.

   C. acres of sparse shrub coverage: 0
   average height of creosote: -- ft., other shrubs: -- ft.

2. Shrub species diversity: # dominate; 4, sub-dominate 3.

3. Presence of annuals: A X; B_____; C_____.
   Percent of native annuals: 100, non-native: 0.

4. Presence of perennial grasses: A X; B_____; C_____.

5. Percent coverage of desert pavement none varnish none

6. Soils description: Sandy alluvial soils present on the site.

7. Percent rocks and boulders present: (describe) A few rocks (3" to 8" in diameter) were observed scattered throughout the site.

8. Presence of washes: none Periodic flooding: none

9. Slope/Aspect: One percent slope; NE aspect.

10. Elevation: 2490 to 2550 feet.

PART IV **OTHER FACTORS OF CONSIDERATION**

1. Type and name of grazing allotment:

perennial_____ ephemeral X

Scat Class (1 - 4): --

2. Proximity to known MGS populations: (be specific; list Data Base records. Should be discussed within text of report.)

No nearby records: . Records in vicinity (see text): X

3. Landowner: Lockheed Corporation

4. Type of County Zoning: commercial Proposed Changes to Zoning?

No

HABITAT EVALUATION FIELD FORM - SITE DESCRIPTION

Site
Name: PALMDALE BUSINESS PARK CENTER
Location: PALMDALE, CALIFORNIA

Survey
Date and Time: APRIL & MAY 1993
Conditions: —

Physical Factors

Soils: SANDY ALLUVIAL SOILS

Desert Pavement: NONE

Rocks/Boulders: A FEW ROCKS (3" to 8" IN DIAMETER) SCATTERED THROUGHOUT SITE

Elevation, Slope, & Aspect:
2490' to 2550'; 1% SLOPE; NE ASPECT

Biota Factors

Shrubs
Types: DESERT SCRUB & JOSHUA TREE WOODLAND COMMUNITIES

Density: MODERATE to HIGH

Perennial Grasses: RICE GRASS, NEEDLEGRASS

Fauna Sign

Species observed: NUMEROUS BIRDS (SEE TEXT)
SIDE-BLOTCHED, WESTERN WHIPTAIL, FENCE LIZARDS
COACHWHIP & MOJAVE RATTLESNAKE

Tracks & Scats:
COYOTE, FOX

Nests/Burrows: NUMEROUS SMALL MAMMAL BURROWS

HABITAT EVALUATION FIELD FORM - LAND USE IMPACTS

OHV Use (NOTE: ESTABLISHED TRAILS ARE MARKED AS MAJOR DIRT ROAD ON Exhibit IV & TRAILS ARE MARKED AS MINOR DIRT ROAD.
- Tracks: ||||
- Established Trails: ||||

Horse &/or Foot Use
- Scats: |||
- Tracks: |
- Established Trails: NONE

Dog Activity
- Scats: ||||
- Tracks: ||
- Diggings: NONE OBSERVED
- Sightings: NONE OBSERVED

Roads
- Interior: NONE
- Exterior: SIERRA HIGHWAY ALONG WESTERN BOUNDARY; AVENUE M ON NORTH BOUNDARY

Urbanization
- Buildings on-site: NONE
- Buildings off-site: NUMEROUS COMMERCIAL BUILDINGS ALONG SIERRA HIGHWAY & AVENUE M.

Garbage Dumping
- Blown trash: SOME SCATTERED THROUGHOUT SITE
- Small Dumps: ||||
- Large Dumps: ||||

Mining Activity
- Small exploration site: NONE
- Large exploration site: NONE

Utilities
- Telephone: > ALONG WESTERN BOUNDARY & ALONG AVENUE M
- Electrical: >

Grazing
- Scats: NONE
- Tracks: NONE

Shrub Disturbance
- Disturbed: A FEW SHRUBS DISTURBED ALONG ROADS & AROUND DUMP SITES
- Damaged:
- Destroyed:

APPENDIX D
LIST OF PREPARES

Randall C. Arnold, Jr.: B.S. in Zoology and M.S. in Biology. Mr. Arnold has 17 years of professional experience and has conducted several hundred flora/fauna surveys throughout California. His areas of expertise include endangered species, wildlife ecology, and botany.

Patti Moore: B.S. in Biology. Ms. Moore has over five years experience as a biologist and has conducted over 100 flora/fauna surveys in California. Her areas of expertise include botany and endangered species.

DRAFT

DESERT VEGETATION PRESERVATION PLAN
SPECIFIC PLAN 92-2
(PALMDALE BUSINESS PARK CENTER)
PALMDALE, CALIFORNIA

PREPARED FOR:

CITY OF PALMDALE
38306 9TH. STREET EAST
PALMDALE, CALIFORNIA 93550

PREPARED BY:

R. C. ARNOLD, JR. & ASSOCIATES
14240 ST. ANDREWS, SUITE 201
VICTORVILLE, CALIFORNIA 92392
(619) 955-8971

JUNE 1993

INTRODUCTION

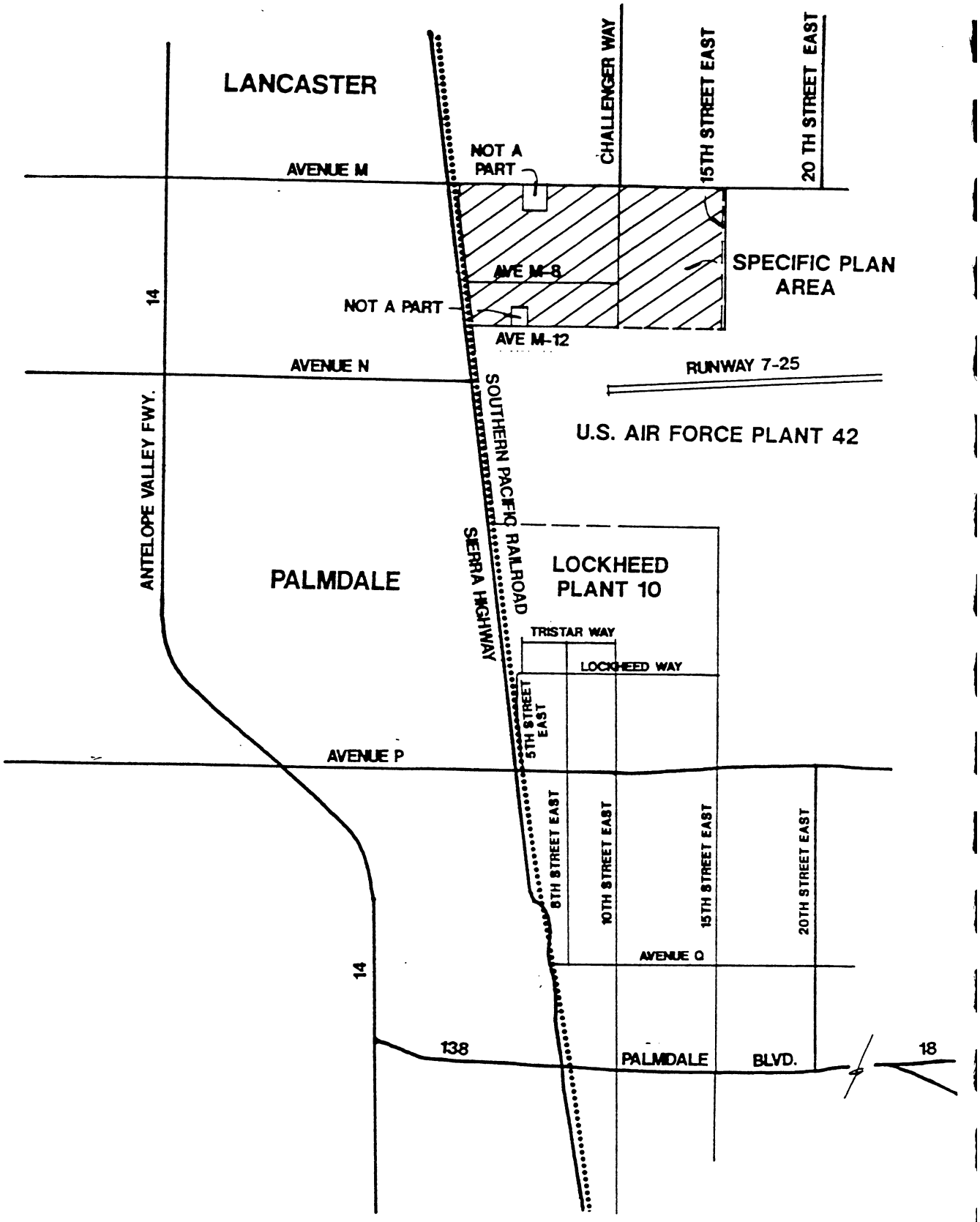
The purpose of this Desert Vegetation Preservation Plan is to protect and preserve the native vegetation occurring on the project site with particular emphasis placed on saving as many Joshua trees as possible. Protection of the Joshua trees and other desert vegetation found on the site will help to retain the unique characteristics and aesthetics associated with the Mojave Desert. Requirements for the preservation of native vegetation are outlined in the City of Palmdale's Ordinance No. 952, Title 14, Chapter 1404 (Appendix A). The project proponent will be required to meet these various preservation criteria, as well as landscaping standards and policies. The minimum preservation standard for Joshua trees is two (2) Joshua trees per gross acre.

Biological surveys were conducted on the 632.4 acre site being proposed as the location for Specific Plan 92-2 (i.e. Palmdale Business Park Center). The surveys were conducted in April and May 1993 to fully evaluate the biological resources and to determine the extent of the Joshua tree woodlands. The locations of the Joshua trees (*Yucca brevifolia*) had been previous mapped by David A. Price Associates using an autocad system (see Methodology Section for more detailed discussion). These computer generated maps were utilized during all phases of the field surveys. California junipers (*Juniperus Californica*) are also protected under Ordinance No. 952; however, no junipers were observed on the site. Results of the surveys, which are presented in this report, are part of the baseline data necessary for consideration of the proposed project by the City of Palmdale and other concerned regulatory agencies. Methodology and other pertinent information are included in this report.

PROJECT LOCATION AND DESCRIPTION

The site, which is owned by Lockheed Corporation, consists of 632.4 acres of undeveloped land located within the City of Palmdale. The property is bordered on the north by Avenue M; by Air Force Plant 42 on the east and south; and by Southern Pacific Railroad Right-of-Way and Sierra highway on the west (Exhibit 1). The proposed Palmdale Business Park Center will be a combination of commercial and industrial complexes with a 27-hole golf facility.

The site is flat with no prominent hills, valleys, or other unique physical features (Exhibit 2). The project site is relatively undisturbed, although it has received some disturbance from various human activities. There are several dirt roads and dump sites scattered throughout the property. Several commercial buildings are located along the north side of Avenue M and along Sierra Highway. A chainlink fence surrounds the property on the east and south, separating the site from Air Force Plant 42.



FEBRUARY 15, 1993

Source of Exhibit:
David A. Price
ASSOCIATES

NORTH

PALMDALE BUSINESS PARK CENTER

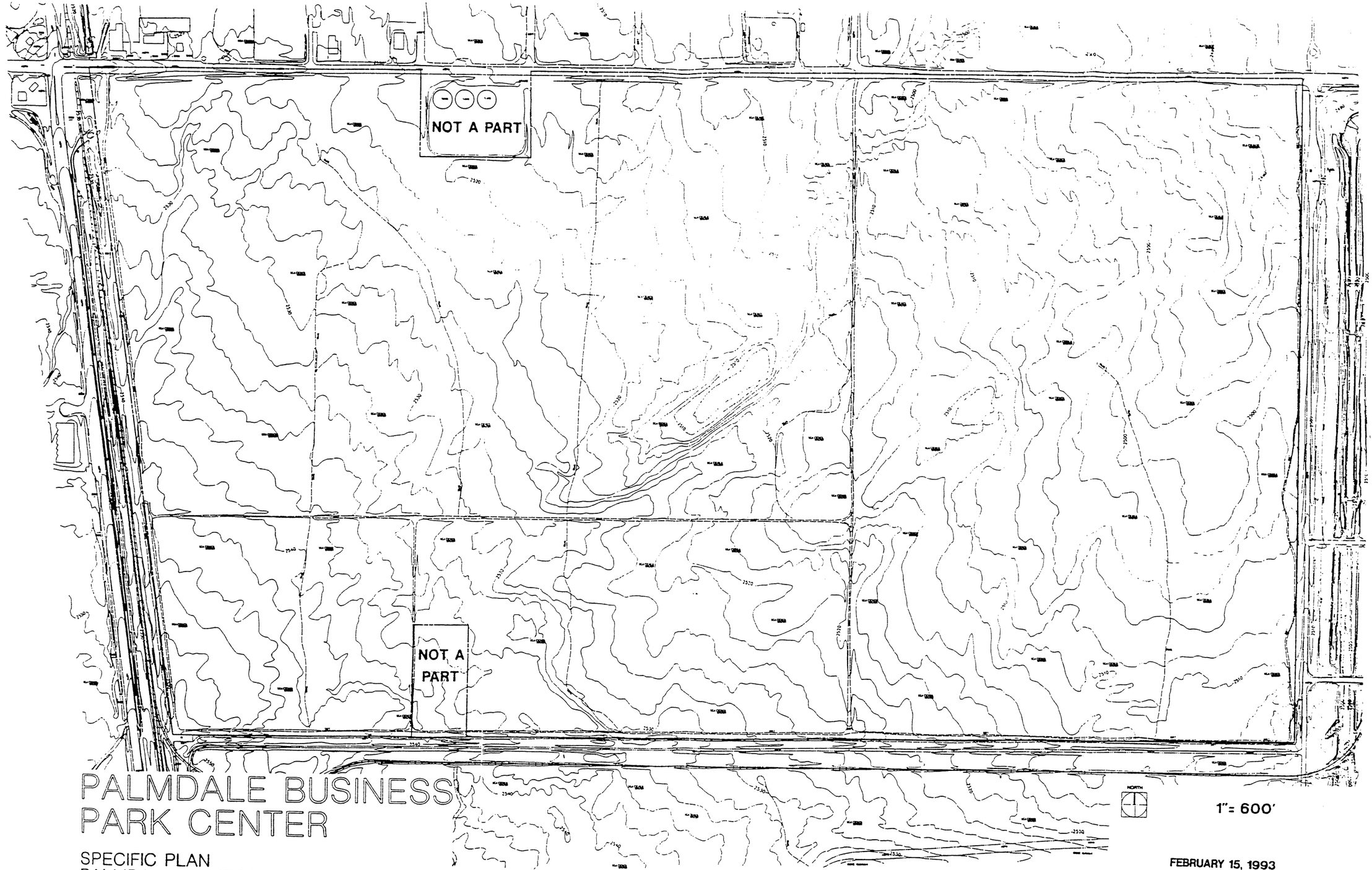
SPECIFIC PLAN
PALMDALE, CALIFORNIA

LOCKHEED CORPORATION

EXHIBIT I

Not To Scale

PROJECT LOCATION MAP



PALMDALE BUSINESS PARK CENTER

SPECIFIC PLAN
PALMDALE, CALIFORINA

LOCKHEED CORPORATION
4500 PARK GRANADA BLVD
CALABASSAS CA 91339-0220
(818) 876-2212

NORTH

1"= 600'

FEBRUARY 15, 1993

Source of Exhibit:

David A. Price ASSOCIATES

Exhibit II

EXISTING TOPOGRAPHY

METHODOLOGY

The site was surveyed by R. Arnold and P. Moore during April and May 1993 in order to fully evaluate the overall biological resources occurring on the site and to map the location of the primary plant communities. A total of 21 mandays were spent in the field. A more detailed discussion of the biological resources, including sensitive plant and animal species, is provided in a separate Biological Survey Report.

Ten yard transects were used during the surveys which resulted in 100 percent coverage of the site. The Joshua tree survey was conducted in conjunction with other surveys performed for sensitive wildlife (i.e. desert tortoise and Mohave ground squirrel) and sensitive plants. The locations of each Joshua tree had been previously mapped using orthographic aerial photos and digital aerial topographic maps. The data from the aerial photos and digital topographic maps were downloaded into an autocad system capable of counting each individual Joshua tree and generating detailed maps. These maps were utilized during all aspects of the field surveys. Notes were also taken regarding the health of each Joshua tree and those individuals which appeared to be dead or dying were marked with surveyors flagging to facilitate future identification.

RESULTS - GENERAL VEGETATION AND WILDLIFE

Descriptions of the general vegetation and wildlife resources occurring on the site are provided below.

VEGETATION

There are two plant communities occurring on the site. These include high quality desert scrub and Joshua tree woodland. There is a considerable amount of intermixing of the two communities; however, the Joshua tree woodland areas occur primarily in the southwestern and northeastern portions of the site. Densities of Joshua trees range from moderate to very high. Areas of desert scrub occur primarily in the northwest, northcentral, and southeast (Exhibit 3).

Desert Scrub

Desert scrub is one of the most common communities in the western Mojave Desert, and is found throughout the project site and in the surrounding area (Exhibit 3). A wide variety of plant species occur in this community. The most common plants observed during field surveys included rabbitbush (*Chrysothamnus nauseosus*), creosote bush (*Larrea tridentata*), saltbush (*Atriplex canescens*), ephedra (*Ephedra* sp.), boxthorne (*Lycium* sp.), hopsage (*Grayia spinosa*), and burrobush (*Ambrosia dumosa*). A few Joshua trees

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NOT A PART

Desert Scrub

Desert Scrub

DENSE STANDS OF JOSHUA TREES
WHICH SHOULD BE PRESERVED
To the extent practice

NOT A PART

Desert Scrub

1"= 600'

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PALMDALE, CALIFORINA

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CALABASSAS CA. 91339-0220
(818) 876-2212

LEGEND

* INDICATES EXISTING JOSHUA TREE
TOTAL: 4592 EXISTING TREES ON-SITE

FEBRUARY 15, 1993

Source of Exhibit:

David A. Price
ASSOCIATES

Exhibit III

EXISTING VEGETATION

(*Yucca brevifolia*) are also scattered throughout the desert scrub.

Other plants occurring on the site interspersed among the dominants included goldenbush (*Haplopappus* sp.), buckwheat (*Eriogonum fasciculatum*), cholla (*Opuntia* sp.), filaree (*Erodium* sp.), winterfat (*Eurotia lanata*), and mustard (*Brassica* sp.). Desert primrose (*Oenothera brevipes*), downey chess (*Bromus tectorum*), rice grass (*Oryzopsis hymenoides*), and needlegrass (*Stipa speciosa*) were also seen during the surveys. A comprehensive species list is provided in Appendix B.

Joshua Tree Woodland

Joshua trees are found throughout the project site; however, the most dense woodland areas are in the southwest and northeast (Exhibit 3). Densities of Joshua trees in the woodland areas range from a few trees per acre up to 100 per acre. There are a total of 4592 Joshua trees on the Project Site. During the field surveys approximately 129 Joshua trees were determined to be dead or dying due to various causes.

Plant species diversity within the Joshua tree woodland areas is virtually identical to that found in the adjacent desert scrub community. Rabbitbush, creosote bush, and saltbush are common throughout the woodlands. No discernable difference in species composition was noted between the two plant communities.

WILDLIFE

The habitats occurring on the property support a diverse variety of wildlife species typical of the western Mojave Desert. A comprehensive species list is provided in Appendix B.

Birds are the most abundant group of vertebrates, with numerous species migrating through the area during the spring and fall months. Numerous resident species are also common to the region including the house sparrow (*Carpodacus mexicanus*), morning dove (*Zenaida macroura*), greater roadrunner (*Geococcyx californianus*), song sparrow (*Melospiza melodia*), common raven (*Corvus corax*), California thrasher (*Toxostoma redivivum*), cactus wren (*Campylorhynchus brunneicapillus*), and northern mockingbird (*Mimus polyglottus*). Raptors such as the red-tailed hawk (*Buteo jamaicensis*) and American kestrel (*Falco sparverius*) are also frequently observed in the area.

Several mammals inhabit the Mojave Desert and are expected to occur on the property. These include the western harvest mouse (*Reithrodontomys megalotis*), desert woodrat (*Neotoma lepida*), little pocket mouse (*Perognathus longimembris*), antelope ground squirrel (*Ammospermophilus leucurus*), California ground squirrel (*Spermophilus beecheyi*), and various mice species (*Peromyscus* sp.). Large mammals observed on the site and/or known to occur in the

area include the black-tailed jack rabbit (*Lepus californicus*), desert cottontail (*Sylvilagus auduboni*), kit fox (*Vulpes macrotis*), and coyote (*Canis latrans*).

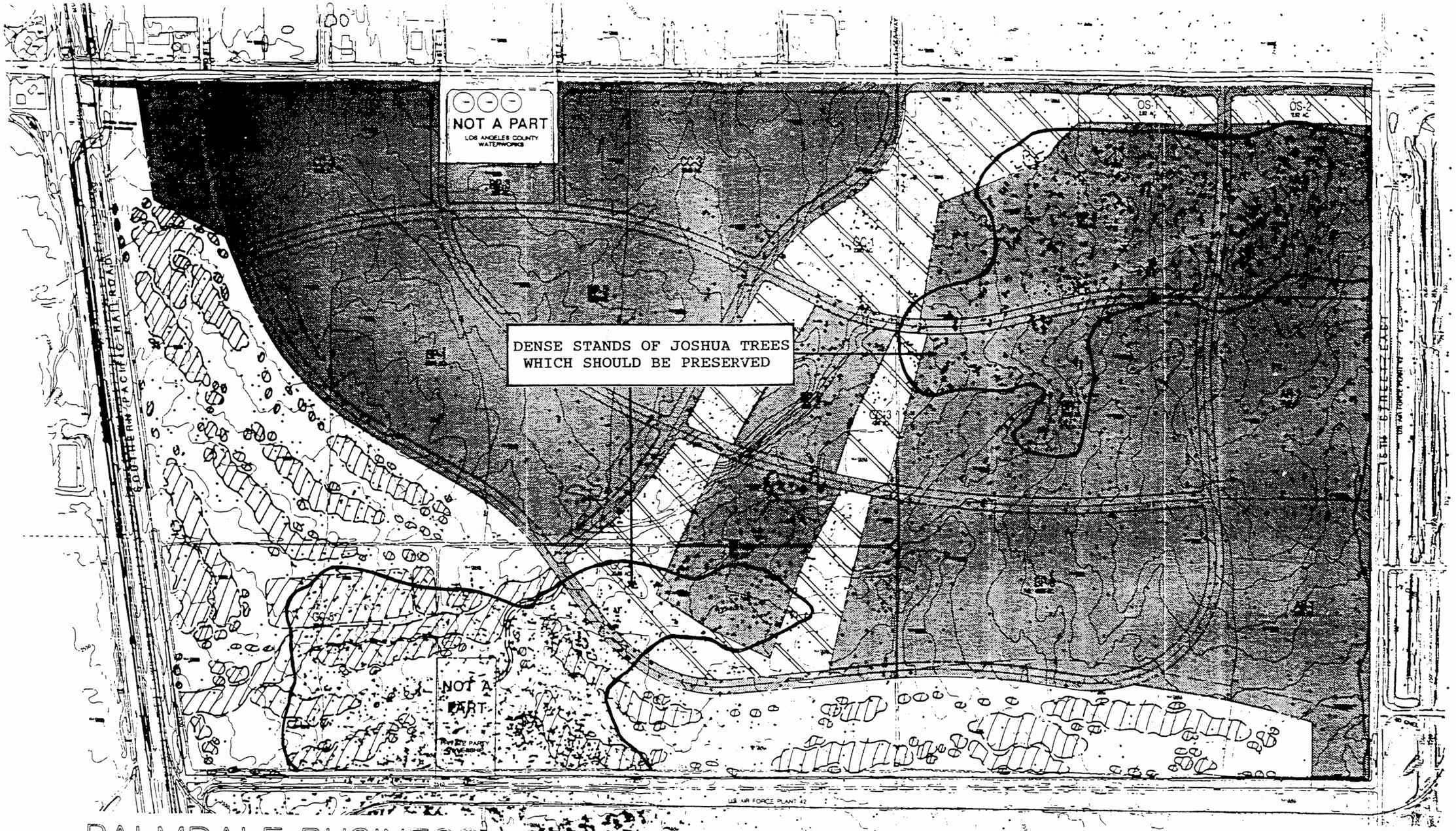
Reptile populations are not as diverse in the region as are birds and mammals; however, several species do occur on the site and were seen during the field surveys. Some of the reptiles observed included the side-blotched lizard (*Uta stansburiana*), western whiptail lizard (*Cnemidophorus tigris*), western fence lizard (*Sceloporus occidentalis*), desert spiny lizard (*S. magister*), coachwhip (*Masticophis flagellum*), and Mojave rattlesnake (*Crotalus scutulatus*). Other snakes known from the area include the gopher snake (*Pituophis melanoleucus*) and sidewinder (*Crotalus cerastes*).

DISCUSSION AND RECOMMENDATIONS

A total of 4592 Joshua trees occur on the property site with the greatest number found within the southwestern and northeastern portions of the site. General landscaping plans have been developed by David A. Price Associates for the project site and are shown in Exhibit 4. Under this plan, approximately 955 Joshua trees would be retained in placed, primarily in the southwest in association with the proposed golf course. Some trees in the central area would also be retained. Approximately 310 Joshua trees would be moved to other areas of the site and utilized for landscaping purposes. The total number of Joshua trees that would be preserved under this plan is 1265, which meets the City's minimum requirement of at least two Joshua trees per acre. However, potential modifications to the proposed locations of the buildings and golf course would allow for the preservation of a greater overall number of Joshua trees and the preservation of portions of the densest stands in the southwest and northeast. These recommendations include:

(1) Locate as many of the golf fairways within the western and southeastern portions of the site where Joshua tree densities are relatively low. Also, move those fairways currently proposed for the central area along the southern property boundary to the southeast and northwest portion of the property where Joshua tree densities are low. In addition, consider reducing the number of fairways from 27 to 18 in order to further minimize impacts to the Joshua tree woodlands.

(2) The northeast portion of the site, as shown in Exhibit 3, supports a dense stand of Joshua trees where minimal grading practices should be utilized, to the extent possible, leaving as much of the native vegetation intact. Furthermore, minimal grading practices should be utilized throughout the rest of the site, where feasible, in order to preserve as much native vegetation and as many Joshua



PALMDALE BUSINESS PARK CENTER

SPECIFIC PLAN
PALMDALE, CALIFORINA

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EXISTING TREES	4592
ESTIMATED PRESERVED TREES IN PLACE	955
ESTIMATED PRESERVED TREES TO BE MOVED	310
TOTAL PRESERVED TREES	1265

1"= 600'

FEBRUARY 15, 1993

LEGEND

DEVELOPMENT AREA -NO TREES PRESERVED IN PLACE

IMPACTED AREAS AT GOLF COURSE -NO TREES PRESERVED IN PLACE

* EXISTING NATIVE VEGETATION -TREES PRESERVED IN PLACE

AREA OF POTENTIAL DESERT VEGETATION RESTORATION

Source of Exhibit
David A. Price ASSOCIATES

Exhibit IV
DESERT VEGETATION PLAN

trees as possible. Use of minimal grading practices will reduce the need for irrigation and achieve additional water conservation as required by the Water Efficient Landscape Ordinance.

(3) Transplant as many Joshua trees as possible to those areas which have been completely graded and are ready for landscaping. Joshua trees can be difficult to successfully transplant, therefore, to compensate for the potential loss of some of the transplanted trees, an additional 25 percent should be added to the total number of Joshua trees to be relocated on the site.

(4) A long term maintenance program should be implemented to ensure the survival of those Joshua trees which will be relocated and used for on-site landscaping. The maintenance program should include irrigation systems, moisture sensors, and controllers capable of handling multiple lines. The maintenance program should be conducted for a minimum of two growing seasons. Joshua trees which are found to be dead or dying at the end of two growing seasons should be replaced by healthy Joshua trees. These newly planted Joshua trees should be monitored for a minimum of two seasons.

(5) The common landscaped areas should be maintained by a Property Owner's Association.

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APPENDIX A

CITY OF PALMDALE ORDINANCE NO. 952

NOTE: The following information has been excerpt from the City of Palmdale's Ordinance No. 952, Title 14 Environmental Management, Chapter 14.04.

14.04.060 Desert Vegetation Preservation Criteria

All development proposals for land which contains desert vegetation shall be subject to the following provisions regarding the preservation of native desert vegetation both on- and off-site:

A. The minimum standard of preservation shall be:

1. Two (2) Joshua Trees or California Junipers per gross acre, averaged for the gross site area covered by the development application, or

2. Where soil conditions or conditions of the Joshua Trees or California Juniper prohibit the preservation of two (2) trees per acre, or where the total number of healthy trees per gross acre is not equal to two (2) per acre, the minimum standard of preservation will be determined by a desert native plant specialist and confirmed by the City's Landscape Architect, or in-lieu thereof, the Director of Public Works designee, in accordance with the following criteria:

a. Soil characteristics of a proposed area for relocation of vegetation.

b. Health of the native desert vegetation, including damage to trunk or root system.

c. Size of the Joshua Tree and the location to where the tree will be transplanted.

d. A suitable top-root ratio.

3. Where possible a minimum of two (2) California Juniper trees per gross acre shall be retained undisturbed on site. California Junipers are valuable components of the Native Desert Vegetation and it is desirable to retain specimens whenever possible. However, California Junipers do not transplant well, are large plants which are difficult to incorporate into landscaping and are not readily available as nursery stock.

4. To enhance the likelihood of survival, native desert vegetation that can not be fenced and left undisturbed will not be left in place while grading. The options for preserving trees on-site after grading are the following:

a. Move the vegetation slated to remain on site to a holding area. After grading has been completed, move vegetation once again to a permanent location.

b. Remove vegetation per options in B. 2 below. After grading, import new Joshua Trees to landscaped area.

c. Grade in phases. Ready the area to receive vegetation first, then transplant and complete grading.

B. The quantity of Joshua Trees or California Junipers calculated under the minimum standard of preservation as determined above shall be preserved by any combination of the following means:

1. The development proposal shall be prepared in a manner which retains on-site those plants that can be incorporated into the design of the development. Development proposals should use native desert vegetation to landscape on-site detention basins, entry statement areas, and other open space sites whenever possible, where xeric landscaping is appropriate.

a. California Junipers retained on site shall be credited toward the two (2) trees per gross acre or other minimum standard of preservation.

b. Other methods of preservation as shown in B. 2. a. through c. and B. 3. below shall not apply to California Junipers.

2. Of the total number of Joshua trees required to be preserved under the two (2) trees per acre required under Section 14.04.060 A.1 the Joshua Trees which are not preserved on-site shall be preserved, by the following means, and shall count towards the required two trees per acre or other minimum standard of preservation:

a. The development proposal shall make available to the City for transplantation any Joshua Trees identified by the City's Landscape Architect, or in-lieu thereof, the Director of Public Works designee, as suitable for use in landscaping any City property or facility.

b. The development proposal shall include an offer to make available to other commercial, industrial or residential development projects, native desert vegetation that can be incorporated into another development proposal's landscaping.

c. The development proposal shall include an offer to make available native desert vegetation to the public for use as landscaping. The native desert vegetation taken from the site may be used for landscaping. Vegetation from the site shall remain available to the public for a minimum of thirty (30) days after appropriate public notice as determined by the Planning Director.

The development proposal will provide for public notice of the availability of Joshua Trees or other desert vegetation for transplantation to other suitable property. The public notice shall be in a form prescribed by the Director of Planning and shall generally conform to Government Code sections 65090 and 65091, although direct mail notice shall not be required. The public notice shall provide at least a thirty (30) day period during which transplantation may occur.

The proponent of the development proposal may require reasonable security and/or indemnification before permitting persons to enter upon the property for transplantation.

The proponent of the development proposal may not impose any fee or other charge upon persons entering upon the property for any purpose relating to the transplantation of native vegetation.

The proponent of the development proposal shall use all reasonable efforts to encourage and permit transplantation to occur to the maximum possible extent.

d. Any Joshua Trees, which are required to be preserved and remain after the previous options have been pursued, may be transplanted to an off-site location, approved by the City's Landscape Architect, or in-lieu thereof, the Director of Public Works designee, at the expense of the proponent of the development proposal. Identifying a suitable off-site location shall be the responsibility of the developer. The City shall provide areas for off-site tree banks. Those City-administered tree banks that are identified will be made available for this use. This measure shall be viewed as an interim solution with the ultimate goal of relocating this native desert vegetation to permanent locations as can be found. Maintenance of vegetation transplanted to a City administered tree bank is the responsibility of the City. The proponent of the development proposal shall be responsible for retaining a qualified consultant to provide initial watering of trees after transplantation to a tree bank as required by the City Landscape Architect, or in-lieu thereof, the Director of Public Works designee, at the expense of the proponent of the development proposal.

3. Only after all other options are exhausted, proponents may pay an in-lieu fee to the City to fulfill their obligation of preservation of native desert vegetation. The fee will be used to provide partial funding for the maintenance and coordination of the Native Desert Vegetation Banks and Preserves. The in-lieu fee will be accepted only when preservation of Joshua and/or Juniper trees is not possible due to site constraints that preclude the feasible preservation of desert vegetation, and no alternative preservation options remain. When a proponent must pay an in-lieu fee, the fee

shall be calculated on the minimum standard of two (2) trees per acre, less any trees preserved by other means. The in-lieu fee amount shall be determined by resolution of the City Council.

a. Where California Junipers are retained on-site they shall be credited toward the minimum standard of two (2) trees per acre. However, where they can not be retained undisturbed on-site, no in-lieu fee is required.

4. Any native desert vegetation in excess of the minimum standard for preservation may be removed after the public has had the opportunity to transplant native desert vegetation per Section 14.04.060 B.3 (1), and after the Native Desert Vegetation Preservation plan and Native Desert Vegetation Removal Permit has been approved by the City, or if applicable, after the payment of the in-lieu fee.

14.04.070 Maintenance Requirements.

Upon completion of construction of the development proposal and after final inspection and acceptance by the City, the following standards relative to on-going maintenance of native desert vegetation shall apply:

A. Provisions shall be made assuring, at the expense of the proponent of the development, that the Joshua Trees and other desert vegetation preserved on site, in landscape easements, or landscape assessment districts are maintained in a healthy condition for a minimum of two (2) growing seasons.

B. After one year, an inspection and evaluation of Joshua Trees and other desert vegetation retained on site will be performed by a desert native plant expert, at the expense of the proponent of the development. Based upon this evaluation, if it is determined that any quantity of Joshua Trees or other desert vegetation have died, it will be the responsibility of the proponent to provide replacement desert vegetation as determined by the City Landscape Architect, or in lieu thereof, the Director of Public Works designee.

C. The Director of Planning shall require posting of a bond or other appropriate security at the time of development proposal approval to assure maintenance of on-site trees, or trees in landscape easements or assessment districts, for a period of two (2) years. If the project is otherwise required to have a bond posted for landscape maintenance requirements, this requirement shall be incorporated into the same bond.

APPENDIX B

PLANT AND ANIMAL SPECIES OBSERVED ON THE PROPERTY SITE AND/OR KNOWN TO OCCUR WITHIN THE REGION.

PLANT SPECIES OBSERVED ON THE PROJECT SITE AND/OR KNOWN TO OCCUR IN THE REGION.

Commom Name	Scientific Name
EPHEDRACEAE	
Ephedra	Ephedra sp.
ASTERACEAE	
Annual Bur-ragweed	Ambrosia acanthicarpa
Burrobush	Ambrosia dumosa
Western ragweed	Ambrosia psilostachya
Great Basin sagebrush	Artemisia tridentata
Mulefat	Baccharis glutinosa
Rabbitbush	Chrysothamnus nauseosus
Horseweed	Conyza canadensis
California bush sunflower	Encelia farinosa
Narrow-leaved goldenbush	Ericameria linearifolia
Pine goldenbush	Ericameria pinifolia
Long-leaved goldenbush	Haplopappus longifolius
Common sunflower	Helianthus annuus
Telegraph weed	Heterotheca grandiflora
Scale-broom	Lepidospartum squamatum
Lemmon's lessingia	Lessingia Lemmoni var ramulosissima
Cocklebur	Xanthium strumarium
BORAGINACEAE	
Salt heliotrope	Heliotropium curassavicum
BRASSICACEAE	
Black mustard	Brassica nigra
CACTACEAE	
Silver cholla	Opuntia echinocarpa
CHENOPODIACEAE	
Four-winged saltbush	Atriplex canescens
Russian thistle	Salsola australis
EUPHORBIACEAE	
Dove weed	Eremocarpus setigerus
FABACEAE	
Bird's-foot lotus	Lotus corniculatus
LAMIACEAE	
Great basin blue sage	Salvia dorri
Vinegar weed	Trichostema lanceolatum
POLYGONACEAE	
California buckwheat	Eriogonum fasciculatum
Yellow turban	Eriogonum pusillum
Buckwheat	Eriogonum spp.

SOLANACEAE	
Western jimsonweed	Datura innoxia
TAMARICACEAE	
Small-flowered tamarisk	Tamarix parviflora
ZYGOPHYLLACEAE	
Creosote bush	Larrea tridentata
AGAVACEAE	
Joshua tree	Yucca brevifolia
Spanish bayonet	Yucca whipplei
LILIACEAE	
Blue dicks	Dichelostemma pulchellum
POACEAE	
Ripgut grass	Bromus diandrus
Red brome	Bromus rubens
Downy chess	Bromus tectorum
Bermuda grass	Cynodon dactylon
Desert needlegrass	Stipa speciosa

WILDIFE SPECIES OBSERVED ON THE PROJECT SITE AND/OR KNOWN TO OCCUR IN THE REGION.

Common Name	Scientific Name
REPTILES	
TESTUDINIDAE	
Desert tortoise	Xerobates agassizi
GEKKONIDAE	
Banded gecko	Coleonyx variegatus
IGUANIDAE	
Common leopard lizard	Gambelia wislizenii
Coast horned lizard	Phrynosoma coronatum
Desert spiny lizard	Sceloporus magister
Side-blotched lizard	Uta stansburiana
TEIDAE	
Western whiptail	Cnemidophorus tigris
COLUBRIDAE	
Glossy snake	Arizona elegans
Western shovel-nosed snake	Chionactis occipitalis
Night snake	Hypsiglena torquata
Common kingsnake	Lampropeltis getulus
Coachwhip	Masticophis flagellum
Spotted leaf-nosed snake	Phyllorhynchus decurtatus
Gopher snake	Pituophis melanoleucus
Long-nosed snake	Rhinocheilus lecontei
Western patch-nosed snake	Salvadora hexalepis
VIPERIDAE	
Sidewinder	Crotalus cerastes
Mojave rattlesnake	Crotalus scutulatus
BIRDS	
ANATIDAE	
Mallard	Anas platyrhynchos
CATHARTIDAE	
Turkey vulture	Cathartes aura
ACCIPITRIDAE	
Sharp-shinned hawk	Accipiter striatus
Cooper's hawk	Accipiter cooperii
Red-tailed hawk	Buteo jamaicensis
FALCONIDAE	
American kestrel	Falco sparverius

PHASLANIDAE	
California quail	Callipepla callifornica
RALLIDAE	
American coot	Fulica americana
CHARADRIDAE	
Killdeer	Charadrius vociferus
LARIDAE	
California gull	Larus californicus
COLUMBIDAE	
Rock dove	Columbia livia
Mourning dove	Zenaida macroura
CUCULIDAE	
Greater roadrunner	Geococcyx californianus
TYTONIDAE	
Common barn-owl	Tyto alba
STRIGIDAE	
Great horned owl	Bubo virginianus
Burrowing owl	Athene cunicularia
APODIDAE	
White-throated swift	Aeronautes saxatalis
TROCHILIDAE	
Costa's hummingbird	Calypte costae
TYRANNIDAE	
Say's phoebe	Sayornis saya
Ash-throated flycatcher	Myiarchus cinerascens
HIRUNDINIDAE	
Northern rough-winged swallow	Stelgidopteryx serripennis
Cliff swallow	Hirundo pyrrhonota
Barn swallow	Hirundo rustica
CORVIDAE	
Scrub jay	Aphelocoma coerulescens
Common raven	Corvus corax
PARIDAE	
Plain titmouse	Parus inornatus
REMIZIDAE	
Verdin	Auriparus flaviceps
AEGITHALIDAE	
Bushtit	Psaltriparus minimus

TROGLODYTIDAE	
Cactus wren	Campylorhynchus brunneicapillus
Rock wren	Salpinctes obsoletus
MUSCICAPIDAE	
Ruby-crowned kinglet	Regulus calendula
Western bluebird	Sialia mexicana
Wrentit	Chamaea fasciata
MIMIDAE	
Northern mockingbird	Mimus polyglottos
Sage thrasher	Oreoscoptes montanus
California thrasher	Toxostoma redivivum
Le Conte's thrasher	Toxostoma lecontei
BOMBYCILLIDAE	
Cedar waxwing	Bombycilla cedrorum
PTILOGONATIDAE	
Phainopepla	Phainopepla nitens
LANIDAE	
Loggerhead shrike	Lanius ludovicianus
STURNIDAE	
European starling	Sturnus vulgaris
VIREONIDAE	
Warbling vireo	Vireo gilvus
EMBERIZIDAE	
Orange-crowned warbler	Vermivora celata
Yellow-rumped warbler	Dendroica coronata
Townsend's warbler	Dendroica townsendi
Black-chinned sparrow	Spizella atrogularis
Song sparrow	Melospiza melodia
White-crowned sparrow	Zonotrichia leucophrys
Dark-eyed junco	Junco hyemalis
Western meadowlark	Sturnella neglecta
Brewer's blackbird	Euphagus cyanocephalus
Hooded oriole	Icterus cucullatus
FRINGILLIDAE	
House finch	Carpodacus mexicanus
Lesser goldfinch	Carduelis psaltria
PASSERIDAE	
House sparrow	Passer domesticus

MAMMALS

VESPERTILIONIDAE	
Yuma myotis	Myotis yumanensis
California myotis	Myotis californicus
Western pipistrelle	Pipistrellus hesperus
Hoary bat	Lasiurus cinereus
Townsend's big-eared bat	Plecotus townsendii
Pallid bat	Antrozous pallidus
MOLOSSIDAE	
Brazilian free-tailed bat	Tadarida brasiliensis
LEPORIDAE	
Brush rabbit	Sylvilagus bachmani
Desert cottontail	Sylvilagus audubonii
Black-tailed jackrabbit	Lepus californicus
SCIURIDAE	
White-tailed antelope squirrel	Ammospermophilus leucurus
Mohave ground squirrel	Spermophilus mohavensis
Western gray squirrel	Sciurus griseus
GEOMYIDAE	
Botta's pocket gopher	Thomomys bottae
HETEROMYIDAE	
Little pocket mouse	Perognathus longimembris
Desert pocket mouse	Perognathus penicillatus
San Diego pocket mouse	Perognathus fallax
Merriam's kangaroo rat	Dipodomys merriami
CRICETIDAE	
Western harvest mouse	Reitrodontomys megalotis
Cactus mouse	Peromyscus eremicus
California mouse	Peromyscus californicus
Deer mouse	Peromyscus maniculatus
Canyon mouse	Peromyscus crinitus
Brush mouse	Peromyscus boylii
Pinon mouse	Peromyscus truei
Southern grasshopper mouse	Onychomys torridus
Desert woodrat	Neotoma lepida
Dusky-footed woodrat	Neotoma fuscipes
MURIDAE	
Black rat	Rattus rattus
Norway rat	Rattus norvegicus
House mouse	Mus musculus
CANIDAE	
Coyote	Canis latrans
Red fox	Vulpes vulpes
Kit fox	Vulpes macrotis

Gray fox	*Urocyon cinereoargenteus*
PROCYONIDAE	
Raccoon	*Procyon lotor*
Long-tailed weasel	*Mustela frenata*
Badger	*Taxidea taxus*
Western spotted skunk	*Spilogale gracilis*
Striped skunk	*Mephitis mephitis*

APPENDIX C
LIST OF PREPARERS

Randall C. Arnold, Jr.: B.S. in Zoology and M.S. in Biology. Mr. Arnold has 17 years of professional experience and has conducted several hundred flora/fauna surveys throuhgout California. His areas of expertise include wildlife ecology and sensitive plant and animals species.

Patti Moore: B.S. in Biology. Ms. Moore has over five years experience as a biologist and has conducted over 100 flora/fauna surveys in California. Her areas of expertise include botany and sensitive plant and animal species.

APPENDIX C

CULTURAL AND PALEONTOLOGICAL SURVEYS

ARCHAEOLOGICAL, HISTORICAL, AND PALEONTOLOGICAL INVESTIGATIONS OF THE PROPOSED PALMDALE BUSINESS PARK CENTER SPECIFIC PLAN PROJECT AREA, CITY OF PALMDALE, COUNTY OF LOS ANGELES, CALIFORNIA

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S.O.P.A. Certified, Paleontologist

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McKenna et al. appreciates the assistance of all those who aided in the completion of this project:

Peter Sturtevant, URS Consultants, Inc.
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Tarquin D. Preziosi, Staff Archaeologist, UCLA
Leta J. Franklin, Associate Archaeologist
Paul E. Langenwalter, Paleontological Consultant
Staff, Palmdale Public Library
Staff, City of Palmdale City Hall
Staff, County of Los Angeles Department of Roads
Staff, Bureau of Land Management, Riverside

This report was prepared by Jeanette A. McKenna, Principal Investigator for McKenna et al. Any comments or questions regarding the contents of this report should be addressed to McKenna et al., Whittier, California.

While conducting research for this area, McKenna et al. found that its Principal, Jeanette A. McKenna, is related to some of the early pioneers by marriage. Ms. McKenna is related to both Glen and Dorene Settle of the Lancaster/Rosamond area, as well as the Burton Brothers of the Tropico Mine. If McKenna et al. is involved in additional studies in the Palmdale/Lancaster/Rosamond ares, a more personal approach to the historical research will be warranted.

****

Based on the data compiled during the recent studies and presented in this report, McKenna et al. has concluded that the surface evidence showed no evidence of significant or eligible prehistoric, historic, or paleontological remains. This data suggests a relatively low probability for buried deposits, as well.

Nonetheless, there is always a potential for buried or, as yet, unidentified resources. In accordance with accepted guidelines, McKenna et al. presents the following recommendations with respect to the current project area:

1. At this time, no archaeological monitoring is necessary during project related excavations. The proponent of the proposed project should, however, be prepared to permit a certified and qualified archaeologist to evaluate any prehistoric or historic resource which may be uncovered or otherwise identified as a result of any project within the current study area;

2. The evaluation process must conform to the requirements and guidelines for Phase II evaluations of prehistoric and/or historic resources, as presented in CEQA;

3. Upon completion of any evaluation (Phase II) the proponent must be prepared to forward the data through the Office of Historic Preservation for review and, if necessary, commit to a Phase III mitigation of impact study, should any resource be identified as significant or potentially eligible for nomination to the National Register of Historic Places;

4. No paleontological monitoring is necessary during project related excavations. The proponent should, however, be prepared to permit recovery and evaluation of any paleontological resources identified during future activities within the project area;

5. The paleontologist must have the authority to halt any activities which are adversely impacting potentially significant or eligible resources.

6. Any paleontological specimens recovered from the property must be professionally handled, cleaned, analyzed, and curated;

7. All studies subsequent to this Phase I investigation must be professional presented in a technical report, which in turn, will be made available for review at the appropriate repository (e.g. UCLA or the Los Angeles County Museum).

8. If resources are uncovered during any ground alteration activities, an archaeological and/or paleontological monitoring program should be established to prevent adverse impacts to additional resources.

ARCHAEOLOGICAL, HISTORICAL, AND PALEONTOLOGICAL INVESTIGATIONS OF THE PROPOSED PALMDALE BUSINESS PARK CENTER SPECIFIC PLAN PROJECT AREA, CITY OF PALMDALE, COUNTY OF LOS ANGELES, CALIFORNIA

by,

Jeanette A. McKenna, Principal
McKenna et al., Whittier CA

---

with Contribution by
Paul E. Langenwalter, Principal
Heritage Resource Consultants, La Mirada CA

INTRODUCTION

The archaeological, historical and paleontological investigations of the proposed Palmdale Business Park Center Specific Plan project area were initiated by McKenna et al. at the request of URS Consultants, Inc., of San Bernardino, California. McKenna et al. began background research in late April, 1993; conducted the field investigations in May, 1993; and prepared this report in early June, 1993. McKenna et al. (see Appendix A), under supervision by Jeanette A. McKenna, Principal Investigator, was responsible for the archaeological and historical investigations. The paleontological research was completed by Paul E. Langenwalter II, Principal of Heritage Resource Consultants, La Mirada, California.

The Palmdale Business Park Center Specific Plan project area consists of approximately 632 acres of land in the northern portion of Palmdale, Los Angeles County, California. Under the City of Palmdale "Guidelines for Archaeological Resources Studies", "Guidelines for Historic Resources Studies", and "Guidelines for Paleontological Resources Studies (all on file, McKenna et al.), the City has required the completion of this Phase I investigation. This report, therefore, addresses the realms of archaeology, history, and paleontology in accordance with CEQA and local requirements.

LOCATION AND SETTING

The Palmdale Business Park Center Specific Plan project area is located within the City of Palmdale, Los Angeles County, California. Investigations completed by McKenna et al. (McKenna 1992) have identified this area as being a part of the proposed Palmdale Enterprize Zone. Figure 1 illustrates the general location of the Palmdale Business Park Center Specific Plan project Area.

In specific terms, the project area is bounded by Avenue M to the north; 15th Street East to the east; the right-of-way for the Southern Pacific Railroad to the west (Sierra Highway); and the alignment for Avenue M-12 to the south. U.S. Air Force Plant 42 bounds the property to the east and south.

This location is associated with Township 6 North, Range 12 West, Sections 1 and 2 (Figure 2; U.S.G.S. Lancaster East and Lancaster West Quadrangles). As illustrated on these 1974 revised U.S.G.S. maps, the property is identified as undeveloped and references no standing structures.

Figure 3 illustrates proposed land uses for the project site. According to this map, the property excludes the private property located along the southern property boundary (north of Avenue M-12) and the Los Angeles County water tanks located south of Avenue M.

Figure 4 illustrates the existing conditions as of February, 1993. According to this map, the project area includes: 1) a frontage road along the eastern side of Sierra Highway and the Southern Pacific Railroad right-of-way; 2) the extension of 10th Street East between Avenue M and Avenue M-12; 3) the extension of 5th Street East between Avenue M-8 and Avenue M-12; 4) a portion of Avenue M-8 between Sierra Highway/Southern Pacific Railroad and 10th Street East; and 5) the extension of Avenue M-12 between Sierra Highway/ Southern Pacific Railroad and 10th Street East.

Summarizing Langenwalter (1993:2), the project area consists of a semi-flat desert floor with Armagosa Creek located to the west and Rock Wash well to the east. The property slopes gently to the northeast and the surface vegetation, indicative of the Desert Scrub Biotic Community (Munz 1974; McMahon 1987), consists of yucca (Joshua Trees), grasses, shrubs.

Geologically, the project area consists of younger alluvium with granule, pebble, and cobble sized clasts (Langenwalter 1993; Dibblee 1960; and Jennings and Strand 1969). Norris and Webb (1990:225 and 322) identify the area as consisting of Cenozoic nonmarine sedimentary rocks and alluvial deposits. The geologic time scale for the Cenozoic Era, as presented by Norris and Webb (1990), is as follows:

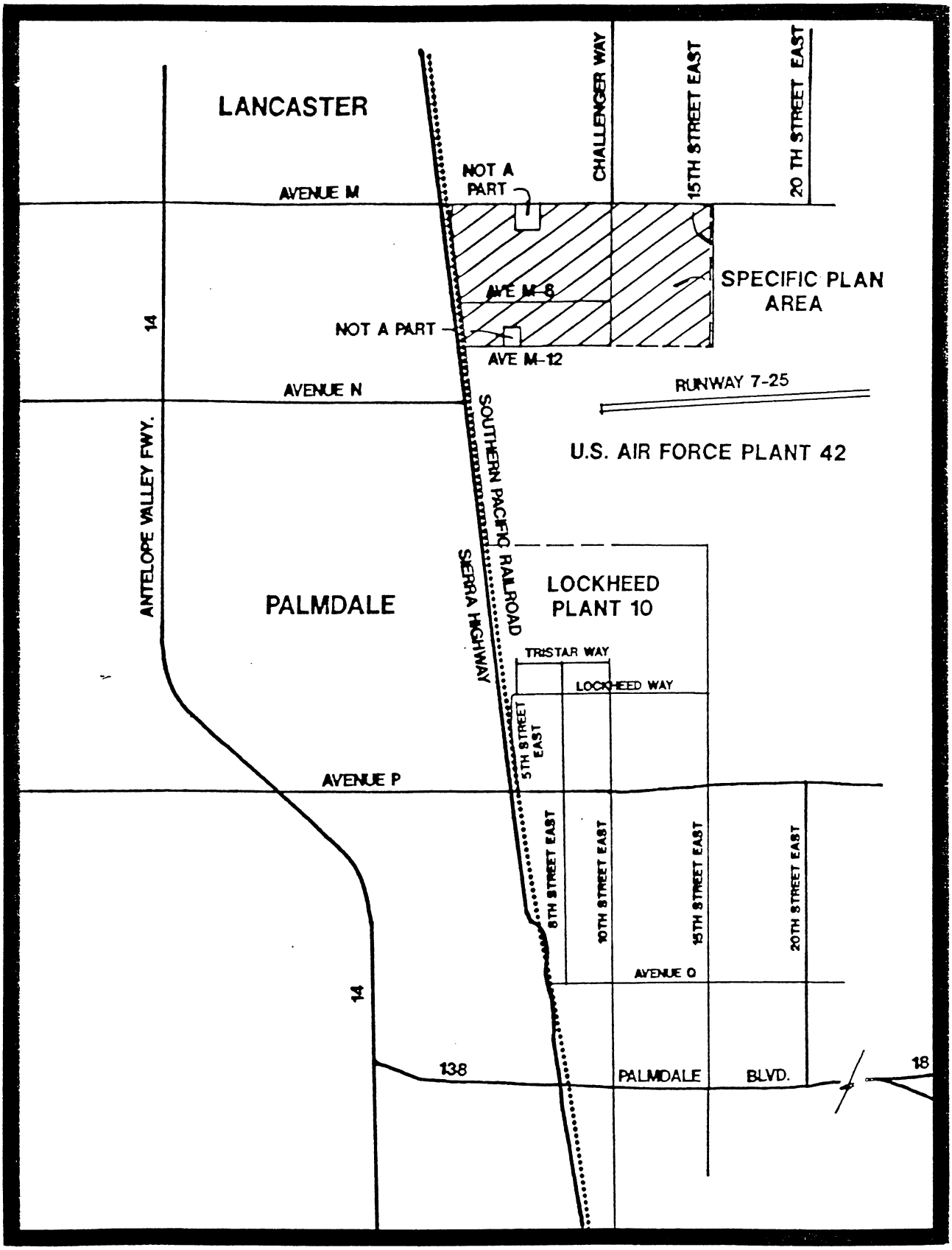

Figure 1. General Location of Project Area.

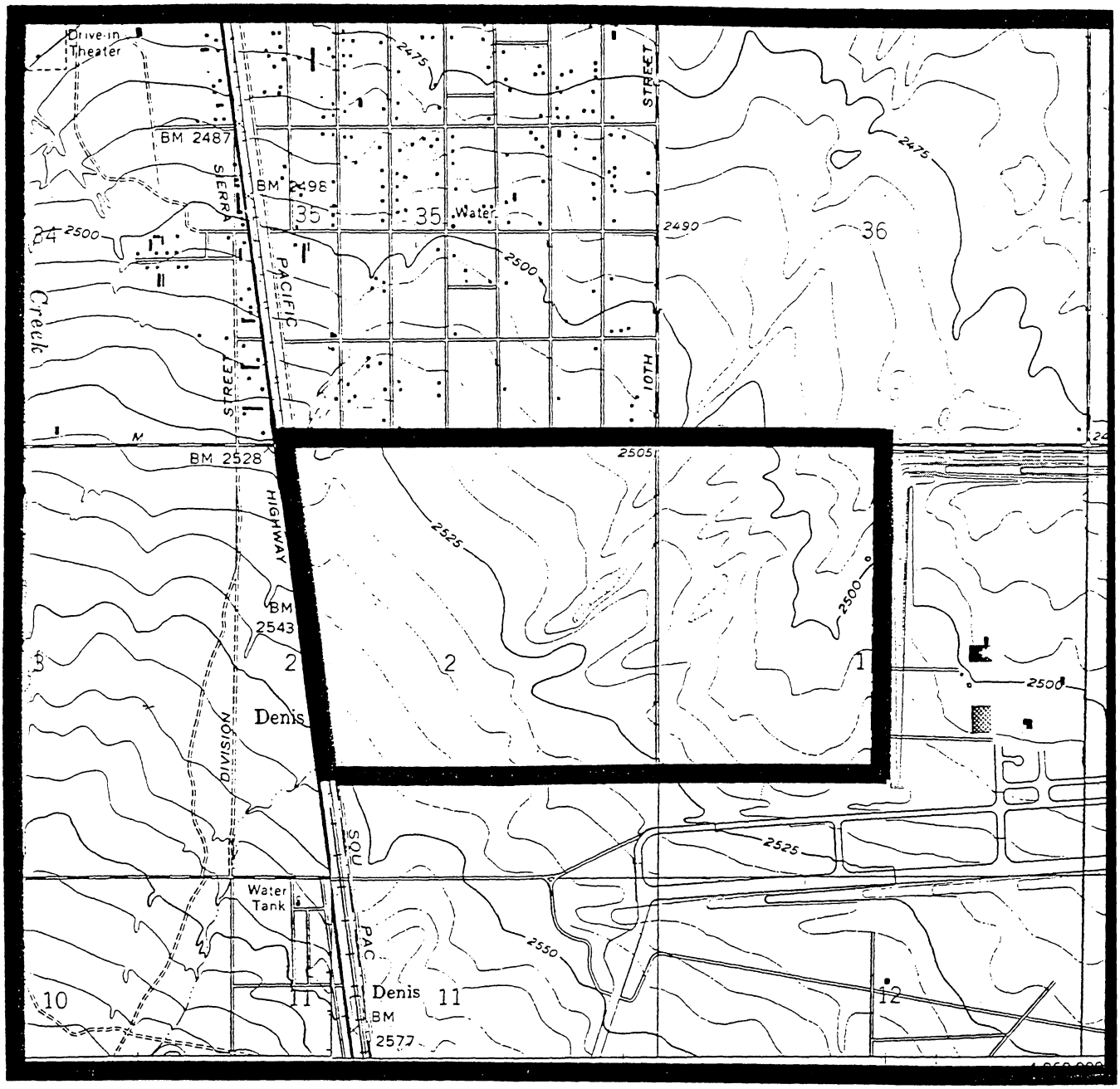

Figure 2. Specific Location of the Project Area.

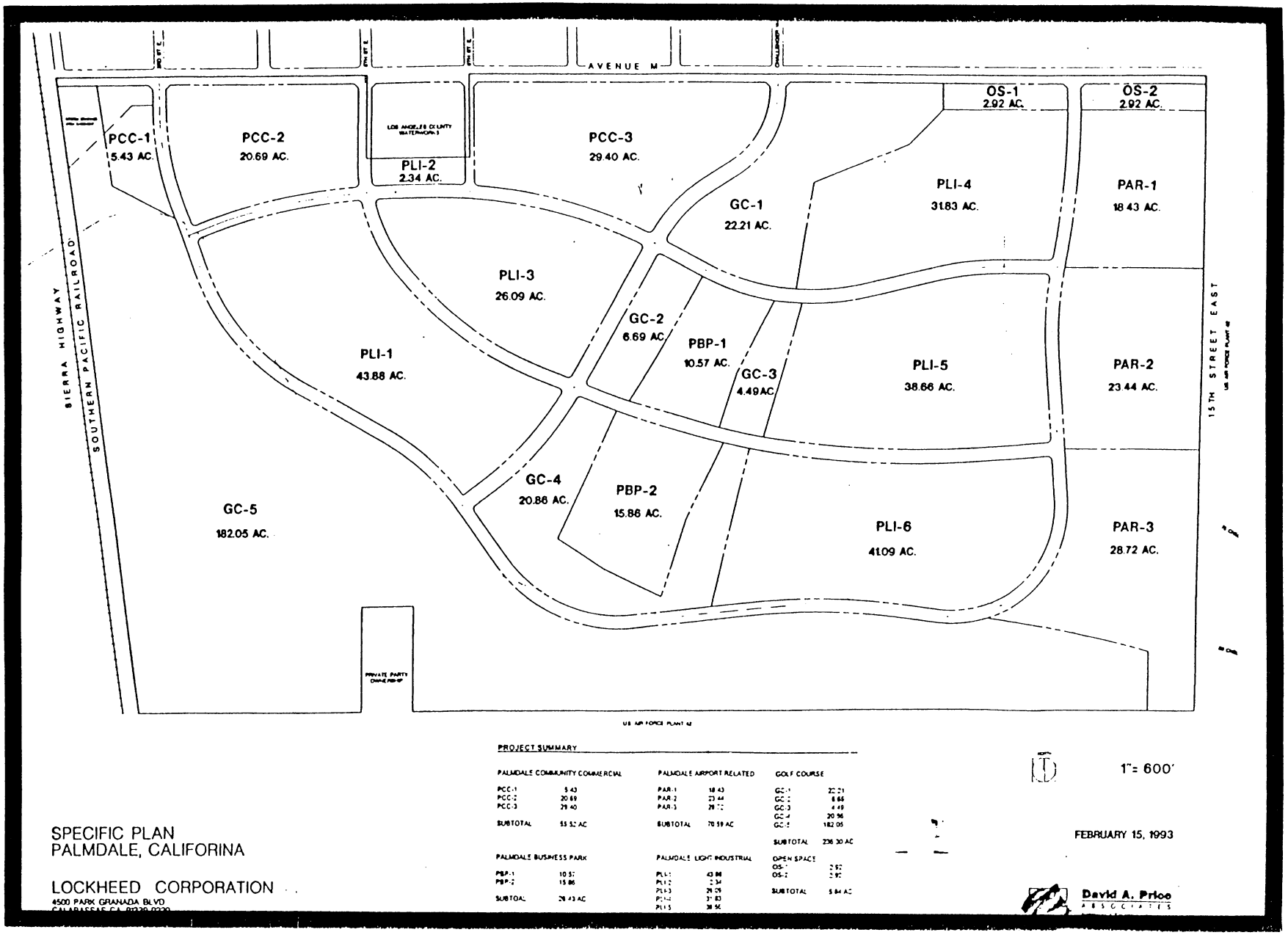

Figure 3. Proposed Project Subdivision Map.

In ca. 1888, the Southern Pacific Railroad, originally established in 1876 in the Antelope Valley (Yenne 1985), decided to relocate their Harold station to a larger facility further north - on flat ground and where the booster engines could get a better start for the climb over the San Gabriel Mountains. The chosen location was the community of Palmenthal/Palmdale. With the railroad station and a post office, Palmdale continued to grow via homesteading and land purchases. Agriculture became a significant enterprise during the wet years, but was doomed by the droughts of the 1890s.

By 1899, the original community of Palmdale consisted of a single family. Buildings were abandoned and materials were salvaged for use elsewhere. The new community of Palmdale was founded along the railroad right-of-way, near the site of the railroad station. The post office was moved to the new community and it was during this time the community of Palmenthal became "Palmdale", differentiating itself from the earlier community.

Palmdale remained a small cluster of commercial buildings along the railroad right-of-way until ca. 1914, when the Los Angeles Aqueduct was completed. This water source enabled the desert community to return to an agricultural economic base and, by 1919, the population in the Antelope Valley had grown to 11,900. Alfalfa, pears, and apples were the main crops.

As for major roads, Sierra Highway runs along the western boundary of the current project area. Citing data made available in the history files of the Palmdale Public Library, Sierra Highway was originally known as the Mint Canyon road. It ran along the railroad right-of-way and through the center of new Palmdale. This road was an unpaved road until ca. 1921, when it was paved by Los Angeles County and renamed "Sierra Highway" (J. Roadhouse, Los Angeles County Department of Roads, personal communication). Sierra Highway became the preferred route between the Antelope Valley and Los Angeles, running along both sides of the railroad right-of-way - west of the right-of-way between Palmdale and Lancaster and east of the right-of-way north of Lancaster (see Figure 6).

Between 1914 and World War II, agriculture was the dominant economic base in the Antelope Valley (Figure 6). After World War II, however, the Valley became one of the major centers for the aerospace and defence industries - especially with the establishment of Edwards Air Force Base in Kern County and Air Force Plant 42 (purchased by the U.S. government in 1952 and originally known as the Palmdale Air-port (see history files, Palmdale Public Library). Lockheed opened its first plant in Palmdale in 1953 and the city was incorporated in 1962.

With respect to the specific project area, the ca. 1928 and 1938 maps (see Figure 7) for the area identify "paved" Sierra Highway

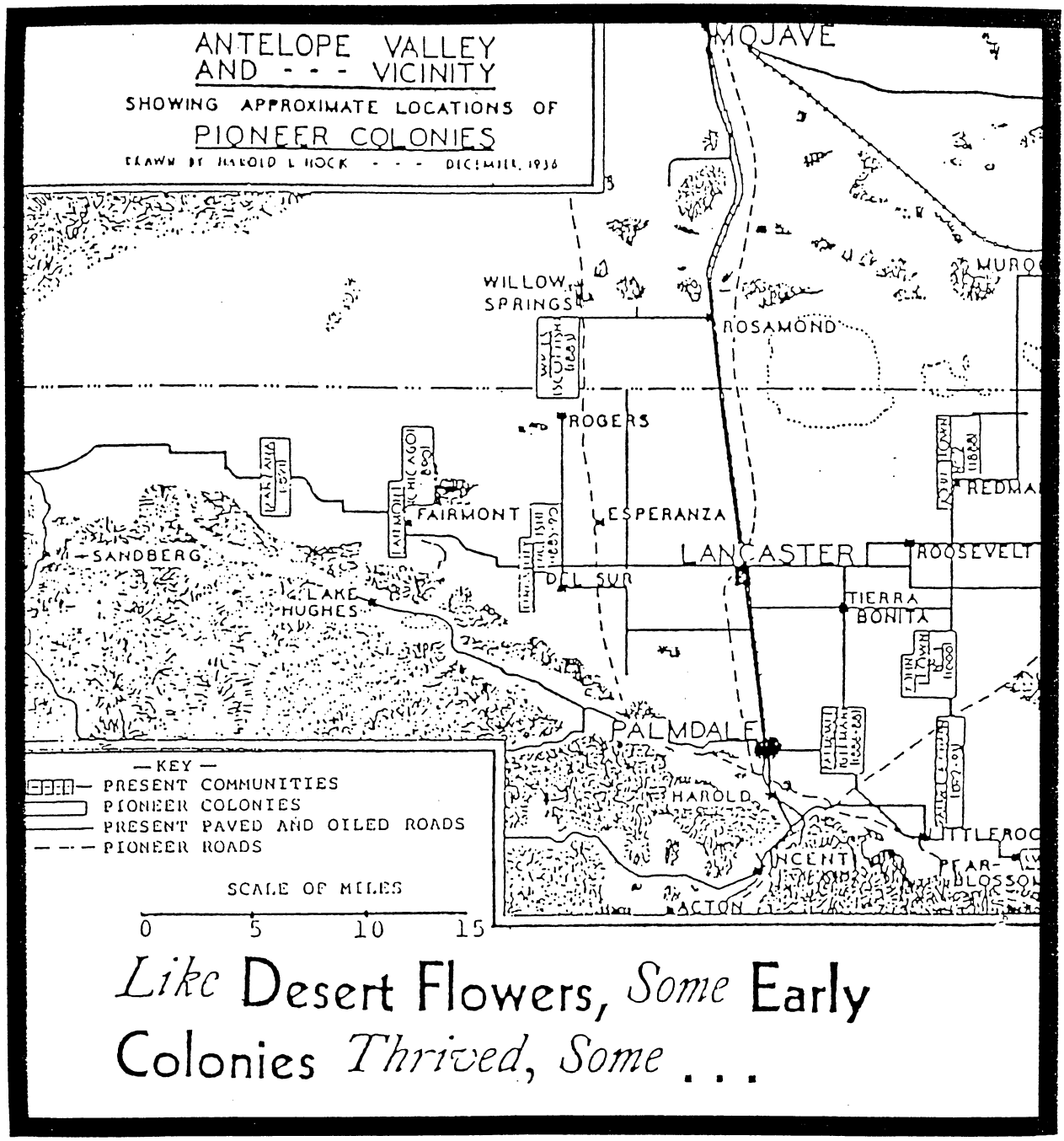

Figure 6. Ca. 1936 Map of Antelope Valley and Vicinity - Showing Approximate Locations of Pioneer Communities (Hock 1936).

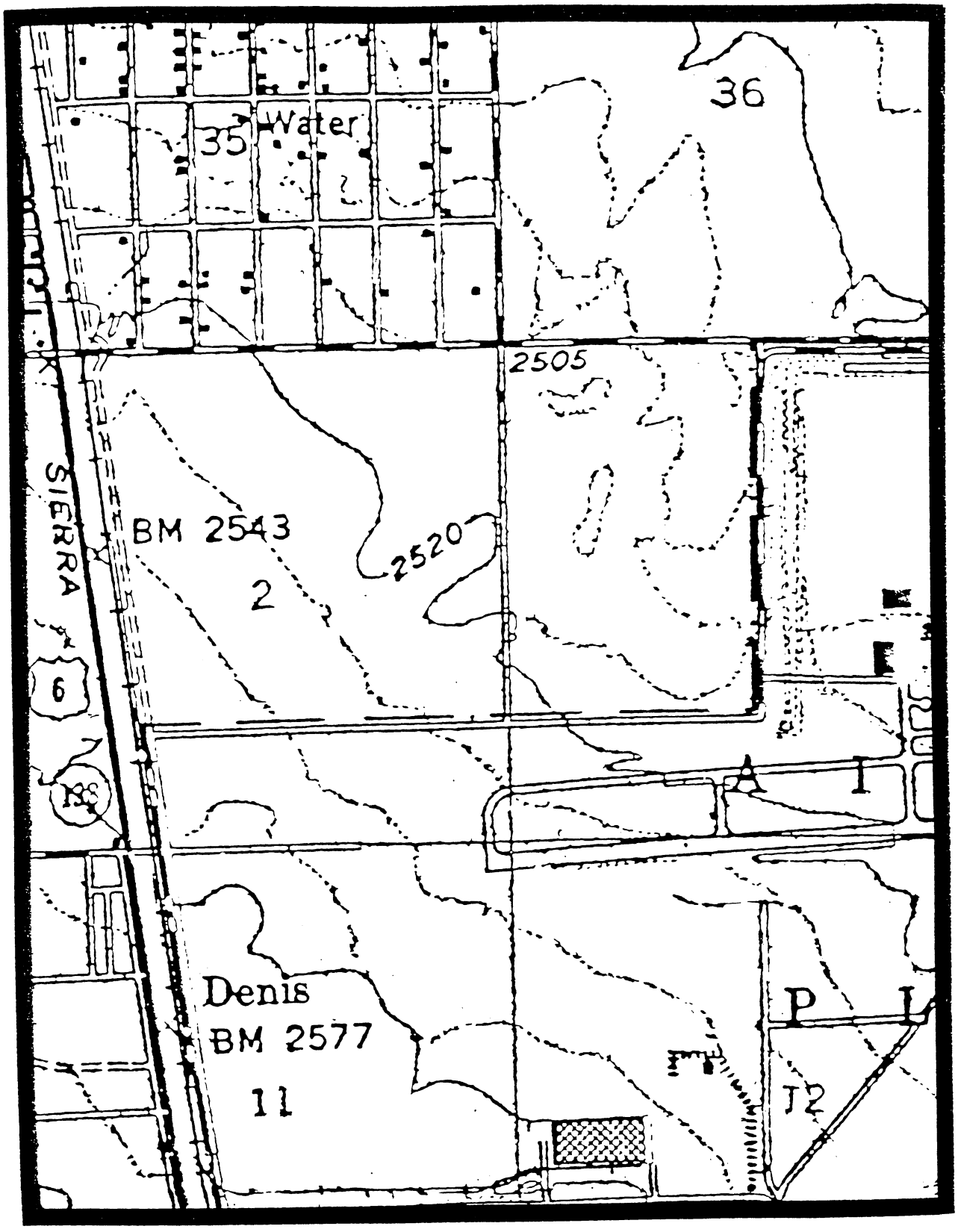

Figure 8. Ca. 1958 U.S.G.S. 15' Lancaster Quadrangle (enlarged to show Sections 1 and 2).

Another homestead entry for the northern portion of Section 2 appears in 1907 (156.27 acres). This homestead is canceled in 1910. A Desert Land Entry for the southern half of the section was filed in 1907, only to be relinquished in 1910.

Also in 1907, an 80 acres homestead is filed for the northeast quarter. This homestead is canceled in 1911.

Desert Lands Entries continue for Section 2 between 1915 and 1924, indicating some use of the property, but no formal transfer of ownership by the government. Oil and/or Gas lines are placed ca. 1948 (likely along the Sierra Highway right-of-way).

McKenna et al. found no information at the City level, the County level or the Federal level to indicate that there was any formal occupation of Section 2 during the historic period - either via homestead or via mining claim or mineral rights. The Desert Land Entry records suggest grazing or possibly planned grazing on this property, but not development of any sort.

With the advent of Plant 42 (associated with the earlier Palmdale Airport), McKenna et al. tentatively concluded that pre-World War II or pre-Plant 42 (Lockheed or others) use of the area was negligible. The modern plat for the area provides no information on the specific project area other than canal/ditch and indemnity list designations (Figure 9).

METHODOLOGY

The methodology employed on this project was designed to be slightly more detailed than the average Phase I investigation because the project required the completion of a paleontological investigation, as well. To adequately address the requirements of CEQA documentation and to comply with the local requirements for the City of Palmdale, McKenna et al. employed the following:

Archaeological Investigations

To address the archaeological investigations, McKenna et al. conducted the following studies:

1. A standard archaeological records check completed through the University of California, Los Angeles (appendix B);

2. Review of the in-house records at McKenna et al. for data pertaining to the City of Palmdale Enterprise Zone (McKenna 1992);

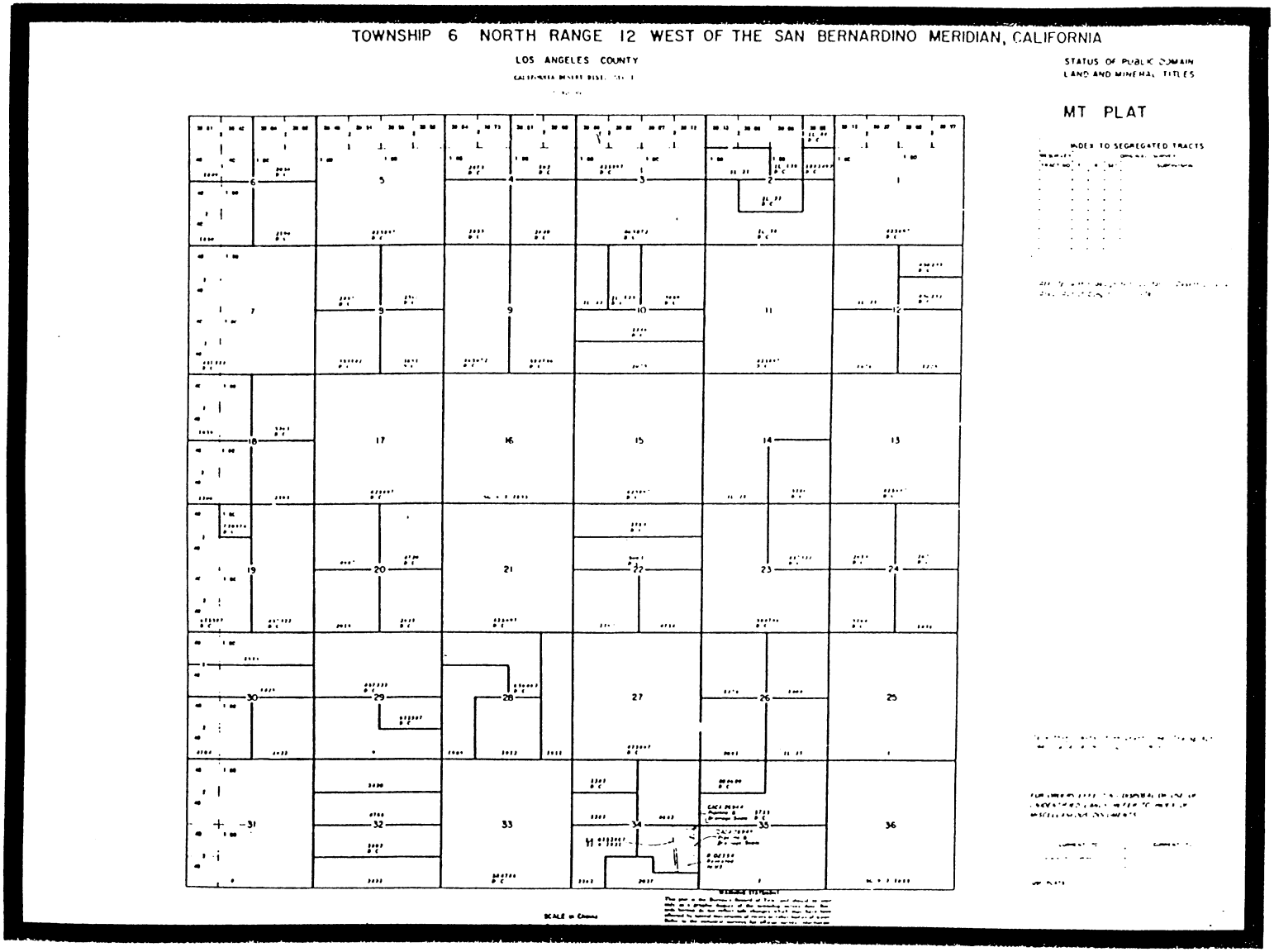

Figure 9. Modern Government Mineral Plat, Township 6 North, Range 12, West, San Bernardino Base and Meridian.

3. An intensive field survey of the project area which was not surveyed earlier and a reconnaissance survey of that portion of the project area surveyed by Talley (1984). The intensive field survey was completed by two professional archaeologists: Jeanette A. McKenna, M.A. and Principal Investigator for McKenna et al., and Leta J. Franklin, M.A. and Associate Archaeologist. The initial field survey was completed between May 3, 1993 and May 6, 1993. Subsequently, Ms. McKenna revisited the site and completed the remaining reconnaissance survey area.

   The field survey consisted of a pedestrian survey. The project area was divided into manageable parcels defined by existing roads and the surveyors traversed the property at intervals of fifteen meters until the entire area was covered.

   The reconnaissance survey was completed by Ms. McKenna and consisted of a pedestrian survey at intervals of forty to fifty meters apart.

   All field studies were supplemented by photographs (Appendix E) and field notes. Subsequently, all artifacts or items identified in the field as either historic or prehistoric were recorded. Archaeological Isolate forms are presented in Appendix D.

Historic Investigations

Historic investigations are generally completed when the proposed project involves the destruction or modification of a structure more than fifty years old; when a resource is identified by the appropriate Archaeological Information Center; mentioned in historic documents; or identified by historic societies. In addition, historic research is required when the project area survey results in the identification of historic remains.

In the case of the current project area, no standing structures were known within the boundaries of the proposed subdivision; no resources were specifically identified by the UCLA Archaeological Information Center or other societies/repositories; and there was a limited amount of information provided by historic maps. Therefore, the likelihood of identifying historic resources within the project area was considered relatively low.

Nonetheless, McKenna et al. felt that the identification of the project area with respect to the two names "Denis" and "Davidson" required a limited amount of investigation. To address the possibility of occupation within the project area, McKenna et al. conducted historic research at the Bureau of Land Management California Desert District offices in Riverside and reviewed the

homestead records, mining claim records, historic map inventory, and cross reference for the township and range.

In addition, Ms. McKenna conducted a significant amount of research at the Palmdale Public Library, reading through the extensive files on local and regional history and reviewing the studies completed by earlier investigators and avocational historians. Ms. McKenna used the McKenna et al. in-house library and visited City Hall and the County Department of Roads in Palmdale. Each repository provided different information used in the production of portions of this report.

The information gathered as a result of the historic research was used to place the project area within a cultural context for the preliminary evaluation of any historic materials which may have been identified as a result of the field investigations.

Paleontological Investigations

The paleontological investigations for the proposed Palmdale Business Park Center Specific Plan project area were completed by Paul E. Langenwalter, Principal Investigator for Heritage Resource Consultants (Appendix C). Mr. Langenwalter completed his studies in accordance with guidelines set by the City of Palmdale.

In this case, the project area was greater than five acres and fell within an area of high or unidentified potential for paleontological resources. As such, the study area was subjected to a field investigation by Mr. Langenwalter, a certified vertebrate paleontologist, and recommendations provided by Mr. Langenwalter conformed to the requirements set by the City (Reynolds 1990).

PREVIOUS RESEARCH

As noted earlier, the previous research was investigated through a standard archaeological records check via the University of California, Los Angeles, Archaeological Information Center (Appendix B). This research illustrated the extent of known studies and recorded resources within the project area and for one mile surrounding the project area. This records check was supplemented with data compiled by McKenna et al. for the Palmdale Enterprise Zone investigations.

As a result of the recent investigations, McKenna et al. determined that eighteen studies had been completed within a one mile radius of the project area; that two of these (Love 1988 and Padon 1989) were adjacent to the study area; and one survey (Talley 1984) involved a relatively large portion of the project area - approximately 300 acres. No resources were recorded as a result of these three studies and, of the remaining study area, one prehistoric

site and two historic sites were known within the one mile radius. No sites were identified within the project area.

Based on the extent of coverage and the low number of resources recorded in the past, McKenna et al. tentatively identified the project area as a "low sensitivity" area for prehistoric and historic resources.

With respect to paleontology, previous research was investigated through the Los Angeles County Natural History Museum, Section of Vertebrate Paleontology. A review of recent studies and general overviews was also completed through the San Bernardino County Museum, Redlands, and the University of California, Riverside, Department of Earth Sciences.

The research for paleontology identified the project area as being within an area of "low sensitivity" for paleontological resources, though the possibility of both the younger and older alluvium (in some areas shallow) yielding paleontological remains still exists (Springer 1993).

RESULTS OF THE INVESTIGATIONS

As a result of the recent investigations, McKenna et al. identified two prehistoric isolates, no significant historic remains, and no evidence of paleontological resources.

Prehistoric Isolates

Two prehistoric isolated finds were identified during the course of the intensive survey within Section 2 (Figure 10). Isolate No. 1 was identified approximately 80 meters west of 10th Street East and 220 meters south of Avenue M. This artifact was identified as a projectile point (Figure 11) measuring 8.5 cm x 2.5 cm x .5 cm and manufactured from a grey chert (cryptochrystaline) material (see Appendix D). The point yielded evidence of both transverse parallel flaking and collateral flaking (Franklin 1993, personal communication) and the base appeared to have been broken and reworked. Each surface yielded evidence of a mineral inclusion/coating which indicated that the initial flake was a thin slice of chert prior to any cultural alterations.

The size of the flake indicates a shaft larger than a typical bow and arrow projectile, but not large enough for a spear or knife blade. There is no evidence of fluting, indicating this is not an early point. Rather, the size and shape suggests a moderate to late point; a point associated with the Vanyume occupation of the late Gypsum Period and/or early Saratoga Springs Period. However, with the reworked base, no true diagnostic assignment can be determined.

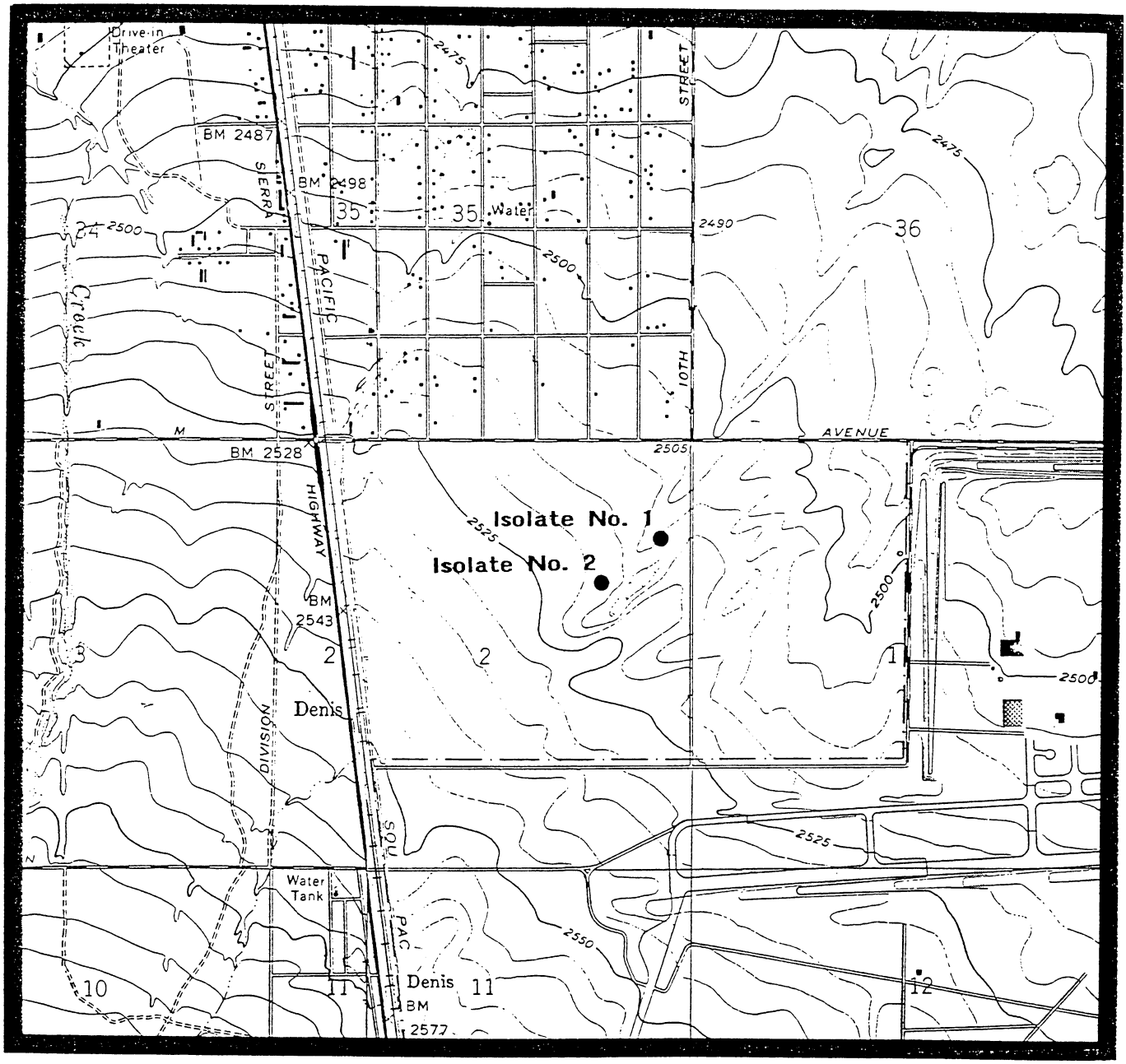

Figure 10. Locations of Two Prehistoric Isolates.

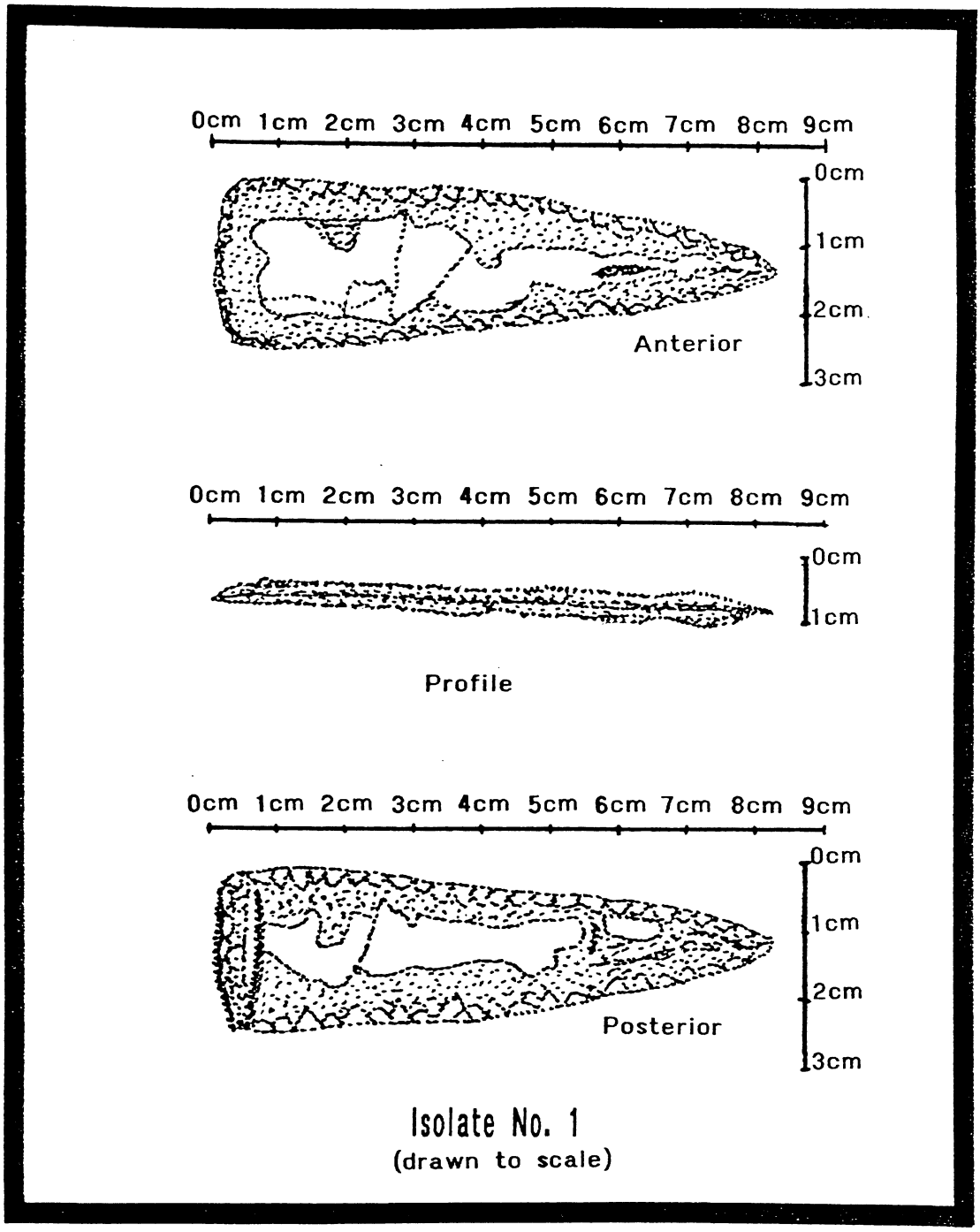

Figure 11. Depiction of Isolate No. 1: Project Point.

Because this point was found in a surface context (recently uncovered from the sandy soil of the area), no archaeological context is available and this artifact, though beautifully manufactured, has no archaeological significance and is, therefore, not eligible form nomination to the National Register of Historic Places. McKenna et al. collected this artifact and no additional mitigation measures are necessary.

Isolate No. 2 was also identified southwest of the intersection of Avenue M and 10th Street East (see Figure 10). This item, illustrated in Figure 12, was identified as a small scraper, was manufactured from a brown chert (cryptochrystaline) and measured 4.0 cm x 3.0 cm x .75 cm (see Appendix D).

McKenna et al. noted two utilized edges on this artifact, though neither edge was used extensively nor reworked to indicate long-term use.

Scrapers can generally date to any temporal period. In this case, the location of the find and the lack of archaeological context make it impossible to assign this artifact to any particular group or time period. Therefore, this artifact, collected by McKenna et al., has been determined to be ineligible for nomination to the National Register of Historic Places and no mitigation measures are necessary.

Historic Resources

McKenna et al. identified numerous concentration of refuse throughout the project area. Of these, none were found to represent historic occupation of the area, but appeared to reflect modern redeposition of refuse from other sources. In a few instances, cans with soldered seems or of relatively early origin were seen. However, these were all within the context of larger concentrations and in areas of quite modern refuse.

McKenna et al. interpreted these concentrations to be of no historic origin or significance and, therefore, not eligible for nomination to the National Register of Historic Places. No mitigation of these areas is necessary.

The McKenna et al. survey crew investigated the location of the concrete pad in the course of the intensive survey. Upon investigation, McKenna et al. found that the pad consisted of two rectangular areas of concrete represented by two entirely different batches of concrete mix. Illustrated in Photographs 9 and 10 (Appendix E), the eastern portion of the pad consisted of a rough and pebbly yellow concrete while the western portion of the pad consisted of a smoother grey concrete. The east and west sides of the pad had an additional small square of concrete representing a

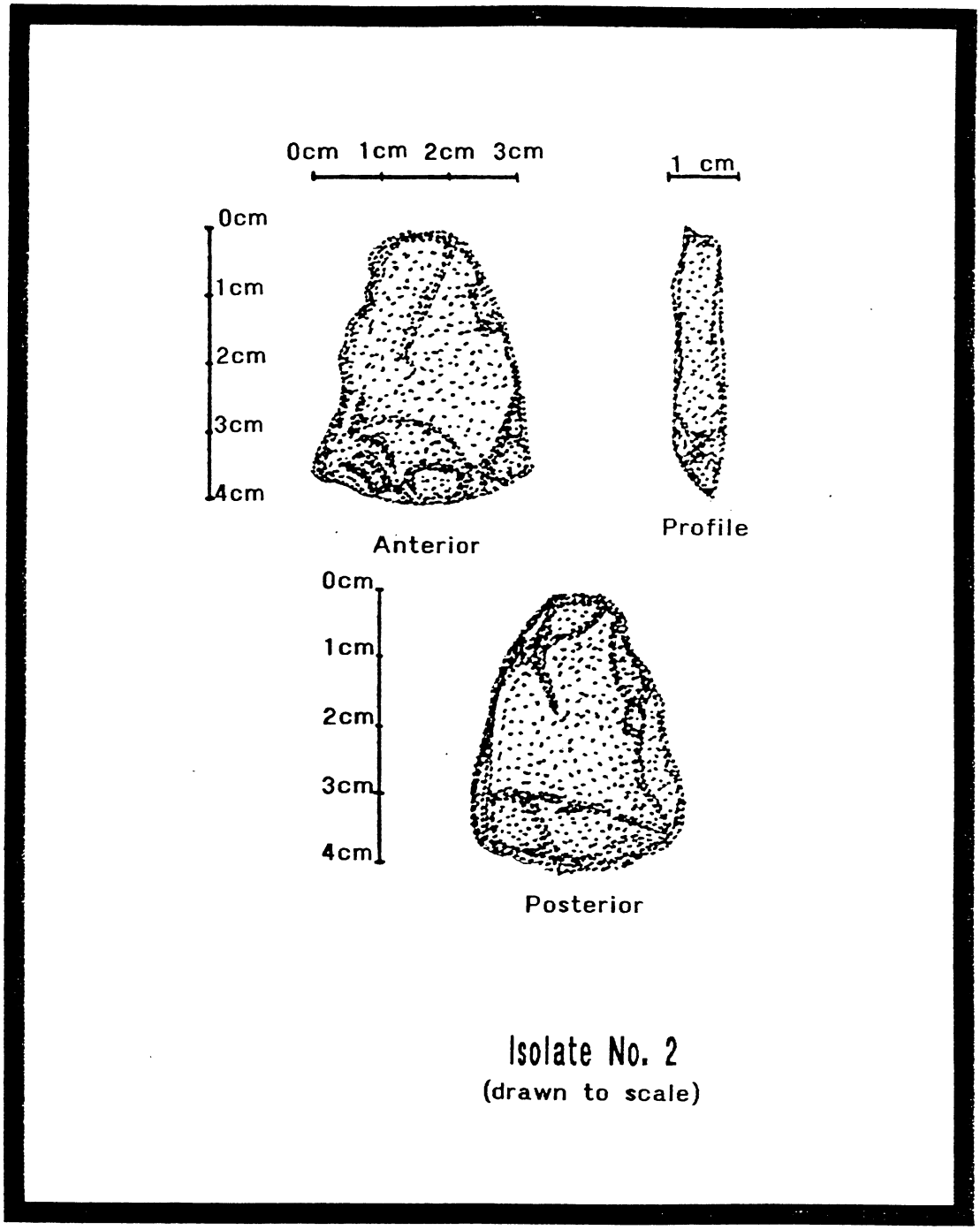

Figure 12. Depiction of Isolate No. 2: Small Scraper.

porch or entry. No evidence of a superstructure was evident and no marking were found in the pad to indicate date of construction. What was evident was the concrete pad(s) did represent poured concrete and not a series of small batches mixed on site.

A light scatter of refuse surrounded the concrete pad area and all items were identified as being of modern origin. McKenna et al. concluded that the remains of the pad and the surrounding refuse represented a post-World-War II use of the property and a use which probably post dated the 1952 U.S. government purchase of the airport property and surrounding acreage.

Since the pad and refuse was determined to be of modern origin, they are insignificant remains and ineligible for nomination to the National Register of Historic Places. No mitigation measures are necessary at this time.

In addition to the remains noted above, the Mckenna et al. survey crew noted the presence of a shallow crater along the western side of 10th Street East. Located approximately .4 miles south of Avenue M, this crater resembled a shallow mine shaft (unfinished). This crater may also have been a depression caused by general surface disturbances associated with earlier soil testing or borrowing. McKenna et al. found no evidence to indicate that a mining claim was active on this property. Therefore, McKenna et al. is tentatively concluding that this is not the remnant of a mine shaft and no additional investigations area warranted. If additional information is uncovered as some later date, more studies may be necessary.

Paleontological Resources

The paleontological investigations resulted in a determination of low probability for paleontological remains within the current project area, but did not rule out the potential should older alluvial deposits be impacted by the proposed project. Therefore, although no resources were identified, Mr. Langenwalter presented a discussion of mitigation measures should resources be uncovered during the course of the proposed future ground altering activities.

CONCLUSIONS AND RECOMMENDATIONS

Based on the data compiled during the recent studies and presented in this report, McKenna et al. has concluded that the surface evidence showed no evidence of significant or eligible prehistoric, historic, or paleontological remains. This data suggests a relatively low probability for buried deposits, as well. Therefore, McKenna et al. is not recommending archaeological, historic, or paleontological monitioring of excavations at this time.

There is always a potential for buried or, as yet, unidentified resources. In accordance with accepted guidelines, McKenna et al. presents the following recommendations with respect to the current project area:

1. No achaeological monitorning is recommended at this time. The proponent of the proposed project should, however, be prepared to permit a certified and qualified archaeologist to evaluate any prehistoric or historic resource which may be uncovered or otherwise identified as a result of any project within the current study area;

2. The evaluation process must conform to the requirements and guidelines for Phase II evaluations of prehistoric and/or historic resources, as presented in CEQA;

3. Upon completion of any evaluation (Phase II) the proponent must be prepared to forward the data through the Office of Historic Preservation for review and, if necessary, commit to a Phase III mitigation of impact study,should any resource be identified as significant or potentially eligible for nomination to the National Register of Historic Places;

4. No paleontological monitoring is necessary at this time. The proponent should, however, be prepared to permit recovery and evaluation of any paleontological resources identified during future activities within the project area;

5. The paleontologist must have the authority to halt any activities which are adversely impacting potentially significant or eligible resources.

6. Any paleontological specimens recovered from the property must be professionally handled, cleaned, analyzed, and curated;

7. All studies subsequent to this Phase I investigation must be professional presented in a technical report, which in turn, will be made available for review at the appropriate repository (e.g. UCLA or the Los Angeles County Museum).

8. If resources are uncovered during any ground alteration activities, an archaeological and/or paleontological monitoring program should be established to prevent adverse impacts to additional resources.

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1986 Prehistory of the Southwestern Area. In: Handbook of North American Indians, Volume II: Great Basin, pp. 183-193. Smithsonian Institution, Washington, D.C.

Yenne, Bill
1985 Southern Pacific. Bonanza Books, New York.

APPENDIX A:

Professional Qualifications

McKENNA et al.
6202 Friends Avenue
Whittier, California 90601
(310) 696-3852
(310) 693-4059 FAX

GENERAL QUALIFICATIONS

McKenna et al. is a small Cultural Resource Management (CRM) firm specializing in the fields of historic archaeology, prehistoric archaeology, and history. With over fifteen years of professional experience in CRM, Jeanette A. McKenna, Owner and Principal Investigator for McKenna et al., has relatively vast experience in the greater Southwest, Great Basin, and California regions. Ms. McKenna is familiar with the full range of cultural resource investigations and has completed projects within the public and private sectors, including larger environmental management firms, planning and engineering firms, and the State and Federal governments.

ORGANIZATION

McKenna et al. is a Womens Business Enterprise (WBE), owned and operated by Jeanette A. McKenna as a Sole Proprietorship under California law. Ms. McKenna serves as the Principal Investigator on all historical and archaeological projects, occasionally serving as a Co-Principal when the project requires additional expertise. Ms. McKenna has both a B.A. and M.A. in Anthropology and is currently certified by the Society for Professional Archaeologists (S.O.P.A.) to conduct both historic and prehistoric archaeological investigations. Additionally, Ms. McKenna is in the process of completing other certification processes for the Society.

McKenna et al., in operation for over four years, was established in 1989 after the separation and desolution of the Hatheway & McKenna General Partnership. McKenna et al. has maintained the in-house capability to complete all necessary tasks required to fulfill the requirements of a cultural resource investigations. Because McKenna et al. is a small firm, the overhead for the company is low and well within a competitive range.

SCOPE OF SERVICES

McKenna et al. is prepared to complete any level of cultural resource management required. If the in-house capabilities are unable to fulfill any requirement, McKenna et al. has a wide range of consultants prepared to assist on a given project.

Major in-house capabilities of McKenna et al. include:

- Cultural Resource Overviews and Management Plans;
- Federal and State Level Environmental Survey Reports (NEPA and CEQA; and under the Arizona Antiquities Act);
- Historic Property Survey Reports (HPSR);
- EIR and EIS Documentation;
- Predictive Modeling and Spatial Analysis;
- Data Management;
- Peer Review;
- In-House and Subcontracting for Archaeological Artifact Analysis.
- Subcontracting for Paleontological Studies;
- Subcontracting for Historic Architectural Studies.

BRIEF BIOGRAPHICAL INFORMATION

- Jeanette A. McKenna -

Ms. McKenna is a graduate of California State University at Fullerton (B.A. in 1977; M.A. in 1982) with three years of Post-Graduate studies at Arizona State University, Tempe. Active in the discipline of Cultural Resource Management (CRM) since 1976, Ms. McKenna has over sixteen years of professional experience. Of these, Ms. McKenna has spent over eleven years in California and another five years in the greater Southwest. Her particular area of interest lies in the desert regions of California and Arizona, with specializations in the Proto-historic and Historic periods. Ms. McKenna also has considerable experience in dealing with prehistoric cultural remains (the majority of her career work being associated with Native American sites).

Ms. McKenna has served on over 250 archaeological or historical projects, the majority of which she managed as the Field Director, Project Manager, or Principal Investigator. She is currently certified by the Society of Professional Archaeologists in Field Archaeology and Historic Archaeology, and is in the process of being certified in additional interdisciplinary areas. Ms. McKenna has recently been elected to the Board of Directors of the Society of Professional Archaeologists (1993-95). In addition, Ms. McKenna is recognized by numerous County agencies as a qualified Cultural Resource manager (Los Angeles Co., Orange Co., San Bernardino Co., Riverside Co., Santa Barbara Co., and throughout Arizona).

Ms. McKenna maintains first-hand involvement with the field projects under her suparvision/responsibility and has authored no less than two hundred cultural resource management reports, papers, and/or chapters; receiving excellent reviews and comments from Federal, State, Local, Public, and Private sector reviewers. Ms. McKenna's associations with Arizona State University's Office of Cultural Resource Management, various private firms, and Hatheway & McKenna have enhanced her ability to adequately manage CRM projects and McKenna et al. is prepared to actively pursue additional projects within the realm of Ms. McKenna's expertise and interests.

APPENDIX B:

Archaeological Records Check

California Archaeological Inventory

Regional Information Center
Orange Los Angeles Ventura

Mailing Address: Archaeological Information Center
UCLA Institute of Archaeology
Fowler Museum of Cultural History
Los Angeles, CA 90024-1510
Phone: 213-825-1980 FAX: 213-206-4723

April 27, 1993

Jeanette McKenna
6202 Friends Ave.
Whittier, CA 90601

RE: Records Search on Lancaster East, Lancaster West, Ritter Ridge and Palmdale Quadrangles.

Dear Ms. McKenna,

As per your request of April 22, 1993, we have conducted an archaeological records search of the above referenced project. This document search included a review of all recorded historic and prehistoric archaeological sites in the vicinity as well as a review of all known cultural resource survey and excavation reports. In addition, we have checked our file of historic maps regarding this region.

These documents revealed:

PREHISTORIC RESOURCES:

One prehistoric site, LAN-1999, has been identified within a one mile radius of the subject area. This site is not within the boundaries of the project area.(see enclosed map and site record).

HISTORIC RESOURCES:

Two historic sites, LAN-1990H and LAN-2039H, have been identified within a one mile radius of the subject area. Neither of these two sites are located within the boundaries of the project area (see enclosed map and site records). Inspection of our historic maps -- Lancaster (1958) 15' series -- indicates that as of 1958 the project area was bounded by Avenue M and the Southern Pacific railroad and bisected by 10th Street. Please see enclosed copy of the Lancaster Quadrangle, 15' series, edition of 1958.

PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS:

Eighteen surveys and/or excavations have been conducted within a one mile radius of the subject area. Three of these, L-162, L-1422 and L-1799 are located within the boundaries of the project area (see enclosed map and bibliography).

Please forward a copy of any reports resulting from this project to our office as soon as possible. Due to the sensitive nature of site location data, we ask that you do not include record search maps in your report. If you have any questions regarding the results presented herein, please feel free to contact our office at (310) 825-1980.

Invoices are mailed approximately two weeks after records searches. This will allow your firm the opportunity to request further information under the same invoice number. Please reference the invoice number listed below when making inquiries. Requests made after invoicing will necessitate a separate invoice with a $15.00 handling fee.

Sincerely,

Tarquin D. Preziosi
Staff Archaeologist

Enclosures:

(X) Map
(X) Bibliography
( ) Site list
(X) Site records
( ) Survey reports
( ) Confidentiality Form
( ) Invoice#4415

UCLA
FILE #

L-116 Love, Bruce W.
1988 ARCHEOLOGY REPORT FOR AMARGOSA DRAINAGE NORTH OF AVENUE M
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: Lancaster West
LINEAR MILES: 1
SITES: NONE
FIRM: PYRAMID ARCHAEOLOGY
AGENCY: City of Lancaster, California
PAGES: 5

L-1[illegible] Love, Bruce
1988 ARCHAEOLOGY REPORT FOR AVENUE M RIGHT-OF-WAY AND AMARGOSA CULVERT PROJECT
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER EAST
QUADS: LANCASTER WEST
LINEAR MILES: 3
SITES: NONE
FIRM: PYRAMID ARCHAEOLOGY
AGENCY: City of Lancaster, California
PAGES: 4

L-1422 TALLEY, PAIGE
1984 VAN NUYS AIR NATIONAL GUARD RELOCATION STUDY AIR FORCE PLANT #42, PALMDALE NAVAL AIR STATION, POINT MUGU NORTON AIR FORCE BASE.
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER EAST
QUADS: CAMARILLO
ACRES: 512
SITES: NONE
FIRM: SCIENTIFIC RESOURCES SURVEYS, INC.
AGENCY: PRC ENGINEERING
PAGES: 23

L-1717 Blodgett, Leslie Mouriquand
1988 REPORT OF ARCHIVAL SEARCH AND FIELD INSPECTION OF APPROXIMATELY 4.5 LINEAR MILES AND PROPOSED DETENTION BASIN ALONG AMARGOSA CREEK, IN PALMDALE, CALIFORNIA.
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER WEST
QUADS: RITTER RIDGE
ACRES: 130
LINEAR MILES: 5
FIRM: C.A.
AGENCY: Michael Brandman Associates
PAGES: 20

L-1789 Padon, Beth
1988 HISTORIC PROPERTY SURVEY REPORT WIDENING AVENUE M CITY OF

UCLA
FILE #

Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: Lancaster East
LINEAR MILES: 4
FIRM: LSA ASSOCIATES, INC.
AGENCY: County of Los Angeles Department of Public Works Stat
AGENCY: California Department of Transportation
PAGES: 58

L-1831 Norwood, Richard H.
1989 CULTURAL RESOURCE SURVEY FOR ANTELOPE VALLEY BUSINESS PARK, 50 ACRE PARCEL, PALMDALE, CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER WEST
ACRES: 50
FIRM: PYRAMID ARCHAEOLOGY
AGENCY: THE LUSK COMPANY
PAGES: 9

L-1851 Norwood, Richard H.
1989 CULTURAL RESOURCE SURVEY FOR 40.85 ACRES, PALMDALE, CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER WEST
QUADS: RITTER RIDGE
ACRES: 41
FIRM: PYRAMID ARCHAEOLOGY
AGENCY: RICARDO CAPRETTA
PAGES: 14

L-1853 Dillon, Brian D.
1986 AN ARCHAEOLOGICAL RESOURCE SURVEY AND IMPACT ASSESSMENT OF THE DEAN PARCEL, AVENUE N AND DIVISION STREET, PALMDALE, CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER WEST
ACRES: 10
FIRM: C.A.
AGENCY: SCIENTIFIC RESOURCES SURVEYS
PAGES: 16

L-1857 Norwood, Richard H.
1989 CULTURAL RESOURCE SURVEY LOCKHEED PLANT 10 EXPANSION, PALMDALE CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: PALMDALE
ACRES: 280
SITES: CA-LAN-1623H, LAN-1624H
FIRM: C.A.
AGENCY: PEARSON AND WUESTHOFF AIA
PAGES: 55

UCLA
FILE #

L-1957 Love, Bruce
1990 CULTURAL RESOURCES INVESTIGATION FOR LANCASTER BUSINESS PARK LANCASTER, CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER EAST
QUADS: LANCASTER WEST
ACRES: 160
SITES: CA-LAN-1422H
FIRM: PYRAMID ARCHAEOLOGY
AGENCY: IMPACT SCIENCE, INC.
PAGES: 19

L-1970 Gerry, Robert
1989 CULTURAL RESOURCES ASSESSMENT OF THE PROPOSED MONIER COMPANY PLANT, PALMDALE, LOS ANGELES COUNTY, CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER EAST
ACRES: 20
SITES: NONE
FIRM: PEAR & ASSOCIATES, INC.
AGENCY: ECOS, INC.
PAGES: 16

L-2102 Love, Bruce
1989 CULTURAL RESOURCE ASSESSMENT TT 44769, A.V. BUSINESS PARK, 10TH WEST AND AVENUE M, PALMDALE, LOS ANGELES COUNTY
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER WEST
ACRES: 80
SITES: NONE
SITES: NONE
FIRM: PYRAMID ARCHAEOLOGY
AGENCY: THE LUSK COMPANY
PAGES: 15

L-2323 Robinson, B. W.
1990 A CULTURAL RESOURCES INVESTIGATION OF A PORTION OF THE AMARGOSA DRAINAGE SYSTEM WITHIN THE CITY OF PALMDALE, LOS ANGELES COUNTY, CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER WEST
QUADS: RITTER RIDGE
ACRES: 430
SITES: NONE
FIRM: C.A.
AGENCY: CITY OF PALMDALE
PAGES: 9

L-2376 NORWOOD, RICHARD H.
1991 PHASE I CULTURAL RESOURCE INVESTIGATION FOR AVENUE L GRADE

UCLA
FILE #

Particulars: SURVEY
QUADS: LANCASTER WEST
ACRES: 20
SITES: CA-LAN-1990H
FIRM: RT FACTFINDERS
AGENCY: DE LEUW, CATHER & COMPANY
PAGES: 23

L-2476 DROVER, CHRISTOPHER E.
1991 ENVIRONMENTAL IMPACT EVALUATION: AN ARCHAEOLOGICAL ASSESSMENT OF THE INDUSTRY TRADE CENTER SPECIFIC PLAN PALMDALE, CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER EAST
QUADS: LANCASTER WEST
QUADS: RITTER RIDGE
QUADS: PALMDALE
ACRES: 9000
SITES: CA-LAN 1801/H, LAN-1998
FIRM: C.A.
AGENCY: RAN PAC ENGINEERING CORPORATION
PAGES: 21

L-2512 NORWOOD, RICHARD H.
1991 PHASE II CULTURAL RESOURCE EVALUATION FOR HISTORIC SITE LAN-1990 H THE WINCHESTER-GRAHM PROPERTY LANCASTER, CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SITE ASSESSMENT
QUADS: LANCASTER WEST
ACRES: 1
SITES: CA-LAN-1990H
FIRM: RT FACTFINDERS
AGENCY: DELEUW, CATHER & COMPANY
PAGES: 34

L-2606 CAMPBELL, MARK
1992 ARCHAEOLOGICAL RECONNAISSANCE REPORT OF A 1 ACRE PARCEL ON THE SOUTHWEST CORNER OF 8TH STREET EAST AND AVENUE L-4 IN LANCASTER, CA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER EAST
ACRES: 1
SITES: NONE
FIRM: CAMPBELL RESEARCH
AGENCY: ANTELOPE VALLEY MOSQUITO ABATEMENT DISTRICT
PAGES: 19

L-2634 BECKER, KENNETH M.
1992 CULTURAL RESOURCES RECONNAISSANCE OF ANTELOPE VALLEY COURTS FACILITY, CITY OF LANCASTER, LOS ANGELES COUNTY, CALIFORNIA
Report on file, UCLA ARCH. INFO. CENTER
Particulars: SURVEY
QUADS: LANCASTER WEST

UCLA
FILE #

SITES: NONE
FIRM: RMW PALEO ASSOCIATES, INC.
AGENCY: BEIN, ROBERT, WILLIAM FROST, AND ASSOCIATES
PAGES: 26

APPENDIX C:

Paleontological Report

A PALEONTOLOGICAL SURVEY AND ASSESSMENT OF THE LOCKHEED NORTH PROPERTY IN PALMDALE LOS ANGELES COUNTY, CALIFORNIA

Paul E. Langenwalter II

Prepared by

HERITAGE RESOURCE CONSULTANTS
P.O. Box 1674
La Mirada, California 90637

Prepared for

McKENNA et al
6202 Friends Avenue
Whittier, CA 90601

HRC Project 254

June 1993

INTRODUCTION

A study of the 536 acre Lockheed North property in Palmdale was conducted by Heritage Resource Consultants to evaluate paleontological resources on the property. This study was commissioned by McKENNA et al in preparation for development of the property. The study was performed in conformance with the requirements of the City of Palmdale and Appendix K of the California Environmental Quality Act. The goals of the survey were to determine the paleontological sensitivity of the geologic formations on the property, identify the kinds and significance of paleontological resources in them and to make recommendations for the conservation of such resources if they are subject to future impacts through development. Although no paleontological resources were discovered, there is a possibility that fossils may be found if earthmoving takes place on the property. This study includes an evaluation of the potential significance of fossil resources which might be discovered, and makes recommendations for the conservation of such resources in the future.

PROJECT LOCATION AND SETTING

The study property is located in the northern part of the City of Palmdale, Los Angeles County, California, occupying parts of Sections 1 and 2 in Township 6 North, Range 12 West. It consists of a rectangular parcel of approximately 536 acres (see Figure 1) The property is bounded on the east and south by the grounds of U.S. Air Force Plant 42 (includes open space, buildings dedicated to aerospace construction and a landing strip). The northern edge of the property is bounded by Avenue M, and an adjacent subdivision. A small commercial strip is located across Avenue M at the northwest corner. The western edge by the Southern Pacific Railroad right-of-way. A small parcel fronting Avenue M west of Challenger Avenue is occupied by a tank farm.

The property consists of semi-flat desert floor located between Armagosa Creek on the west and Little Rock Wash on the east. Drainage channels on the property trend to the northeast, following the gentle slope of the land. The property is presently vacant (May 1993). It is covered by desert vegetation, including grasses and shrubs, dominated by yucca. The yucca forest is most dense in the eastern part of the property. Several dirt roads (some are partly paved) are located on the property. These include an extension of Challenger Way, Avenue M-8, Avenue M-12, and an unnamed road adjacent and parallel to the railroad right-of-way. The area is covered by a broad scatter of recent trash. Most of the trash is located adjacent to the dirt roads which traverse the property.

METHODS

The methods used in this study included: 1) review of the records of known paleontological sites in the region, 2) a survey of paleontological and geological publications for the project region, and 3) a survey of the property.

A record check was obtained from the Section of Vertebrate Paleontology at the Natural History Museum of Los Angeles County. Additional information on paleontological site distribution was based on Jefferson's (1991 a and b) synthesis of Quaternary paleontological sites in California. His data base includes records from the Sections of Invertebrate and Vertebrate Paleontology at the Natural History Museum of Los Angeles County, the San Bernardino County Museum, and the Department of Earth Sciences, University of California, Riverside, and 19 other record-holding institutions in the western United States. Each of these institutions maintain regional paleontological collections, supporting maps, records and documents. The information from these sources was used to determine if

paleontological sites had been previously identified on the property.

The literature survey consisted of a review of the professional literature pertaining to the project region, including selected unpublished documents produced during surveys of other properties in the region. Geologic maps of the region were consulted and analyzed to make initial estimations of the potential for paleontologic resources on the property and for the purpose of planning field studies.

The field survey included a walk over and surface examination of the property. The walk over was divided into parts by the systematic examination of individual landforms or features (eg.- areas between roads or natural landforms, etc.). Tailings from selected ant hills and animal burrows were examined in an effort to locate microfossils.

RESULTS AND SENSITIVITY

The area within the project boundaries is covered by Younger Alluvium (Dibblee 1960; Jennings and Strand 1969). It consists of yellowish brown sands containing granule, pebble and cobble sized clasts. The upper portion of these sediments are Holocene in age, although some of the lower portions of this rock unit are probably Late Pleistocene. They potentially contain paleontological remains (see Jefferson 1989).

The records (McLeod 1993) and literature searches indicate that no previously recorded paleontological resources occur on the study property, or in the vicinity. No paleontological resources were discovered during the survey conducted as part of this study. The alluvium in the area of the study property is considered to have a "low sensitivity" (fossil remains rare or

absent; Reynolds 1990), and it is unlikely that any paleontological remains would be encountered on the property.

Recent paleontological studies over large areas of the western Mojave Desert indicate that areas mapped as Younger Alluvium actually have Older Alluvial deposits occurring near surface and that minimal excavation has resulted in the discovery of numerous Pleistocene fossil sites (Springer 1993). The Older Alluvium has yielded more than 60 invertebrate and vertebrate species (freshwater mollusks, insects, fish, amphibians, reptiles, birds and mammals). A synopsis of the Late Pleistocene fauna is presented by Jefferson (1989). The potential for encountering paleontological resources in Older Alluvial deposits that underlie the property is probably low. The Older Alluvium may not be encountered at all if excavation on the property is shallow.

RECOMMENDATIONS

Based on the findings of this report, no paleontological resources are known on the study property, and none are likely to be found as the result of earth moving. The potential for the presence of paleontological remains on the study property is very low at best. Therefore, mitigation of impacts to paleontological resources is unnecessary.

During the course of development of the property, it is recumbent on the owners of the property, their agents, contractors, or subcontractors to immediately report the discovery of any fossils or possible fossils to a qualified vertebrate paleontologist for evaluation.

If fossils are encountered on the property during development, the following mitigation procedures should be followed:

1. The project paleontologist should immediately evaluate the fossils which have been discovered to determine if they are significant and, if so, to develop a plan to collect and study them for the purpose of mitigation.

2. The paleontologist/paleontological monitor must be empowered to temporarily halt or redirect excavation equipment if additional fossils are found to allow evaluation and removal of them if necessary. The monitor should be equipped to speedily collect specimens if they are encountered.

3. The monitor, with assistance if necessary, should collect individual fossils and/or samples of fossil-bearing sediments. If specimens of small animal species are encountered, the most time and cost efficient method of recovery is to remove a selected volume of fossil-bearing earth from the grading area and stockpile it off-site for processing by screen washing.

4. Fossils recovered during earthmoving or as a result of screen-washing of sediment samples should be cleaned and prepared sufficiently to allow identification. This allows the fossils to be described in a report of findings and reduces the volume of matrix around specimens prior to storage, thus reducing storage costs.

5. A report of findings should be prepared and submitted to the public agency responsible for overseeing developments and mitigation of environmental impacts upon completion of mitigation. This report would minimally include a statement of the types of paleontologic resources found, the methods and procedures used to recover them, an inventory of the specimens recovered, and a statement of their scientific significance.

6. The paleontological specimens recovered as a result of mitigation should by donated to a qualified scientific

institution where they would be afforded long term preservation to allow future scientific study.

LITERATURE CITED

Dibblee, T.W., Jr. 1960. Geologic Map of the Lancaster Quadrangle, Los Angeles County, California. U.S. Geologic Survey Mineral Investigations Field Studies Map MF-76.

Jefferson, G.T. 1989. Late Pleistocene and Earliest Holocene Fossil Localities and Vertebrate Taxa from the Western Mojave Desert. In The West-Central Mojave Desert: Quaternary Studies between Kramer Junction and Afton Canyon, edited by R.E. Reynolds. San Bernardino County Museum, Redlands, California.

Jefferson, George T. 1991a. A Catalogue of Late Quaternary Vertebrates from California: Part One, Nonmarine Lower Vertebrate and Avian Taxa. Natural History Museum of Los Angeles County, Technical Reports 5.

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Jennings, Charles W. and Rudolph G. Strand. 1969. Geologic Map of California, Los Angeles Sheet: California Division of Mines and Geology, Scale 1:250,000.

McLeod, Samuel. 1993. Personal communication to P. E. Langenwalter. Natural History Museum of Los Angeles County, Los Angeles, California.

Springer, Scott. 1993. Personal communication to P. E. Langenwalter. San Bernardino County Museum, Redlands, California.

Reynolds, Robert. 1990.Paleontologic Sensitivity City of Palmdale, Los Angeles County, California. San Bernardino County Museum, Redlands, California.

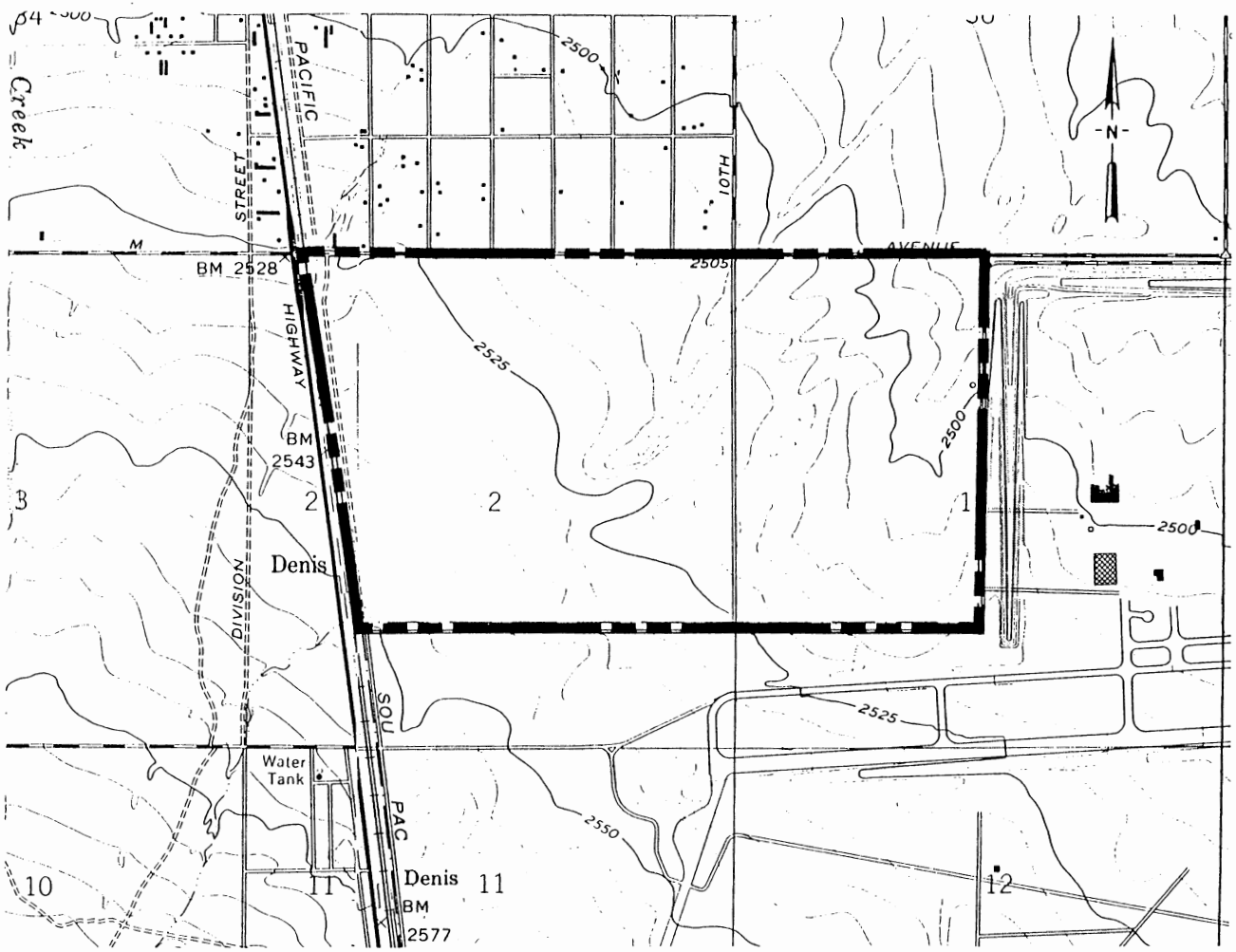


Figure 1. Lockheed North property. Scale 1:24,000.

APPENDIX D:

Archaeological Isolate Forms

ARCHAEOLOGICAL ISOLATE RECORD FORM
(McKenna et al., Whittier, CA)

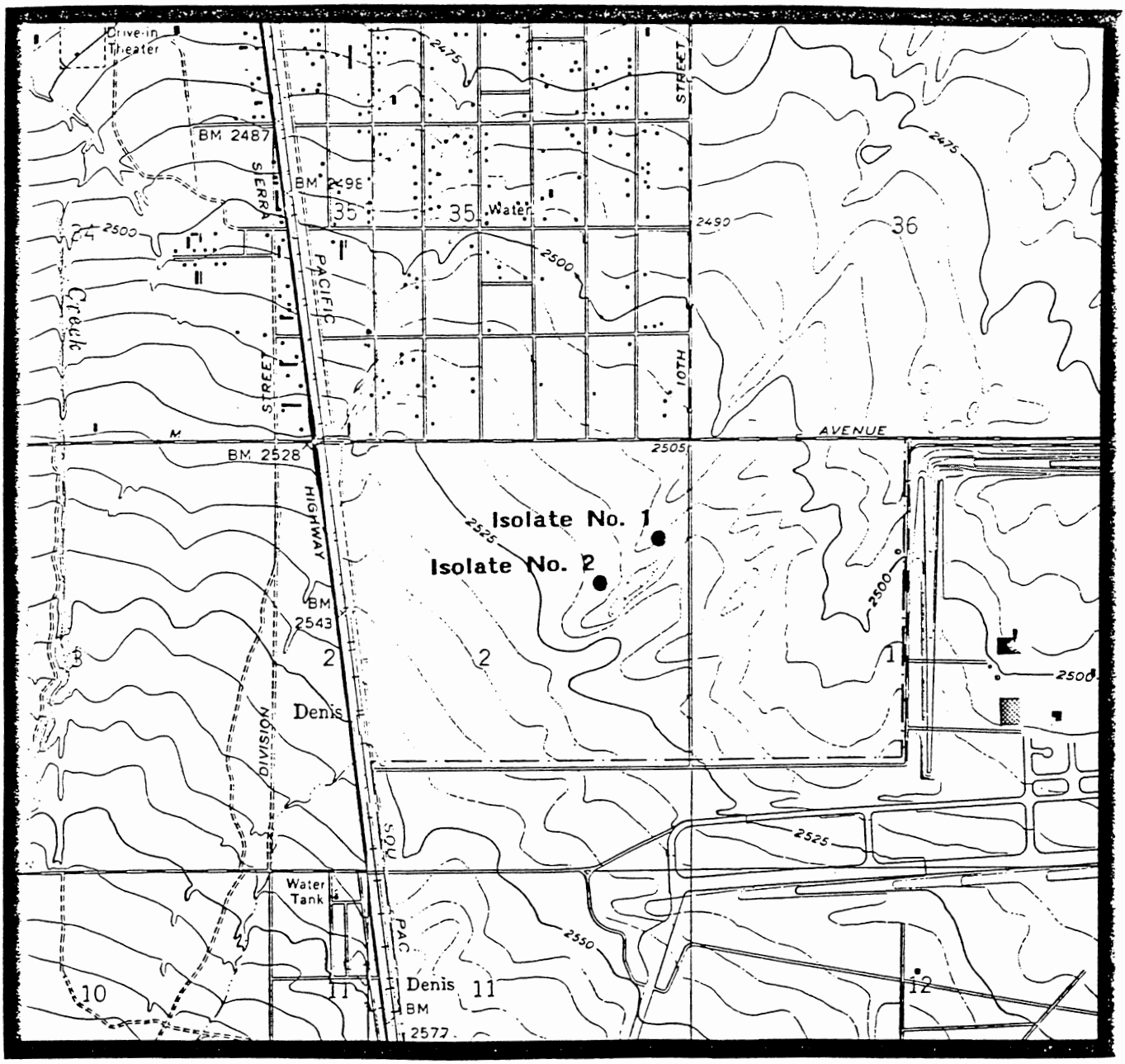
PERMANENT NUMBER: _____
TEMPORARY NUMBER: Palmdale-1
AGENCY DESIGNATION: _____

1. COUNTY: Los Angeles
2. USGS QUADRANGLE: Lancaster East (revised 1974)
3. UTM COORDINATES: ZONE: 11 / 398040 EASTING 3833800 NORTHING
4. TOWNSHIP: 6N RANGE: 12W / SW 1/4 SE 1/4 NE 1/4 NE 1/4; SECTION 2
5. MAP COORDINATES: 496 (mm South); 48 (mm East)
6. ELEVATION: 2510' above mean sea level
7. LOCATION: Artifact was identified approximately 220 meters south of Avenue M and 80 meters west of the dirt road extension of 10th Street East. Artifact was found in soft sandy deposit amid small concentration of Joshua trees and in the area of light modern refuse scatter. Area appears to have been recently weathered; artifact was likely buried for some time.
8. ARTIFACT DESCRIPTION: Projectile point - approximately 8.5 cm x 2.5 cm x .5 cm; appears to have been a larger point, but base was reworked; two types of pressure flaking were evident - transverse parallel flaking and collateral flaking; with reworked base, no diagnostic data available for this artifact. Identified as a grey chert with inclusions and mineral stains. Some would refer to this as a crypochrystaline silicate (CCR).
9. COLLECTED: Yes. (May 3, 1993)
10. CURATED: Temporarily at McKenna et al., Whittier, California
11. NEAREST WATER: No nearby water sources. Little Rock Wash located 6 miles to the east, in Section 2 of Range 11 West.
12. VEGETATION COMMUNITY(IES): Desert Scrub Community with Joshua tree presence.
13. LANDFORM: Valley floor of alluvium
14. GEOLOGY: sandy alluvium
15. EXPOSURE: open
16. SLOPE: slight to northeast
17. LAND OWNERS: Lockheed Aircraft, Palmdale, California
18. REMARKS: Artifact was identified in area recently weathered by winter rains and condition of artifact suggests it was buried for some time (not weather worn, itself). Point was reworked.
19. REFERENCES: see McKenna 1993 (with contributions by P.E. Langenwalter II/Paleontology); on file, UCLA Archaeological Informaton Center.
20. NAME OF PROJECT: Lockheed North Specific Plan EIR Documentation; Phase I investigation.
21. PHOTOGRAPHS: on file, McKenna et al.
22. PHOTO ACCESION NUMBER: N.A.
23. DATE OF RECORDING: May 3, 1993
24. RECORDER(S): Jeanette McKenna and Leta Franklin
25. PROFESSIONAL AFFILIATIONS: McKenna et al., 6202 Friends Avenue, Whittier, California - for URS Consultants, San Bernardino, California

ARCHAEOLOGICAL ISOLATE RECORD FORM
(McKenna et al., Whittier, CA)

PERMANENT NUMBER: _____
TEMPORARY NUMBER: Palmdale-1
AGENCY DESIGNATION: _____

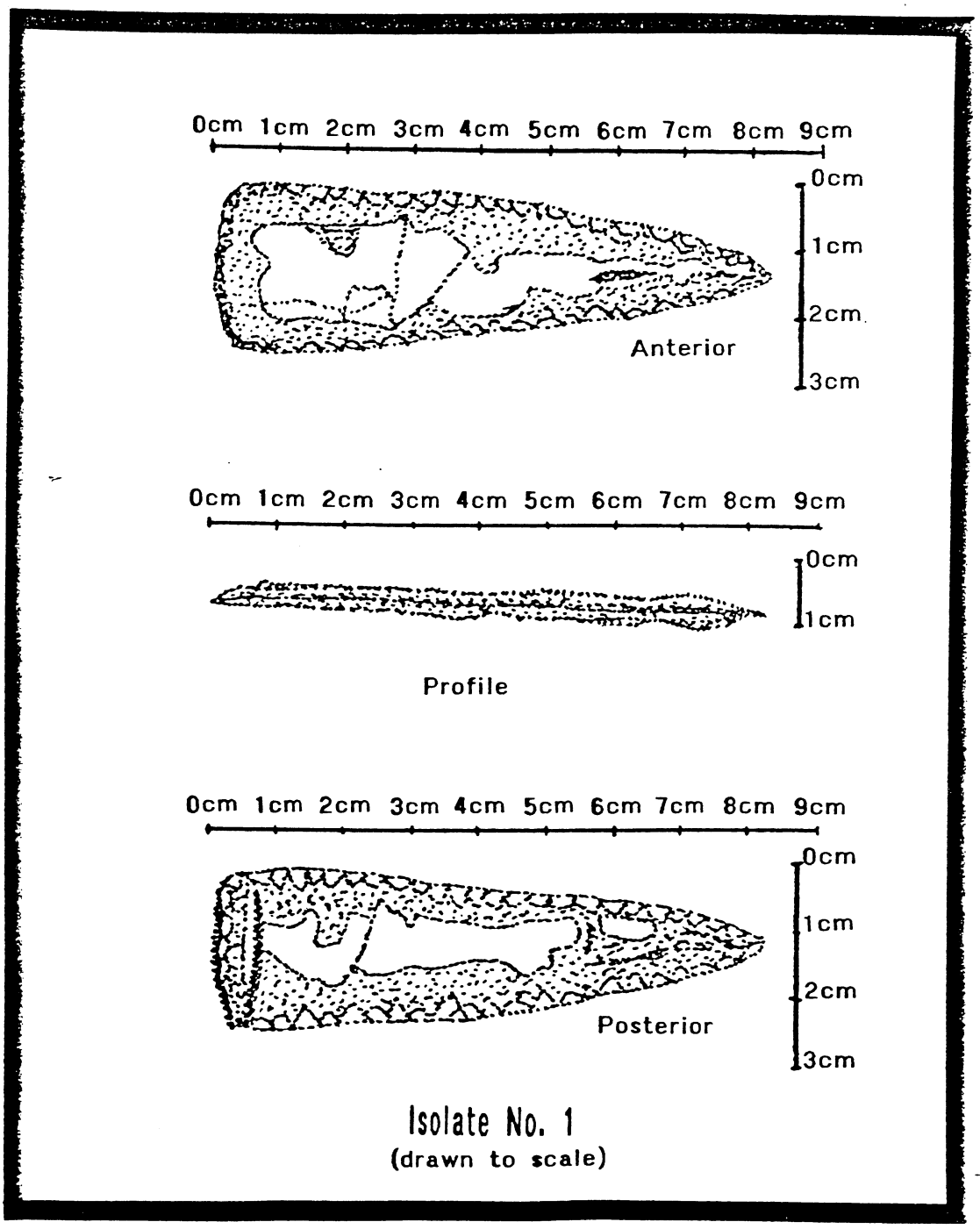
Archaeological Isolate Location Map



ARCHAEOLOGICAL ISOLATE RECORD FORM
(McKenna et al., Whittier, CA)

PERMANENT NUMBER: _____
TEMPORARY NUMBER: Palmdale-1
AGENCY DESIGNATION: _____

Archaeological Isolate Continuation Form



Isolate No. 1
(drawn to scale)

ARCHAEOLOGICAL ISOLATE RECORD FORM
(McKenna et al., Whittier, CA)

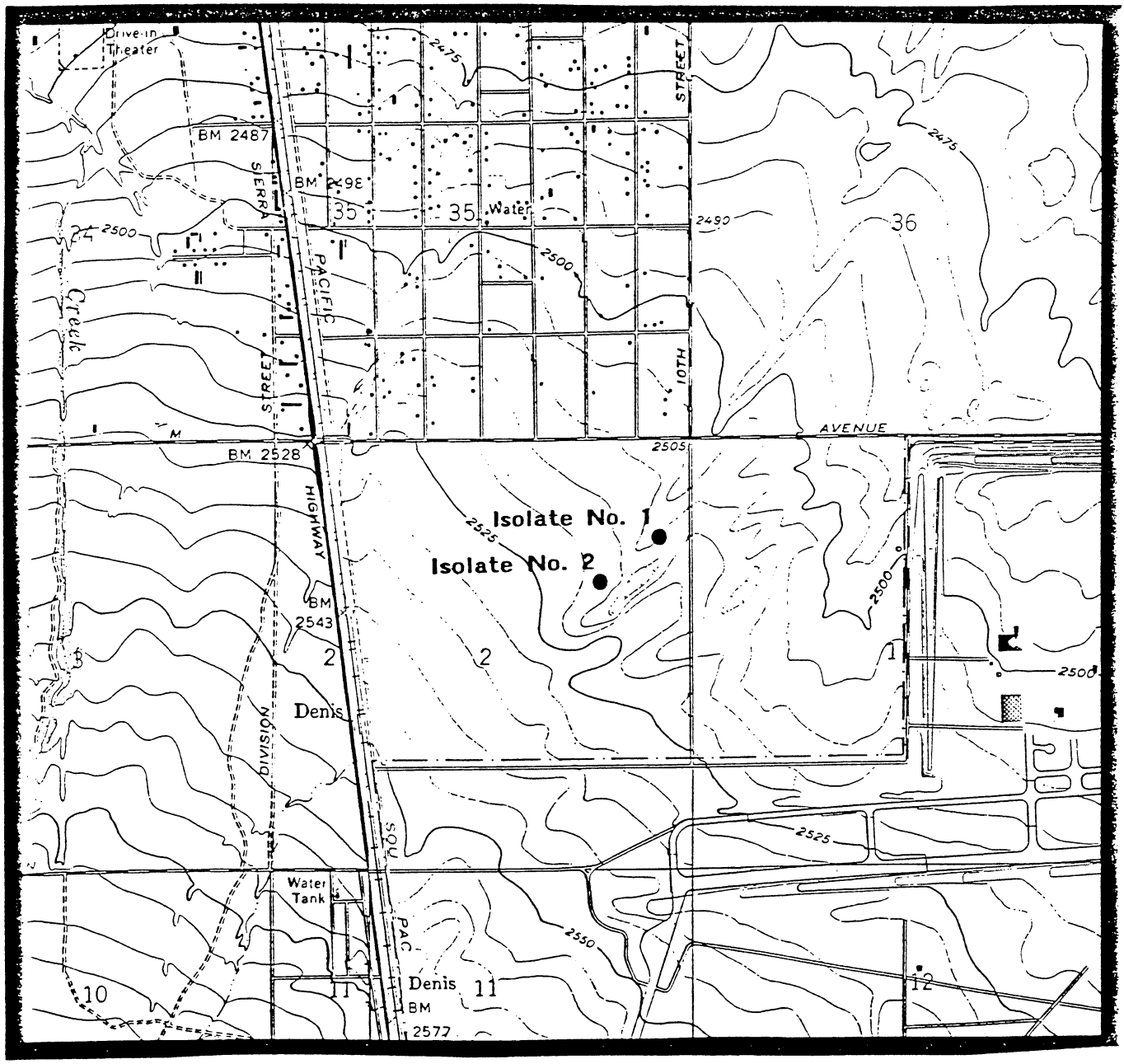
PERMANENT NUMBER: _____
TEMPORARY NUMBER: Palmdale-2
AGENCY DESIGNATION: _____

1. COUNTY: Los Angeles
2. USGS QUADRANGLE: Lancaster East (revised 1974)
3. UTM COORDINATES: ZONE: 11 / 397800 EASTING 3833640 NORTHING
4. TOWNSHIP: 6N RANGE: 12W / SW 1/4 NW 1/4 SE 1/4 NE 1/4; SECTION 2
5. MAP COORDINATES: 503 (mm South); 39 (mm East)
6. ELEVATION: 2520' above mean sea level
7. LOCATION: Artifact was identified at coordinates read from compass: Center tank at L.A. Co. yard = 300 degrees E of mag. north; intersection of Sierra Hwy. and Avenue M = 273 degrees east of mag. north; intersection of Avenue M and 10th Street East = 20 east of mag. north. Area associated with small depression where recent rains formed swale; identified on USGS map.
8. ARTIFACT DESCRIPTION: Small scraper - roughly triangular and measuring 4.0 cm x 3.0 cm x .75 cm; brown chert with minor inclusions. Two utilized edges identified. No specific diagnostic traits. Location provided no archaeological context to associate this artifact with other possibly buried deposits. Artifact appears to have been uncovered by recent rains. Some may refer to this as a crypochrystaline silicate (CCR).
9. COLLECTED: Yes. (May 3, 1993)
10. CURATED: Temporarily at McKenna et al., Whittier, California
11. NEAREST WATER: No nearby water sources. Little Rock Wash located 6 miles to the east, in Section 2 of Range 11 West.
12. VEGETATION COMMUNITY(IES): Desert Scrub Community with Joshua tree presence.
13. LANDFORM: Valley floor of alluvium
14. GEOLOGY: sandy alluvium
15. EXPOSURE: open
16. SLOPE: slight to northeast
17. LAND OWNERS: Lockheed Aircraft, Palmdale, California
18. REMARKS: Artifact was identified in area recently weathered by winter rains and condition of artifact suggests it was buried for some time (not weather worn, itself). Point was reworked.
19. REFERENCES: see McKenna 1993 (with contributions by P.E. Langenwalter II/Paleontology); on file, UCLA Archaeological Informaton Center.
20. NAME OF PROJECT: Lockheed North Specific Plan EIR Documentation; Phase I investigation.
21. PHOTOGRAPHS: on file, McKenna et al.
22. PHOTO ACCESION NUMBER: N.A.
23. DATE OF RECORDING: May 3, 1993
24. RECORDER(S): Jeanette McKenna and Leta Franklin
25. PROFESSIONAL AFFILIATIONS: McKenna et al., 6202 Friends Avenue, Whittier, California - for URS Consultants, San Bernardino, California

ARCHAEOLOGICAL ISOLATE RECORD FORM
(McKenna et al., Whittier, CA)

PERMANENT NUMBER: _____
TEMPORARY NUMBER: Palmdale-2
AGENCY DESIGNATION: _____

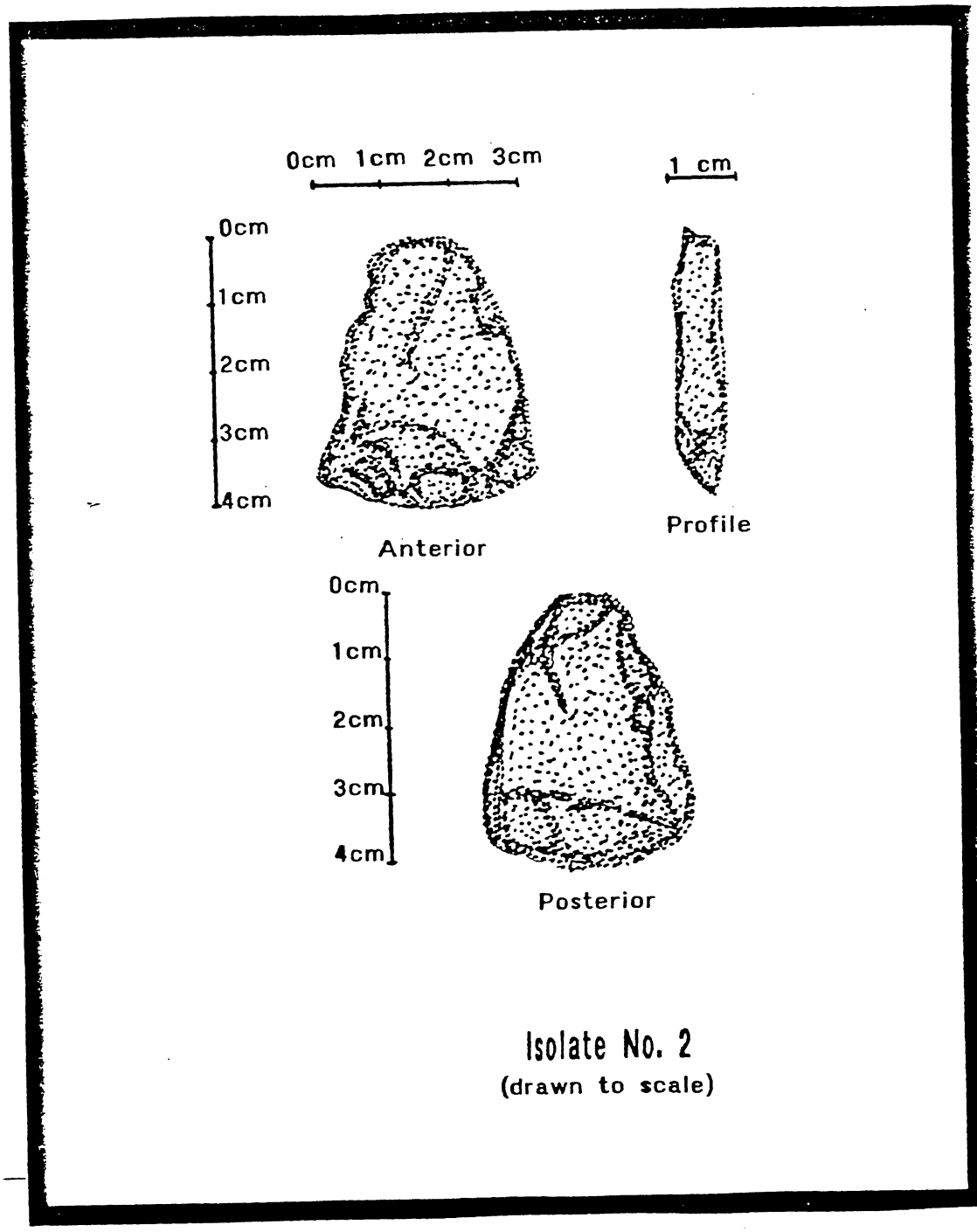
Archaeological Isolate Location Map



ARCHAEOLOGICAL ISOLATE RECORD FORM
(McKenna et al., Whittier, CA)

PERMANENT NUMBER: _____
TEMPORARY NUMBER: Palmdale-2
AGENCY DESIGNATION: _____

Archaeological Isolate Continuation Form

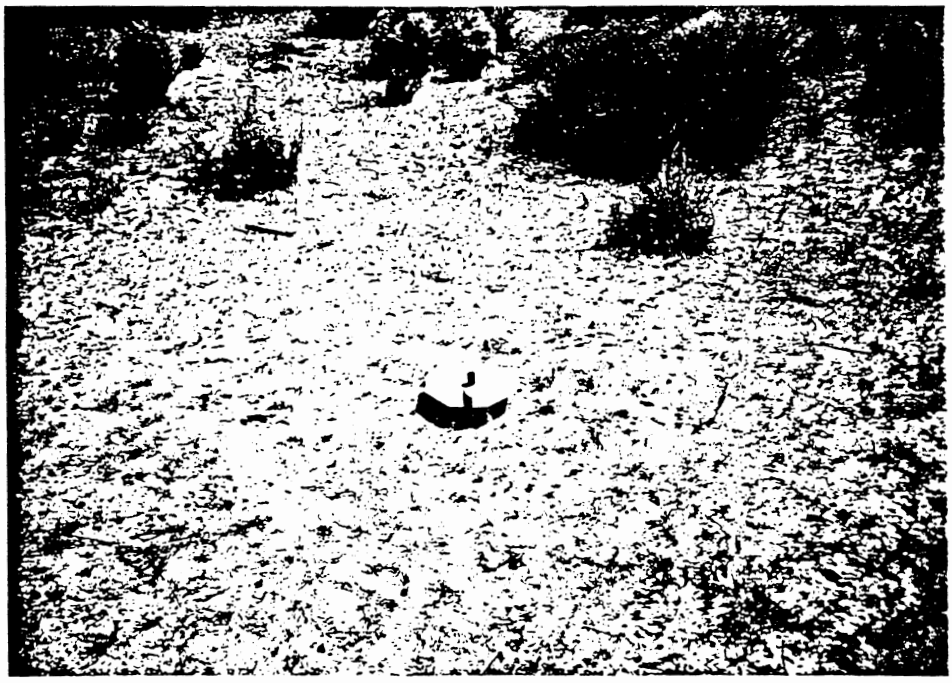


Isolate No. 2
(drawn to scale)

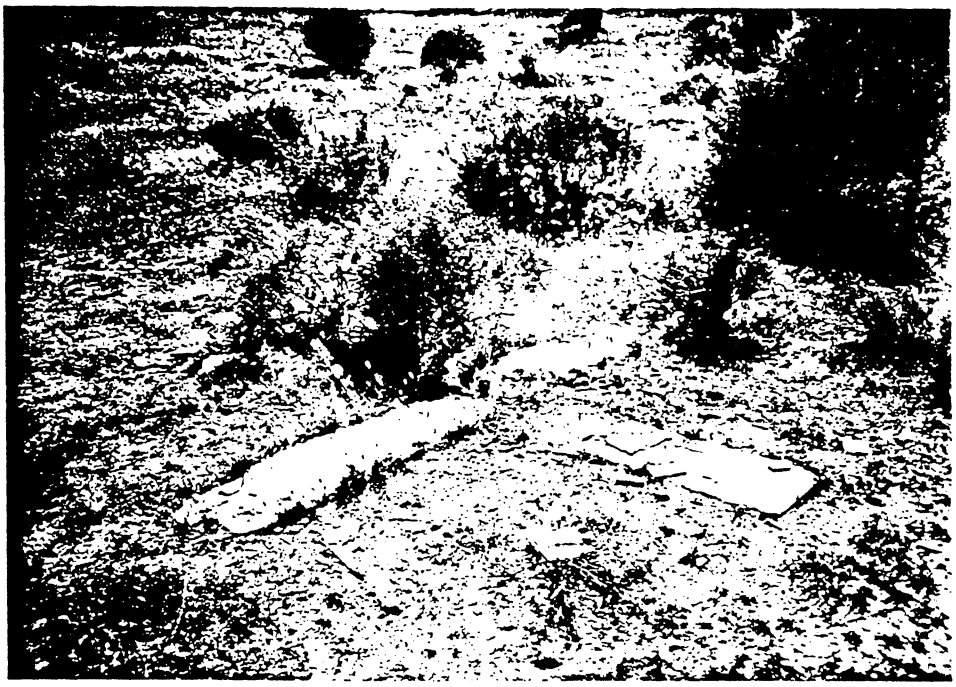
APPENDIX E:

Photographic Record

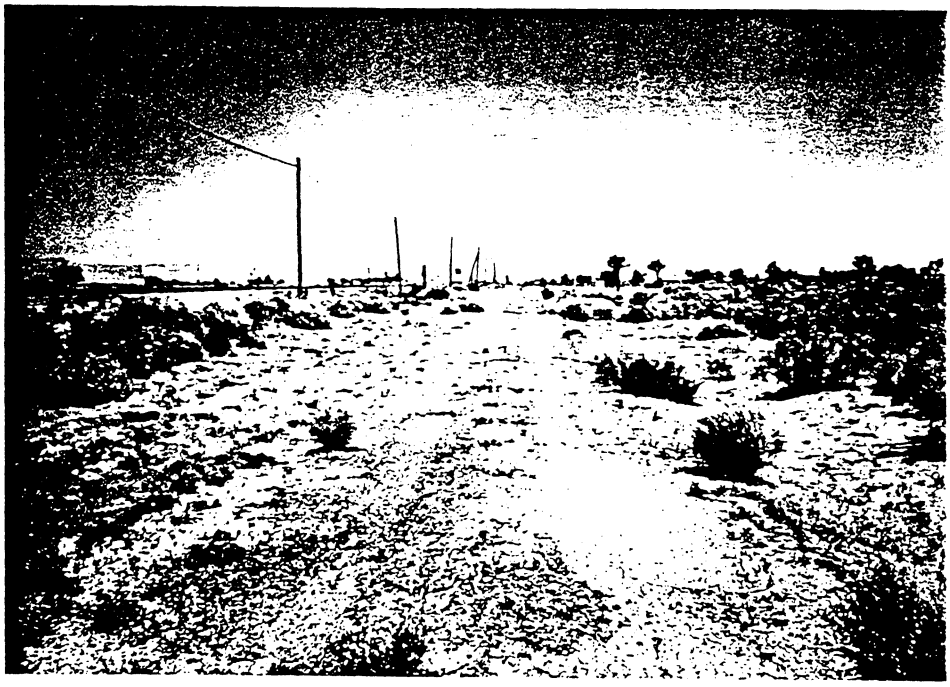
Photograph 1. Warning Sign on Fench in Southern Portion of Project Area.



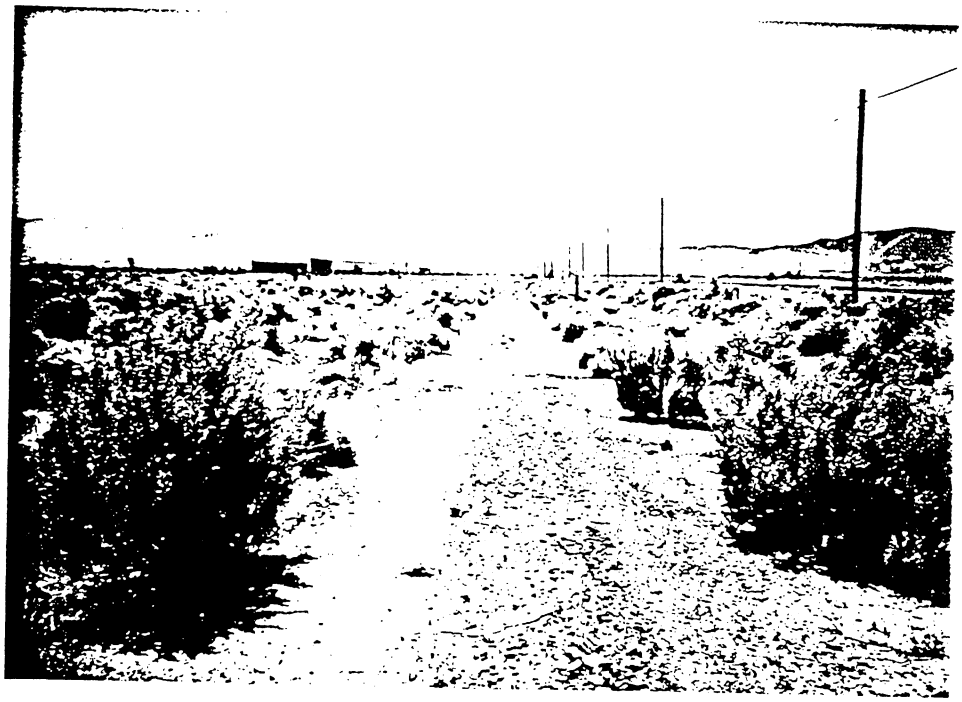
Photograph 2. Metal Disk Fixed to Ground Near Southern Boundary of Project Area - Possibly for Holding Flag or Marker.



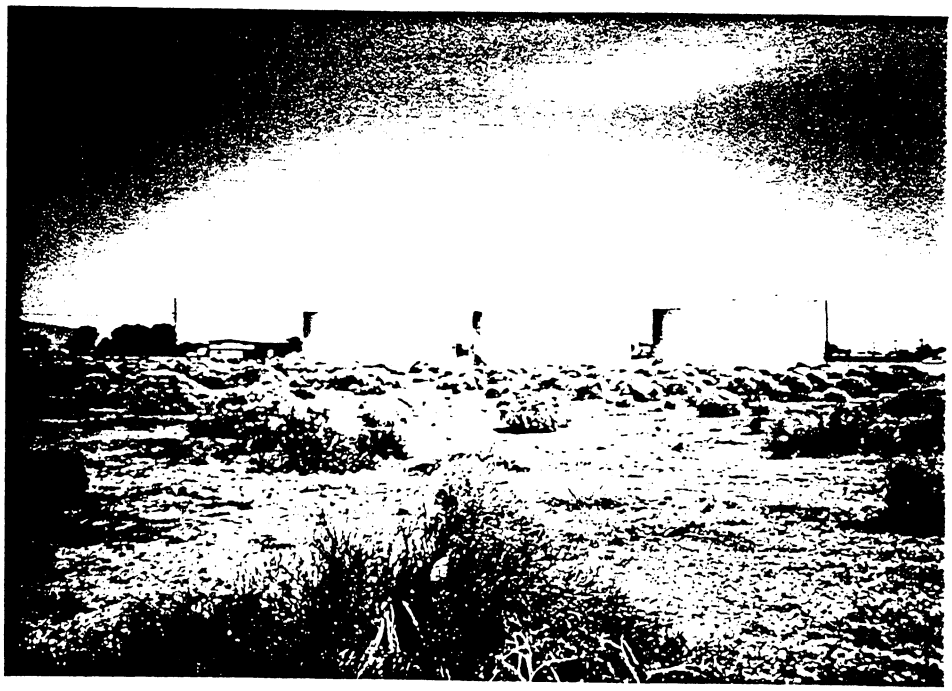
Photograph 3. Aerial Marker Noted in Southwestern Portion of Project Area.



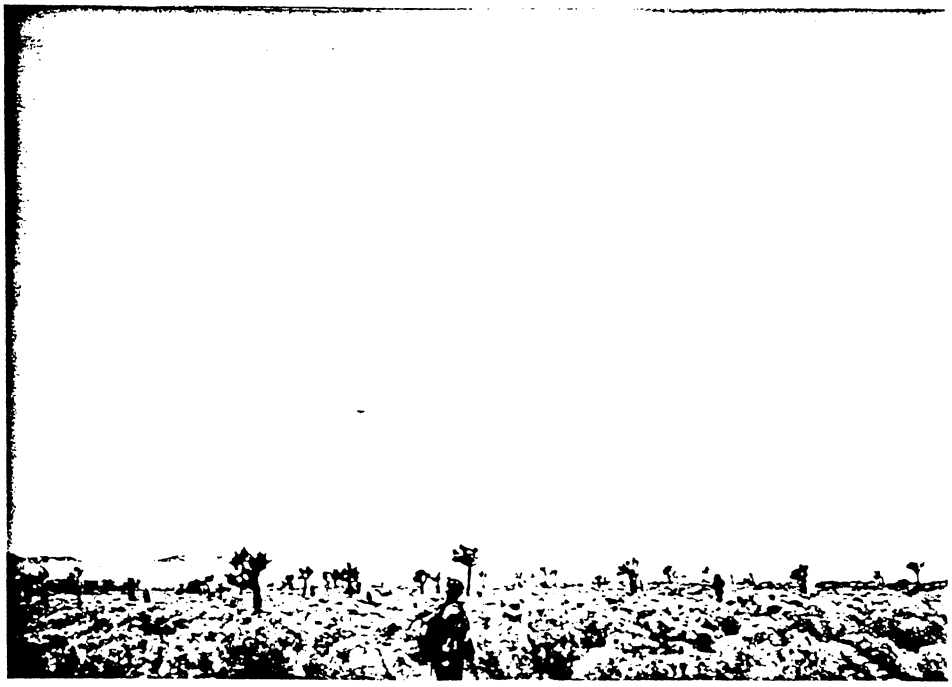
Photograph 4. General Overview of Access Road Located along Sierra Highway (Western Boundary); facing north/northwest.



Photograph 5. General Overview of Access Road Located along Sierra Highway (Western Boundary); facing south/southeast.



Photograph 6. Los Angeles County Tanks Located along Avenue M, facing north.



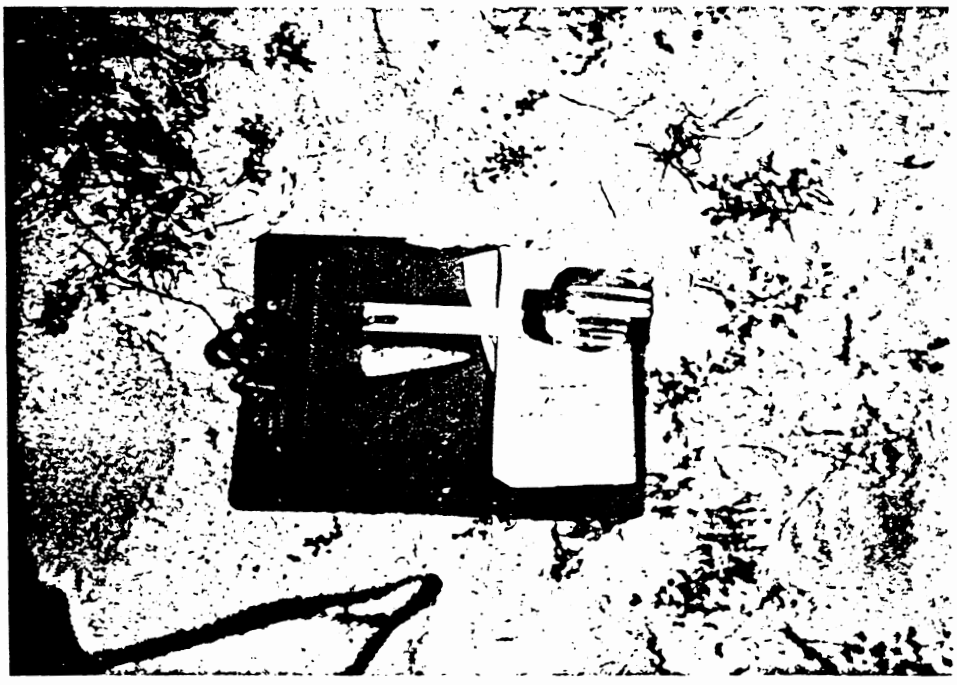
Photograph 7. General Overview of Project Area with Stealth Fighter in Air over Palmdale.

Photograph 8. Example of Modern Refuse Identified along East 10th Street Alignment (west of road).

Photograph 9. Concrete Foundation Identified in Southeast Quarter of Section 2 (facing southwest).

Photograph 10. View of Two Concrete Pads Identified as a Single Structure (Section 2).

Photograph 11. Anterior View of Isolate No. 1, Projectile Point (see Appendix D).



Photograph 12. Posterior View of Isolate No. 1, Projectile Point (see Appendix D).

Photograph 13. General View of Isolate No. 2, Small Scraper (picture blurred; see Appendix D).

APPENDIX D

AIR QUALITY TECHNICAL REPORT

TECHNICAL REPORT: AIR QUALITY

Existing Conditions

Regional Setting

The Palmdale Planning Area lies within the Southeast Desert Basin (SEDAB). The SEDAB, one of the largest air basins in California, encompasses portions of Los Angeles, Kern, San Bernardino, Riverside, and Imperial counties. Although the Antelope Valley is separated from the highly populated and highly urbanized South Coast Air Basin (SoCAB) by the San Gabriel Mountain Range, the Antelope Valley is often the recipient of ozone and related pollutants generated in the SoCAB. To control these pollutants, the project area falls within the jurisdiction of the South Coast Air Quality Management District (SCAQMD) with no distinction made between the two geographically separate and meteorologically unique air basins.

The SCAQMD has prepared an Air Quality Management Plan (AQMP) for the SoCAB to meet clean air standards. Since this plan was adopted in 1989, SCAQMD has applied the document to both the SoCAB and the SEDAB portions of the District. The provisions of the AQMP are applicable to Palmdale and the rest of the Antelope Valley.

The AQMP, last amended in 1991, contains "control measures" that are intended to improve air quality throughout the region. At the present time, the AQMP contains approximately 40 currently implementable, or Tier 1, control measures which affect local governments. These control measures range from eliminating leaf blowers to implementing trip reduction programs. Involvement by local government to implement these measures varies but may include providing enforcement of future district rules, adoption of ordinances, and modifications of local general plans.

The AQMP recognizes that there will be population and economic growth in the area and has recommended that air pollution control strategies take this into account. Downwind areas, such as Palmdale, should be allowed the same opportunities for relative growth as other areas in the two air basins. It is also assumed in the AQMP that equal control efforts will be exerted by all communities. The result of this approach is that all areas within the AQMP will need to achieve a higher level of emissions control if air quality standards are to be attained.

Climate. Climate and air quality are determined by the location, topography, and urbanization of an area. The climate of the southeast desert, as that of all Southern California, is governed by the strength and location of a semi-permanent, subtropical, high pressure cell over the Pacific Ocean. In general, the climate for the majority of the region is characterized by hot summers, cold winters, infrequent rainfall, active air movement, and very low relative humidities.

The pattern of mountains and valleys are primarily responsible for the wide variety of rainfall, temperatures, and localized winds that occur throughout the SEDAB region. Temperature variations have an important influence on basin wind flow, dispersion along mountain ridges, vertical mixing, and photochemistry. Precipitation is highly variable seasonally. Summers are often completely dry. In the winter, an occasional storm from the high latitudes sweeps across the

coast bringing rain or snow. Annual rainfall is lowest in the low desert regions, higher in the high desert and foothills, and highest in the mountains.

Air Quality Monitoring. The SCAQMD is responsible for monitoring air quality in the SEDAB. The closest and most representative monitoring station is located in the City of Lancaster, approximately five miles north of Palmdale. Air quality measurements taken at the station for the past 5 years are shown on Table 1.

Table 1
SUMMARY OF ANNUAL AIR QUALITY DATA
LANCASTER AIR QUALITY MONITORING STATION

	1989	1990	1991	1992	1993
Ozone (O_3)					
State Standard (1-hr avg. >0.09 ppm)					
Federal Standard (1-hr avg. >0.12 ppm)					
Maximum 1-hr ambient concentration (ppm)	0.21	0.15	0.14	0.17	0.16
# of days state standard exceeded	95	52	62	78	59
# of days federal standard exceeded	27	7	8	25	14
Carbon Monoxide (CO)					
State Standard (1-hr: 20 ppm; 8-hr: 9 ppm)					
National Standard (1-hr: 35 ppm; 8-hr: 9 ppm)					
Maximum concentration 1-hr/8-hr period	13/7.1	11/8.3	10/7.1	9/5.4	8/5.9
# of days state standard exceeded (1-hr/8-hr)	0/0	0/0	0/0	0/0	0/0
# of days national standard exceeded (1-hr/8-hr)	0/0	0/0	0/0	0/0	0/0
Nitrogen Dioxide (NO_3)					
State Standard (1 hr avg. >0.25 ppm)					
Federal Standard (0.0534 AAM in ppm)					
Maximum 1-hr ambient concentration	0.08	0.09	0.11	0.16	0.11
# of days state standard exceeded	0	0	0	0	0
% AAM above federal standard	0	0	0	0	0
Total Suspended Particulates (TSP)					
State Standard (24-hr avg. 150 ug/m^3)					
National Standard (24-hr avg. 260 ug/m^3)					
Maximum 24-hr concentration	154	217	NM	NA	NA
% samples state 24-hr standard exceeded	NA	NA	--	NA	NA
% samples national 24-hr standard exceeded	NA	NA	--	NA	NA
Suspended Particulates (PM10)					
State Standard (24-hr avg. 50 ug/m^3)					
National Standard (24-hr avg. 150 ug/m^3)					
Maximum 24-hr concentrations	110	342	780	68	70
% samples exceeding state 24-hr standard	45	38	19	5	9
% samples exceeding national 24-hr standard	0	3	5	0	0

AAM = annual arithmetic mean
ppm = parts per million
ug/m^3 = micrograms per cubic meter
NA = standard not applicable

Source: SCAQMD Annual Air Quality Monitoring Data 1987 through 1993, Vol's XIX - XXIII.

Ambient air quality is described in terms of compliance with state and national standards. Ambient air quality standards (AAQS) are levels of air pollutant concentrations, with an adequate margin of safety, considered safe to protect the public health and welfare. National AAQS were established by the EPA in 1971 for six pollutants, called criteria pollutants. States have the option to add other pollutants, require more stringent compliance, or include different exposure periods. California and National AAQS are listed in Table 2.

Table 2
AMBIENT AIR QUALITY STANDARDS

Air Pollutant	California Standard	----- National ----- Primary	Standard
Ozone	>0.09 ppm, 1-hr avg.[a]	>0.12 ppm, 1-hr avg.	0.12 ppm, 1-hr avg.
Carbon Monoxide	≥9.1 ppm, 8-hr avg. >20 ppm, 1-hr avg.	≥9.5 ppm, 8-hr avg. >35 ppm, 1-hr avg.	≥9.5 ppm, 8-hr avg.[b] >35 ppm, 1-hr avg.
Nitrogen Dioxide	>0.25 ppm, 1-hr avg.	0.053 ppm, annual avg.	0.053 ppm, annual avg.[c]
Sulfur Dioxide	≥0.05 ppm, 24-hr avg. with ≥0.10 ozone or with 24-hr TSP ≥100 ug/m^3	0.03 ppm, annual avg. >0.14 ppm, 24-hr avg.	>0.50 ppm, 3-hr avg.
Suspended Particulate Matter[d] (PM10)	>30 ug/m^3 annual geometric mean; >50 ug/m^3, 24-hr avg.	>150 ug/m^3, 24-hr avg.; >50 ug/m^3 annual arithmetic mean	>150 ug/m^3, 24-hr avg., >50 ug/m^3 annual arithmetic mean
Sulfates	≥25 ug/m^3, 24-hr avg.[e]	none	
Lead	≥1.5 ug/m^3, 24-hr avg.	>1.5 ug/m^3, calendar quarter	>1.5 ug/m^3
Hydrogen Sulfide	≥0.03 ppm, 1-hr avg.	none	
Vinyl Chloride	≥0.010 ppm, 24-hr avg.	none	
Visibility-Reducing Particles	Insufficient amount to reduce prevailing visibility to less than 10 miles at relative humidity less than 70%, 1 observation	none	

[a] Effective 3/9/87. The standard was previously ≥0.10 ppm, 1-hr avg.
[b] Effective 9/13/85. The standard changed from ≥9.3 ppm to ≥9.5 ppm
[c] Effective 7/1/85. The standard changed from >.0532 ppm to >.0534 ppm
[d] Effective 7/1/87. The standards were previously:
Primary: Annual geometric mean TSP >75 ug/m^3 and 24-hr avg. TSP >260 ug/m^3
Secondary: Annual geometric mean TSP >60 ug/m^3 and 24-hr avg. TSP >150 ug/m^3
[e] Effective 3/9/87. The standard changed from ≥25 ppm to >25 ppm

Note: ppm = parts per million by volume; ug/m^3 = micrograms per cubic meter; > = greater than; ≥ = greater than or equal to; TSP - total suspended particulates

Source: South Coast Air Quality Management District 1991

Attainment Status. The California Air Resources Board (CARB) is required to designate areas of the state as attainment, nonattainment, or unclassified for any state standard. An attainment designation for an area signifies that pollutant concentrations did not violate the standard for that pollutant in that area. A nonattainment designation indicates that a pollutant concentration violated the standard at least once, excluding those violations caused by an exceptional event.

The air pollutants of concern in the SEDAB are ozone and particulate matter less than 10 microns in diameter, or PM10. Carbon monoxide, sulfur dioxide, nitrogen dioxide, and lead levels are all below state and national AAQS. A brief discussion of ozone and PM10 and the levels at which they occur in the SEDAB is provided in the following paragraphs.

Ozone. The SEDAB is designated as a nonattainment area for the state and national ozone standard. Levels of ozone have exceeded the state standard an average of 84 days per year over the past 5 years at the Lancaster station. In 1991, ozone levels exceeded the state standard on 62 days. Because ozone formation is the result of photochemical reactions between nitrogen oxides (NOx) and reactive organic gases (ROG), peak concentrations of ozone occur downwind of precursor emission sources. Ozone levels in areas that lie at the base of the San Gabriel and San Bernardino Mountains are among the highest in the United States. When temperatures are hot enough to break the inversion layer, these mountains funnel ozone from the highly urbanized SoCAB up their sides and into the SEDAB.

PM10. Particulate matter (PM) is composed of finely divided solids or liquids such as dust, soot, aerosols, fumes, and mists. In 1987 the EPA replaced the total suspended particulate standard with the new PM10 standard, which includes only smaller PM (10 microns or less in diameter) that are capable of penetrating the lungs. Since adoption of the standard, the SEDAB has been designated in nonattainment. PM10 concentrations at the Lancaster station have exceeded the state standard in approximately 33 percent of the samples taken over the past 3 years.

Meteorological Influences on Air Quality

The SEDAB is characterized by frequent and consistent daytime winds. The lack of vegetation allows active air movement much closer to the ground than is typical in more humid climates where there is more vegetative cover. In addition, most of the SEDAB is comprised of sweeping valleys that, despite the presence of bordering mountain ranges, facilitate pollutant dispersal.

Temperature and availability of sunlight influence air pollutant concentration and formation of secondary pollutants. Conditions that favor ozone formation (e.g., adequate sunshine, early morning stagnation in source areas, high surface temperatures, strong and low morning inversion, restricted daytime vertical mixing, daytime subsidence) are commonly present during the summer months. Ozone is frequently transported during the formation process, resulting in high ozone concentrations downwind from ozone precursor sources.

Local Setting

The City of Palmdale lies just north of the Transverse Mountain ranges in an area of the high desert known as Antelope Valley. Palmdale is situated near the edge of a large, flat-floored valley basin with average elevations of 2,450 to 2,700 feet above mean sea level. There are no current major

stationary sources of air contaminants, such as large polluting facilities (i.e., power plants, factories etc.). Residential, commercial, and industrial developments which comprise a large portion of the valley are typically concentrated near the town centers. Traffic on Highway 14 and along the City's main roads are the major mobile emission sources in the area.

Climate is characterized by summer days that are much warmer than those experienced by the areas on the coastal side of the Transverse Range. The Palmdale area is also much cooler in the winter than the marine or semi-marine climates due to the draining effect of the sloping land. Annual average daytime temperatures range from 97.7°F in summer to 58.6°F in winter. Low temperatures average 65°F in summer to 31.9°F in winter. During calm, clear winter nights, the basins and valleys of the desert receive the cool air that drains from the surrounding higher slopes resulting in the occasional layer of frost on winter mornings.

Average annual precipitation in the Palmdale area is 5.15 inches and occurs almost exclusively from November through early April. The area receives more rain than the low desert but significantly less than the nearby foothills and mountain areas. The Antelope Valley is an area of high winds with prevailing flows from the southwest. Average daytime maximum speeds are approximately 14 mph in the summer and 9.5 mph during winter months. The general flow is interrupted by occasional winter storms and Santa Ana winds.

Project Impacts

Air quality impacts from the proposed project will include short-term construction impacts as well as stationary and mobile source emissions that will result from the development and operation of the proposed project. The air quality analysis is based on the information and methodologies contained in the South Coast Air Quality Management District Final CEQA Handbook.

Construction Impacts

Three main types of construction-related air quality impacts are expected to result form the proposed project. They include: (1) mobile source emissions from construction workers travel; (2) PM10 emissions due to grading and materials hauling; and (3) onsite construction equipment emissions.

Given the magnitude of the proposed project detailed information on construction equipment and number of construction workers was not available. It was not possible, therefore, to utilize the detailed tables that are contained in Appendix 9 of the CEQA Handbook. The screening tables in Chapter 9 of the Handbook were used in order to calculate the construction exhaust emissions from the development of the Palmdale Business Park Center Specific Plan. A 10-year construction period with an average of 261 days per year was assumed for the project. The construction exhaust emissions from the 27-hole golf course and related facilities were not calculated since a category for such user is not included in the screening tables. As a result the construction emissions are likely to be somewhat higher than what is presented in the following analysis.

Construction exhaust emissions for the Palmdale Business Center Specific Plan are presented in Table 3. Construction workers travel includes worktrips by construction workers, site visits by building inspectors, and project management personnel as well as non-work trips associated with

lunches, deliveries and miscellaneous activities. The second group of construction exhaust emissions were for material hauling vehicles. This includes the hauling of materials to and from the construction site. The final category of construction exhaust emissions for onsite construction equipment. This includes equipment such as bulldozers, graders, scrapers, loaders, and forklifts. Significant construction impacts are expected to result from NOx. The significance threshold for the pollutant is exceeded by a wide margin (995 pounds per day).

Table 3
CONSTRUCTION EXHAUST EMISSIONS

Development Scenario ('000 square feet)[1]	
Community Commercial	645.9
Airport Related	1,743.2
Business Park	342.2
Light Industrial	2,545.3
Total	5,276.6

Source Category	ROC	NOx	CO	PM10[2]
Construction Workers Travel	.0012	.0010	0.0148	0.0001
Material Hauling Vehicles	10.64	156.32	34.0	11.1
Construction Equipment Operation	63.09	938.98	204.09	66.68
Total	74.53	1,095.30	238.19	3,542.78
Threshold Values	75.0	100.00	550.0	150.0
Significant	No	Yes	No	Yes

Notes: [1] Exhaust emissions from golf course construction not included.
[2] Includes PM10 from fugitive dust.

PM10 emissions for grading activities were estimated by assuming that grading would take place over the 10-year development period and that no more than 10 percent of the project site would be graded at any one time. According to the SCAQMD CEQA Handbook, 55 pounds per day/acre of PM10 are generated for each day of grading activity. If 63 acres of the project site were graded at the same time, it would result in a total of 3,465 pounds of PM10 being generated. This would cause the PM10 significance criteria to be exceeded.

The proposed project (at buildout) is expected to generate 74.53 pounds per day of ROC, 1,095.30 pounds per day of NOx, 238.19 pounds per day of CO, and 3,542.78 pounds per day of PM10.

Significant emissions (see Table 3) during the construction phase of the proposed project would occur for both NOx and PM10.

Operational Impacts

Air quality impacts during the operation of the proposed project are expected to result from stationary and mobile sources. The two main stationary source emissions from the proposed project are expected to result from consumption of electricity and natural gas as well as from industrial uses at the project site. Mobile source emissions are expected from employee, customer and delivery trips to and from the proposed project site.

Table 9-8 of the SCAQMD CEQA Handbook was utilized in order to estimate area source operation emissions from energy consumption that would result from the proposed project. Daily emissions from these sources are expected to total 1.32 pounds of ROC, 152.6 pounds of NOx, 26.5 pounds of CO, and 5.27 pounds of PM10. The unmitigated NOx emissions from these sources are significant (exceeds the significance criteria of 100 pounds per day).

The proposed Palmdale Business Park Center Specific Plan will contain a number of land uses (airport related and light industrial) that are expected to generate stationary source emissions. Due to the broad nature of proposed land uses and the lack of detailed information on the types of industries that would be locating within the Specific Plan area, it is not possible to estimate stationary source emissions at this time.

The most significant project related air quality impact is expected to result from the trips that will be made to and from the proposed business park center. According to the traffic study that was completed for the proposed project a total of 53,743 trips are expected to be generated by buildout in the year 2021. The proposed project is expected to generate 4,489 trips during the AM peak and 6,430 trips during the PM peak.

The proposed project is expected to reach full buildout by the year 2021. The SCAQMD CEQA Handbook, however, only provides estimate of trip lengths, average speeds and emission tables through the year 2010. The year 2010 was therefore used as the forecast year for the air quality analysis. This is likely to be a worst-case scenario since conditions are expected to improve after the year 2010 especially due to expected technological improvements.

The next step in the analysis of mobile source emissions was to determine the split between work and non-work trips in order to estimate vehicle miles traveled. Table A9-5-C in the CEQA Air Quality Handbook was utilized in order to determine the split. Based on this information by the year 2010, 38.88 percent of all trips would be work trips while the remaining 61.12 percent would be non-work trips. In order to determine vehicle miles traveled it was necessary to multiply the number of work and non-work trips times the average length of that particular type of trip. According to Table A9-5-D, the average trip length for work trips in Los Angeles County in 2010 is expected to be 10.8 miles. The average trip length for non-work trips for the same year is 6.3 miles. The total number of vehicle miles traveled (VMT) is then obtained by multiplying the number of work and non-work trips by the average trip length and adding them together. This calculation was done for each of the three time periods.

Once the VMT is obtained it is necessary to determine the average speed in order to calculate emissions. The average speed by county varies depending on the time of day. Table A9-5-F was utilized in order to determine average speeds for the AM peak, PM peak and offpeak hours. The

average speeds were 21 miles per hour for the AM peak, 15 miles per hour for the PM peak and 37 miles per hour for the offpeak hours.

Since the expected vehicle mix was not available from the traffic study, it was assumed that all vehicles would have a gross vehicle weight of 6,000 pounds or less. Table A9-5-J-10 was utilized in order to determine running exhaust and evaporative, cold start, hot start, hot soak and diurnal mobile source emissions from the proposed project. The table for calendar year 2009 was utilized since a table was not available for the year 2010. Since the speed categories are divided into five mile per hour increments the speeds were rounded either up or down for the purposes of calculating emissions. The analysis utilized temperature area 2 for Los Angeles County in order to calculate emissions. Different travel periods were utilized for particular criteria pollutants. The AM peak period was utilized to calculate CO and NOx emissions, the PM peak for PM10 and offpeak periods for ROC.

The number of vehicle miles traveled for a particular year are multiplied by the emission factor in grams per mile (at a particular vehicle speed) in order to determine daily emissions. The result which is expressed in grams per day is then divided by 454 in order to determine the pounds per day of that particular criteria pollutant. These totals represent the running exhaust and evaporative emissions that can be expected from the proposed project. Cold start, hot start and hot soak emissions are based on the number of trips during each of the travel periods. Diurnal emissions were calculated separately based on the number of vehicles.

The total mobile source emissions for the proposed project are presented in Table 4. At full development the proposed project is expected to generate 727.2 pounds of CO, 40.8 pounds of NOx, 268.2 pounds of ROC and 12.0 pounds of PM10 on a daily basis. Of the four criteria pollutants, the proposed project would exceed the significance threshold for both CO and ROC. Even with the application of a number of mitigation measures identified in Section 4.10.3, the mobile source air quality impacts of the proposed project will remain above the thresholds shown in the Air Quality Handbook.

Table 4
SUMMARY OF MOBILE SOURCE EMISSIONS FROM PROPOSED PROJECT

	Pollutant (lbs/day)			
2010	ROC	NOx	CO	PM10
Run. Ex. & Evap.	45.6	23.1	218.9	12.0
Cold Start	122.6	12.0	471.1	---
Hot Start	21.7	5.7	37.2	---
Hot Soak	27.4	---	---	---
Diurnal	50.9	---	---	---
TOTAL	268.2 (75)	40.8 (100)	727.2 (550)	12.0 (150)

Table 5 summarizes the air quality impacts that can be expected to occur as a result of the proposed project. During the construction phase of the proposed project significant air quality impacts are expected for both NOx and PM10. The significance thresholds for ROC, NOx and CO are expected to be exceeded during the operation of the proposed project. In order to reduce these impacts a number of mitigation measures will need to be implemented.

Table 5
SUMMARY OF CONSTRUCTION AND OPERATION EMISSIONS FROM PROPOSED PROJECT

	(lbs/day)			
	ROC	NOx	CO	PM10
Unmitigated Daily Construction Emissions				
• Material Hauling	10.64	156.32	34.0	11.1
• Construction Workers' Travel	.0012	.0010	.0148	.0001
• Construction Equipment	63.09	938.98	204.09	66.68
Fugitive Dust Emissions	N/A	N/A	N/A	3,465.0
Total Construction Emissions	74.53	1,095.30	238.19	3,542.78
Construction Significance Thresholds	75.0	100.0	550.0	150.0
Significant?	No	Yes	No	Yes
Unmitigated Daily Operation Emissions				
Exhaust Emissions	268.2	40.8	727.2	12.0
Stationary Sources (Area Source)	1.3	152.6	26.5	5.3
Total Operation Emissions				
Operation Significance Thresholds	75.0	100.0	550.0	150.0
Significant?	Yes	Yes	Yes	No

Mitigation Measures

A number of mitigation measures should be implemented in order to reduce net construction emissions to a less than significant level. In order to reduce PM10 emissions during grading of the project site, the following mitigation measures should be utilized:

- All active construction sites shall be watered twice daily.
- Groundcover in disturbed areas shall be replaced as quickly as possible.
- Enclose, cover, water twice daily, or apply non-toxic soil binders according to manufacturer specifications, to exposed piles (i.e., gravel, sand, dirt) with 5 percent or greater silt content.
- Non-toxic soil stabilizers shall be applied (according to manufacturer's specification) to all inactive construction areas (previously graded areas inactive for 10 days or more).

In order to reduce NOx emissions for construction equipment, the following mitigation measure shall be applied:

- Electricity from power poles shall be utilized rather than from temporary diesel power generators.

A number of mitigation measures will be required to be implemented in order to mitigate significant unmitigated emissions from stationary and mobile sources.

The following additional mitigation measures shall be implemented in order to reduce emissions from stationary sources during the operation of the proposed project:

- Walls and attic insulation shall meet Title 24 requirements.

- Light-colored roofing materials shall be utilized in order to reflect light.

A Transportation Demand Management (TDM) Plan shall be implemented for the Palmdale Business Park Center Specific Plan through the formation of Transportation Management Association District. The TDM Plan will include a number of components:

- Flexible work shifts through staggered work hours with employees starting and ending work at different times. Options include flextime where employees are required to be at work during a core period (e.g., 9:00 a.m. to 3:00 p.m.) as well as a 4-day work week with different employees off on different days.

- Measures to increase carpooling/vanpooling, such as rideshare registration, personalized distribution of carpool, passes, matching promotions, and vanpool incentives.

- Transit subsidies would be required to encourage employees to use public transit. The employer would either purchase the transit pass for the employee or provide a Transit check.

- Employers would be required to adopt parking restrictions in order to discourage employees from using their cars to get to work. Parking restrictions could include charging employees for parking, limiting the number of available parking spaces, and providing parking closer to the buildings for carpools and vanpools.

- A fifth TDM measure would be for employers to allow employees to work either at home or at remote work sites. The employee would be given a computer and modem and be able to do some of his work at home. Satellite work centers could also be established closer to the employees home. The intent of this measure is to reduce the number of days that the employee needs to go into the office.

APPENDIX E

NOISE STUDY TECHNICAL REPORT

TECHNICAL REPORT: NOISE

Existing Conditions

Background

Noise is most often simply defined as unwanted sound. When sufficiently loud, noise may interfere with normal activities such as sleep, work and speech. It can also cause annoyance, hearing damage, and other physiological and even psychological problems. Generally, effects of noise are related to its perceived loudness which in turn is a function of the sound pressure level (SPL), the frequency content of the sound, and the duration of exposure.

Sound is simply mechanical energy generated by a source, or sources, which is then propagated through a flexible medium, such as air, in the form of small waves of minute air pressure fluctuations. These pressure fluctuations or differentials, if large enough, can be detected by a receiver and are the basis for the measurement of sound.

The pressure fluctuations or SPL is measured in decibels (dB), a logarithmic scale referenced to the faintest sound pressure (20 micronewtons per square meter) detectable by the human ear. The logarithmic decibel scale is necessary due to the large spread in sound pressures and how it is perceived by the human ear. Sound pressure levels (in dB) are calculated using the following relationship:

$$SPL = 20 \log_{10} (p/p_o) \text{ dB re } p_o$$

where the reference pressure $(p_{o)} = 2 \times 10^{-5} \text{ N/m}^2$

Therefore, SPL is a measure of sound relative to the reference pressure. Since SPLs are logarithmic units they cannot be added algebraically.

The perceived loudness of sounds is also related to its frequency. Frequency, expressed in cycles per second, or units known as Hertz (Hz), is a measure of how often the air is alternately compressed and rarefied by the sound. The ear is most sensitive to sounds with frequencies around 4,000 Hz. Sensitivity diminishes at lower and higher frequencies, particularly at frequencies below 500 Hz. Sound level meters have been designed to account for the dependence of perceived loudness upon frequency, and are constructed with weighting circuits, or filters. The A-weighting filter is most commonly used to measure environmental noise. Measurements are reported in units of A-weighted decibels, expressed as dBA (dB representing the absolute value of the sound and A the weighting or correlation factor).

Several community noise exposure rating methods, or noise metrics, have been established for assessing the potential impact of an intruding noise source. The day-night average sound level (Ldn), developed and adopted by the EPA, is the metric preferred by federal agencies, and is used by the Department of Defense in describing noise exposure in the vicinity of military air bases, and the Federal Aviation Authority in describing the noise environment around airports. The Ldn is the average 24-hour sound level (i.e. the average of hourly equivalent sound levels [Leq's] over a one day or 24-hour period) with a nighttime correction or penalty of 10 dB applied to noise measured

between 2200 and 0700 hours (10:00 p.m. to 7:00 a.m.) to account for the increased nighttime sensitivity to noise.

A similar noise metric, the community noise equivalent level (CNEL), developed for California Airport Noise Standards, uses the same nighttime weighting as the Ldn but adds an additional penalty of 5 dB to noise measured during the time period from 1900 to 2200 hours (7:00 p.m. - 10:00 p.m.). CNEL is the metric used by the City of Palmdale to characterize and compare noise environments and to assess potential noise impacts. The CNEL and Ldn are not actual measurements but a computation of measured sound levels averaged over a 24-hour period. Consequently, periodic, or short-term, high noise level events may be obscured by these metrics. Numerically, the two metrics are equal for most community noise environments, often within 1 dB.

Regulatory Setting

Federal Statutes and Guidelines. The Noise Control Act of 1972 (P.L. 92-574) provides noise-level guidelines, developed by the EPA, to protect public health and welfare with a sufficient margin of safety. The guidelines provide a basis for the states and other political subdivisions to establish and enforce noise regulations and land use policies.

Air Force Regulations and Guidelines. Air Force Air Installation Compatible Use Zone (AICUZ) Program. The program is designed to provide updated information on flight operations at Air Force bases and, by incorporating federal and state noise standards, develop compatible land use and zoning guidelines to assist local community planning efforts in dealing with the impacts of base operations.

State Statutes and Regulations. Noise Compatibility Guidelines of 1976. The State Department of Health Services' Office of Noise Control developed noise compatibility guidelines for various land uses (see Table 3.11-1). An Ldn, or CNEL, criterion of 65 dB for outdoor levels, has been adopted by federal and most state and local agencies as the upper limit of acceptable noise in residential communities. The Department of Housing and Urban Development (HUD) has adopted an Ldn level of 65 dB as the upper limit of acceptable aircraft and non-aircraft noise with regard to residential development and funding for community planning. Current Air Force guidelines, in their AICUZ programs, recommend a 65 dB Ldn as the upper limit for residential development unless special noise insulation features are incorporated in buildings. The California Airport Noise Standards prescribe a CNEL criterion of 65 dB in defining noise impact areas about airports. The most common criteria for determining acceptable indoor noise in residential communities is an Ldn or CNEL value of 45 dB. In addition, California Noise Insulation Standards (Title 25 California Code of Regulations, Chapter 1, Subchapter 1, Article 4) require that indoor noise levels in residential areas do not exceed a CNEL of 45 dB.

City of Palmdale General Plan: Draft Noise Element. The City's Draft Noise Element, in accordance with section 65302(f) of the California Government Code, includes a discussion of noise and its impacts, identifies noise-sensitive land uses and noise sources, and provides guidelines such as the State Office of Noise Control's Recommended Acceptable Noise Guidelines for making land use decisions. The guidelines are included as Table 3.11-1. The Draft Noise Element also provides policies and guidelines to: achieve noise compatibility among adjacent land uses, and protect and maintain areas having acceptable noise environments; develop a City noise ordinance; govern land

Table 3.11-1

STATE RECOMMENDED NOISE LEVEL GUIDELINES

(Adapted from City of Palmdale General Plan Noise Element, Table N-1)

use within the 65 CNEL contour line of USAF Plant 42; and ensure compliance with California's Noise Insulation Standards (e.g., acoustical analysis reports).

Airport Land Use Commission. The City shall support the Airport Land Use Commission of Los Angeles County in planning for appropriate land uses around USAF Plant 42 through consistency of the City General Plan and the County's Comprehensive Airport Land Use Plan.

Noise Sensitive Land Uses. The City will coordinate with appropriate agencies and developers to reduce unnecessary noise in the vicinity of noise-sensitive locations, including maintaining liaison with: transportation agencies in the design, location and attenuation of noise levels from existing and planned facilities and roadways; and the Southern Pacific Railroad line to reduce noise levels generated by train movement within the City.

Noise Sources and Receptors. The City will maintain a map identifying receptors and sources for new development in order to anticipate and/or avoid incompatible land uses. Acoustical analysis reports will be required to incorporate the receptor and source map in the report.

Acoustical Design. The City will require developments to implement noise control measures during construction. Acoustical design shall include measures to control noise at the source, along the transmission path or at the receptor.

Existing Noise Environment

The existing noise environment within the City of Palmdale is primarily a reflection of the effects of the major noise sources, including roadway traffic, railroad operations, aircraft operations and overflights, as well as stationary sources typically found in most urban communities.

In an effort to more clearly characterize and define the noise environment in the City Planning Area, the City conducted a community noise survey and developed noise contours (Palmdale 1992a). The noise survey characterized and identified existing noise levels at specific locations within the City and surrounding the Project site. The noise contour analysis provided a means to visually delineate the areas affected by transportation-related noise generators (e.g., major roadways, Southern Pacific Railroad lines, and aircraft operations at USAF Plant 42). The analysis provided an estimate of existing and future transportation-related noise levels using prediction models and computer-generated CNEL noise contours (City of Palmdale 1992b).

A total of 12 measurement sites were used during the survey. The sites were assumed to be representative of four general land use categories: residential, commercial, public use (park and school), and undeveloped property. Based on the results of the noise survey, the following noise levels are expected to be representative of the noise environment for existing land uses at and surrounding the Project site.

- Residential Land Uses. The only residential areas surrounding the Project site or potentially affected by principal access routes are located within the City of Lancaster in an area west of Challenger Way (10th Street north of Avenue M). Land uses in this area include scattered commercial and industrial developments and rural single family residences. Based on the City's 1987 community noise survey (Palmdale

1992a) taken at 12 representative residential sites, median noise levels (L50, or noise levels exceeded 50% of the time) are expected to range between 55.5 and 63.0 dBA; background levels (L90, or levels exceeded 90% of the time) between 45.5 and 59.5 dBA; and peak noise levels (L10) between 64.5 and 69.0 dBA. The levels reflect noise generated by truck traffic along major roadways and aircraft fly-overs and landings at USAF Plant 42.

- Commercial Locations. As discussed above, commercial land uses near the Project site are limited to areas to the northwest in the City of Lancaster. The median noise levels (L50) are expected to be between 59.5 and 63.5 dBA, background levels (L90) of 55 dBA, and peak noise levels (L10) from 66 to 73 dBA.

- Undeveloped Locations. The area north and east of the site consists primarily of undeveloped land which the City's General Plan designates as industrial. The median noise levels (L50) measured at undeveloped property locations ranged between 60.5 and 68.5 dBA depending upon their proximity to major noise sources. Background levels (L90) were from 53.5 to 62 dBA, with peak levels (L10) between 64.5 and 85.5 dBA. The peak noise level of 85.5 dBA reflects noise generated by numerous aircraft approaches and landings which occurred during the measurement period at locations near the primary runway at USAF Plant 42. The existing noise levels would be considered normally acceptable for industrial and commercial land uses, but only conditionally acceptable for most noise sensitive land uses (see Table 3.11-1).

The noise measurements recorded during the noise survey are considered fairly indicative of the existing range of noise levels within and surrounding the proposed Project site. The maximum noise levels (Lmax) ranged from 53.5 to 99.0 dBA with the highest levels recorded during a locomotive pass-by (99 dBA) and aircraft operations (92 - 95 dBA). Aircraft noise was recorded at half of the 12 measurement locations during the noise survey. Railroad noise was characterized by its long duration with some pass-bys taking several minutes for trains carrying as many as 100 rail cars with noise levels ranging from 64 dBA to 73 dBA for the cars. Disregarding the effect of a number of aircraft approaches at one of the locations, peak noise levels were between 63 and 75.5 dBA, and median noise levels between 55.5 and 68.5 dBA.

The noise from aircraft operations appears to be the primary noise source affecting most parts of the City as well as the Project site. The effects of traffic noise were not nearly as pronounced. The noise levels recorded 150 feet from Sierra Highway ranged from 68 to 74 dBA. Truck traffic noise levels recorded along some arterials ranged from 68 to 72 dBA at 150 feet.

Noise Sensitive Land Uses. Noise sensitive land uses as defined in the Draft Noise Element of Palmdale General Plan are those land uses that are...

> "...particularly susceptible to noise intrusions because of the nature of the use being made of the land, the expectation of the occupants regarding an appropriate noise environment, and because of the fact that, in most cases, these uses involve long-term exposure to the noise environment affecting the property. In other words, residential uses (both single-family and multi-family) involve situations where the

residents have an expectation that their daily lives will not be exposed to excessive noise levels which interfere with normal residential activities... and the ability to sleep uninterrupted by outside noise sources."

These considerations are not limited to residential uses, but also apply to land uses such as nursing homes, convalescent hospitals or other long-term medical care facilities. In addition, schools, libraries, and churches are also typically considered noise sensitive uses because external noise is considered inconsistent with the intended use of the facilities and the reasonable expectation on the part of the users that these facilities are free from excessive interruption or interference by external noise sources.

There are no existing noise sensitive land uses near, or potentially affected, by the Project site. The closest residential areas, as discussed above, are located within the City of Lancaster, north of Avenue M in an area west of Challenger Way (10th Street). Other single- and multi-family residential areas are located south of Avenue Q, bordering Avenue R, and near the intersection of Sierra Highway and Palmdale Boulevard.

Noise Sources. The noise sources affecting the Project site and surrounding areas are transportation-related, principally aircraft operations (i.e., Air Force Plant 42), Southern Pacific Railroad (Valley Mainline), Sierra Highway, and several other arterials and roadways that will ultimately comprise the Project site's primary access routes. Time-averaged, day-night (i.e., CNEL) noise contour lines for transportation noise sources are presented in Figure 3.11-1. The noise contours provide a estimate of existing sound levels, but may overestimate the exposure since the contours do not reflect potential noise reduction, or attenuation, due to barriers or other structures near the sources. The transportation sources in the vicinity of the Project site are discussed in the following paragraphs.

Southern Pacific Railroad. The noise levels of the Valley Mainline and Sierra Highway generate a combined CNEL of 60 dBA that extends approximately 1,800 feet from their center. Much of the western section of the Project site south of Avenue M lies within this combined 60 dBA CNEL contour line (see Figure 3.11-1). Railroad noise levels were calculated using the U.S Department of Housing and Urban Development Noise Assessment guidelines. The assumptions used in the calculations are presented in the General Plan's Draft Noise Element (Palmdale 1992a) and the Draft Program DEIR for the General Plan (Palmdale 1992b).

Major Roadways. Table 3.11-2 provides a summary of traffic-related noise levels along the principal roadways near the Project site and/or potentially impacted by the Project. Traffic noise levels were computed using the Federal Highway Administration (FHWA) Highway Noise Prediction Model (FHWA RD-77-108). The FHWA model input parameters include traffic volumes, vehicle mix, vehicle speed, and roadway geometry. Caltrans' vehicle reference energy levels for automobiles, medium and heavy trucks were used in the computations.

Traffic volumes were based on the weekday peak period (morning or evening) traffic counts collected October, 1992 by DKS (1994). The vehicle mix, considered typical of Southern California roadways, consisted of 97.4% automobiles, 1.84% medium trucks, and 0.8% heavy

Figure 3.11-1

EXISTING TRANSPORTATION NOISE CONTOURS

(Adapted from City of Palmdale General Plan Noise Element, Exhibit N-4)

Table 3.11-2
ROADWAY TRAFFIC NOISE LEVELS EXISTING CONDITIONS[1]

Roadway	Existing Traffic Geometrics		Peak Hour Volume[2]	CNEL Contour Line[3] (@ 100 feet) (dBA)	CNEL Contour Line[4] (feet)		
	Lanes	Speed Limit			70 dBA	65 dBA	60 dBA
North - South Roadways							
Sierra Highway							
North of Avenue L	4	50	1980	66	25	120	400
South of Avenue L	4	50	1636	65	20	90	330
North of Avenue M	4	50	1927	65	20	105	300
South of Avenue M	4	50	2402	66	30	150	480
North of Avenue N	4	50	2382	66	30	150	480
South of Avenue N	4	50	2525	66	40	160	500
4th Street East							
North of Avenue M	2	40	262	55	--	1	20
South of Avenue M	2	40	0	--	--	--	--
6th Street East							
North of Avenue M	2	35	100	49	--	--	1
South of Avenue M	2	35	0	--	--	--	--
10th Street East							
North of Avenue L	2	50	735	58	1	40	150
South of Avenue L	2	50	752	62	10	40	150
North of Avenue M	2	50	761	62	10	40	150
South of Avenue M	2	50	0	--	--	--	--

Roadway	Existing Traffic Geometrics		Peak Hour Volume[2]	CNEL Contour Line[3] (@ 100 feet) (dBA)	CNEL Contour Line[4] (feet)		
	Lanes	Speed Limit			70 dBA	65 dBA	60 dBA
15th Street East							
North of Avenue M	2	35	400	55	--	1	25
South of Avenue M	2	35	0	--	--	--	--
East - West Roadways							
Avenue L							
West of Sierra Hwy	4	50	728	61	1	30	150
East of Sierra Hwy	4	50	0	--	--	--	--
Avenue M							
West of Antelope Valley Hwy	2	50	718	61	5	35	140
East of Antelope Valley Hwy	4	50	1138	64	14	70	220
West of 10th Street W	4	50	1275	64	11	70	280
East of 10th Street W	4	50	1161	63	7	55	250
West of Sierra Hwy	4	50	1140	63	5	60	230
East of Sierra Hwy	4	50	1415	64	10	80	290
West of 4th Street E	4	50	1546	64	15	80	300
East of 4th Street E	4	50	1394	64	10	70	270
West of 6th Street E	4	50	800	62	3	30	150
East of 6th Street E	4	50	800	62	3	30	150
West of 10th Street E	4	50	1090	63	5	50	230
East of 10th Street E	4	50	345	58	--	5	50

Table 3.11-2, Continued, Page 3 of 3

Roadway	Existing Traffic Geometrics		Peak Hour Volume[2]	CNEL Contour Line[3] (@ 100 feet) (dBA)	CNEL Contour Line[4] (feet)		
	Lanes	Speed Limit			70 dBA	65 dBA	60 dBA
West of 20th Street E	2	50	328	58	--	5	50
East of 20th Street E	2	50	104	53	--	--	3
Avenue N							
West of Sierra Hwy	2	50	419	59	1	20	80

Notes:
[1] Computed traffic noise levels using the Federal Highway Administration (FHWA) Highway Noise Prediction Model (FHWA-RD-77-108); and Caltrans' vehicle reference energy levels for automobiles, medium and heavy trucks.

[2] Weekday peak period (morning or evening) traffic counts collected October, 1992 (DKS 1994).

[3] Contour lines measured 100 feet from near edge of the roadway.

[4] Contour lines measured from near edge of roadway.

trucks. Vehicle speed and roadway geometry were based on existing geometrics (roadway speed limits and number of lanes).

Site-specific information on the nature and types of noise attenuating conditions/structures (e.g., flat and soft surfaces, buildings, walls, berms) was not available and these parameters were not included in the modeling. Consequently, the model results reflect a "worst-case" or hard-site condition.

As shown in Table 3.11-2, the computed "worst-case" CNEL (average day-night noise levels) at 100 feet from the near edge of the roadway is generally below 65 dBA. There are no noise-sensitive land uses along these roadway segments, virtually all of the designated land uses are either commercial/manufacturing, industrial, or U.S. Air Force and related. Consequently, the computed traffic-related noise levels along the roadway segments are consistent with existing land uses.

Aircraft Noise (USAF Plant 42 and Palmdale Regional Airport). Figure 3.11-1 shows the noise contour lines for aircraft operations at Plant 42 and Palmdale Regional Airport. The contour lines, which reflect both aircraft operations and engine run-ups, were developed by the Department of the Air Force as part of the Air Installation Compatible Use Zone (AICUZ) program for military airfields and provided to the City of Palmdale as part of the Air Force Systems Command (AFSC) Master Plan AICUZ Map (USAF 1990).

The CNEL metric, as discussed above, represents the average equivalent A-weighted "adjusted" sound level during a 24-hour day, and may obscure periodic or short-term elevated noise levels. However, the CNEL metric provides a common measure for a variety of differing noise environments and is useful in comparing noise environments and indicating the potential degree of adverse noise impacts.

The noise contours presented in Figure 3.11-1 reflect existing aircraft operations (takeoffs and landings) and engine run-ups. The 80 dBA CNEL contour line does not currently extend beyond the Plant 42 boundary. The Project site is presently located outside of the 70 dBA CNEL, and only a small portion of the northern section of the site is exposed to noise levels exceeding 65 dBA.

Project Impacts

Potential impacts associated with the Project consist of (1) impacts on surrounding land uses, and community exposure to increased noise levels directly attributable to the activities of the businesses and industries within the Business Park Center; and (2) onsite impacts of the surrounding ambient noise environment on the Business Park Center patrons and businesses/industries.

Development of the Project will result in both short-term and long-term noise effects in the project area. Short-term effects are principally associated with construction activities. Long-term effects will result from increased vehicular traffic volumes generated by the project as well as onsite noise generated by daily operational activities of the various industrial and commercial businesses.

The principal noise sources affecting the site consist of aircraft operations at Air Force Plant 42, traffic generated noise from adjacent arterials and collector streets, and Southern Pacific railroad operations.

Impacts on Surrounding Land Uses

Construction Noise. Noise generated by construction operations would be short-term and affect only limited portions of the surrounding Project area during the course of the various phases of site development. Construction activities and equipment typically generate noise levels of 80-90 dBA at distances of 50 feet. Noise levels during construction would vary considerably depending upon on the location and nature of the activities but can be expected to range between 60-80 dBA at the site perimeters. Given the absence of any sensitive noise receptors in the immediate project area, construction noise is not considered a significant temporary impact. However, restricting construction activities to weekdays during daytime hours would limit disturbances on adjacent land uses and residential areas along Project access routes.

Project-Generated Traffic. As discussed in the Transportation Section, the Business Park Center, at buildout or following completion of the final phase (Phase 8) around the year 2021, is projected to generate approximately 53,700 daily vehicle trips, and about 4,500 trips and 6,400 trips during peak morning and evening peak hours. Many of the principal access routes are expected to be expanded and improved to accommodate not only the additional Project-related traffic but future traffic conditions at buildout of the City's General Plan. Project area land uses assumed in the City's General Plan are expected to generate approximately 61,800 daily vehicle trips, including 6,600 peak morning and 6,000 peak evening trips.

Existing and projected traffic noise levels were predicted using the Federal Highway Administration (FHWA) Highway Noise Prediction Model discussed above. Traffic volumes used in the model include Project-related traffic volumes, and background traffic volumes based on the City's Traffic Model adjusted for 2021 conditions. As was the case for the existing conditions, input parameters used in the model reflect worst-case or "hard-site" conditions.

Model results are presented in Table 3.11-3. As shown in the table, the CNEL at 100 feet from the near edge of the roadways along the major arterials (Sierra Highway, Avenue M, Avenue L) and 10th Street East, the principal north-south access route, is generally near 70 dBA. Average day-night noise levels (CNELs) within 100 feet of the near edge of other access routes and minor arterials in the vicinity of the Project site are projected to be well below a CNEL of 65 dBA. Since future noise-sensitive land uses are not anticipated along these roadways, and current designated land uses along these roadways are expected to remain unchanged, noise impacts resulting from increased project-related traffic are not considered significant.

Project-Generated Commercial Air Traffic. It is anticipated that the Business Park will generate a reasonable number of passenger trips but is not expected to significantly affect the number of daily flights within the a 15-year planning period.

Operational Noise. Potential onsite Business Park noise-generating activities are expected to include various pieces of mechanical equipment, trash pickup, truck deliveries, and varied activities associated with the proposed manufacturing, storage, and commercial enterprises.

Mechanical equipment such as air conditioning, refrigeration units, and automotive repair and car wash equipment not enclosed in buildings. These types of equipment can produce noise levels

Table 3.11-3
ROADWAY TRAFFIC NOISE LEVELS FUTURE CONDITIONS — PROJECT BUILDOUT (2021)[1]

Roadways	Existing Traffic Geometrics		Peak Hour Volume[2]	CNEL Contour Line[3] (@ 100 ft.) (dBA)	CNEL Contour Line[4] (feet)		
	Lanes	Speed Limit			70 dBA	65 dBA	60dBA
North - South Roadways							
Sierra Highway							
North of Avenue L	6	55	3221	68	60	250	850
South of Avenue L	6	55	3358	69	75	280	850
North of Avenue M	6	55	4537	70	100	350	1300
South of Avenue M	6	55	4902	70	100	380	1300
North of Avenue N	6	55	4890	70	100	380	1300
South of Avenue N	6	55	5087	70	100	380	1300
4th Street East							
North of Avenue M	2	40	1456	62	10	50	190
South of Avenue M	2	40	1567	63	10	50	190
6th Street East							
North of Avenue M	2	40	1103	61	3	30	130
South of Avenue M	2	40	1579	63	10	50	200
10th Street East							
North of Avenue L	6	55	5837	71	130	510	1700
South of Avenue L	6	55	6002	71	120	500	1600
North of Avenue M	6	55	1379	65	5	70	350
South of Avenue M	6	55	1117	64	1	20	300

Roadways	Existing Traffic Geometrics		Peak Hour Volume[2]	CNEL Contour Line[3] (@ 100 ft.) (dBA)	CNEL Contour Line[4] (feet)		
	Lanes	Speed Limit			70 dBA	65 dBA	60dBA
15th Street East							
North of Avenue M	4	35	371	55	--	--	1
South of Avenue M	4	35	189	51	--	--	1
East - West Roadways							
Avenue L							
West of Sierra Hwy	8	55	2927	68	45	200	200
East of Sierra Hwy	8	55	2718	67	45	200	800
Avenue M							
West of Antelope Valley Hwy	8	55	3880	69	80	320	1100
East of Antelope Valley Hwy	8	55	3982	69	80	320	1100
West of 10th Street W	8	55	2548	67	40	190	750
East of 10th Street W	8	55	2889	68	50	220	850
West of Sierra Hwy	8	55	2621	67	40	190	760
East of Sierra Hwy	8	55	4082	69	80	320	1050
West of 4th Street E	8	55	5802	71	130	500	1700
East of 4th Street E	8	55	4971	70	100	400	1400
West of 6th Street E	8	55	4552	70	100	370	1250
East of 6th Street E	8	55	3686	69	70	280	1100
West of 10th Street E	8	55	3454	68	60	250	890
East of 10th Street E	8	55	2552	67	40	180	720

Roadways	Existing Traffic Geometrics		Peak Hour Volume[2]	CNEL Contour Line[3] (@ 100 ft.) (dBA)	CNEL Contour Line[4] (feet)		
	Lanes	Speed Limit			70 dBA	65 dBA	60dBA
West of 20th Street E	8	55	3189	68	60	250	860
East of 20th Street E	8	55	1562	65	15	100	390
Avenue N							
West of Sierra Hwy	6	50	692	61	1	20	120

Notes:

[1] Computed traffic noise levels using the Federal Highway Administration (FHWA) Highway Noise Prediction Model (FHWA-RD-77-108). The FHWA model uses traffic volumes at buildout (Phase 8) of the Project site (circa 2021), vehicle mix, vehicle speed, and future roadway geometry. Caltrans' vehicle reference energy levels for automobiles, medium and heavy trucks were used in the computations. In the absence of information on the nature and types of site-specific noise attenuating conditions or structures (e.g., flat and soft surfaces, buildings, walls, berms), ultimately used at the site, these parameters were not included in the modeling. Consequently, the input parameters used in the modeling reflect worst-case or "hard-site" conditions.

[2] Estimated peak period (morning or evening) traffic volumes including Project-related traffic and background volumes estimated using the Palmdale Traffic Model for the year 2010 that were adjusted for 2021 conditions (DKS 1994).

[3] Contour lines located 100 feet from near edge of the roadway.

[4] Contour lines located from near edge of roadway.

which would be perceptible and potentially annoying to individuals within areas of the Business Park Center but would not be of sufficient intensity to impact areas outside its boundaries.

Noise generated by trash pickup and compacting vehicles can reach levels of 80 to 85 dBA at 50 feet for short durations. Since these activities are expected to be limited to screened (e.g., walls, berms, fences) rear areas, significant impacts to areas outside of the confines of the site are not anticipated.

Delivery trucks are expected to be a common noise source within the project site. Noise produced by idling delivery trucks commonly exceed noise levels of 75 to 80 dBA within 50 feet. Loading docks or staging areas are permitted only in rear and side lot areas of buildings, and are required to be set back and recessed, and screened from neighboring properties or streets.

The types of industrial and commercial uses planned for the project that constitute potential noise sources include: automotive/light truck repair, manufacturing and assembly, and storage and distribution. Any or all of these uses could result in noise levels that would be perceivable in areas outside of the site. However, since these uses would only be permitted within enclosed buildings and limited primarily to the industrial park along the northern and western boundaries of the site, impacts on surrounding land uses are not anticipated.

Onsite Impacts

The impacts of unacceptable onsite noise levels resulting from surrounding sources may (1) have adverse effects on the public who frequent the site; (2) reduce the productivity of workers and create an unpleasant workplace; and (3) cause financial hardships on tenants and property owners unable to attract customers or workers. The major surrounding noise sources affecting the site are discussed in the following paragraphs.

Southern Pacific Railroad. The noise levels of the Valley Mainline and Sierra Highway are projected to generate a combined CNEL of 65 dBA extending approximately 800 feet from their center. The western section of the Project site, mostly designated as golf course land use, is expected to be exposed to railroad/roadway noise levels exceeding 65 dBA (Palmdale 1992a; Palmdale 1992b). In addition, the anticipated 15 - 20 daily operations, consisting of 4 locomotives and 120 rail cars per train, could result in single noise events resulting in onsite exposures exceeding 75 dBA. Nevertheless, the anticipated average day-night (CNEL) noise levels generated by railroad operations are expected to be compatible with the proposed land uses identified in the Palmdale Business Park Center Specific Plan (David A. Price 1994) for the western quadrant of the site.

Roadway Traffic. Results of the traffic noise model presented in Table 3.11-3, indicate that the future CNEL at 100 feet from the near edge of major arterials (Sierra Highway, Avenue M, Avenue L) and the principal north-south access route (10th Street East) adjacent to the Project site are projected to be approximately 70 dBA. Although the CNEL along Sierra Highway is projected to increase, the increase will be overshadowed by the effect of railroad noise discussed above.

The CNELs within 100 feet of the near edge of other access routes and minor arterials near or surrounding the Project site are projected to be well below 65 dBA CNEL. Future noise levels

along these roadways are projected to increase as much as 10 dBA and will expose larger areas of the Project site to increased noise levels. However, noise levels are not expected to result in onsite noise levels exceeding 65 dBA CNEL due to intervening attenuation (e.g., barriers, buildings, landscaping, distance). Consequently, based on land uses in the Specific Plan Land Use Plan, the traffic-related noise levels are expected to be consistent with the proposed Business Park Center land uses, and traffic-related noise levels are not considered significant onsite impacts.

U.S. Air Force Plant 42. The Airport Commission of the Los Angeles County Division of Airports and the USAF reached a joint-use agreement allowing phased incremental increases with USAF approval up to a maximum of 400 commercial aircraft operations (takeoffs and landings) per day. However, the agreement is subject to environmental review and preparation of an EIR, as well as certification by the South Coast Air Quality Management District which may delay the expanded use. Currently 50 commercial flights/day are allowed to use use Plant 42 landing facilities under a Division of Airports agreement with USAF Plant 42.

The noise contours presented in Figure 3.11-2 reflect noise exposure resulting from 400 commercial operations, the maximum allowable number of operations. The contour lines are based on the AICUZ noise contours developed by the USAF for the AFSC Master Plan, as part of USAF participation in the local land use planning process (USAF 1990). As shown in the figure, except for a small segment in the northeast quadrant, all of the Project site is within the 75 dBA CNEL contour line. All of the southern margin and most of the western quadrant of the site is within the 80 dBA CNEL contour.

Consequently, the projected exterior noise levels at the site, particularly the southern and western areas of the site, would normally be considered unacceptable or incompatible with certain land uses, including: motels, hotels, schools, hospitals, nursing homes, playgrounds, parks, and golf courses; but not necessarily with land uses such as industrial, manufacturing, commercial, or office buildings (see Table 3.11-1).

However, the Noise Element of the City's General Plan makes allowances for certain land uses where: (1) the public is present only for limited periods of time and have a choice as to whether to frequent the area/establishment, such as commercial operations; (2) interior noise levels are high enough that exterior noise levels are not intrusive, such as industrial or manufacturing operations; or (3) less "noise sensitive" recreational uses due to the relative infrequency of use and voluntary nature of public use, such as golf courses. Furthermore, the City's General Plan makes a provision for "(E)ncouraging development of these types of land uses in areas affected by significant and continuing noise sources, such as major arterial roadways, Air Force Plant 42, and railyards, therefore offers the City significant planning opportunities and advantages."

APPENDIX F

TRAFFIC IMPACT STUDY

TRAFFIC IMPACT STUDY

Palmdale Business Park Center

Final Report(Revised)

prepared for

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by

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December 6, 1994
P92154

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1.0 INTRODUCTION

1.1 General Introduction

This project considers the development of the Palmdale Business Park Center in the City of Palmdale. The project site is bounded by Avenue M to the north, 15th Street East to the east, Sierra Highway to the west, and the US Air Force Plant 42 property to the south. Figure 1.1 shows the project location. Although the project site is located solely within the City of Palmdale's limits, the City limits for Lancaster and Palmdale runs down the centerline of Avenue M, the project's main access roadway.

The project would consist of 63.0 acres of Community Commercial, 26.2 acres of Business Park, 89.3 acres of Airport Related (Warehouse), 167.1 acres of Light Industrial, and a Golf Course. The City of Palmdale's General Plan assumed that the land use for the project site would consist of 150 acres of Office Commercial and 200 acres of Business Park space. This study evaluates the existing conditions and the future conditions at both project buildout (2021) and General Plan Buildout.

1.2 Study Scope

The scope of this traffic analysis was developed by DKS Associates in conjunction with David A. Price Associates and the Planning and Public Works Departments of the City of Palmdale, California. The technical methodology, assumptions, and geographic study area were all identified as part of the study approach. Morning and evening peak period traffic turning movement counts were collected during the periods of October 7th (Wednesday) and 8th (Thursday) and October 13th (Tuesday), 14th (Wednesday), and 15th (Thursday) of 1992.

The following traffic scenarios were identified in this study:

- Existing Conditions (Year 1992)
- Future Conditions - Project Buildout (2021)
- Future Conditions - City of Palmdale General Plan Buildout (ADT analysis only)

The year 2021 scenario includes the estimated impacts of proposed future developments that will take place by 2021. The General Plan buildout scenario includes all planned and proposed developments within the study area as defined by the Cities of Palmdale and Lancaster. For purposes of consistency with the City of Palmdale's General Plan, the buildout analysis was performed on an Average Daily Traffic (ADT) basis.

The remainder of this report is divided into six chapters. Chapter Two examines the existing street system and the traffic conditions in the study area. Chapter Three forecasts traffic conditions with the project for year 2021 and discusses on-site circulation. Chapter Four forecasts traffic conditions at General Plan buildout. Chapter Five examines access to the site by other modes (e.g. bus, bicycle). Chapter Six summarizes the analysis provided in this report.

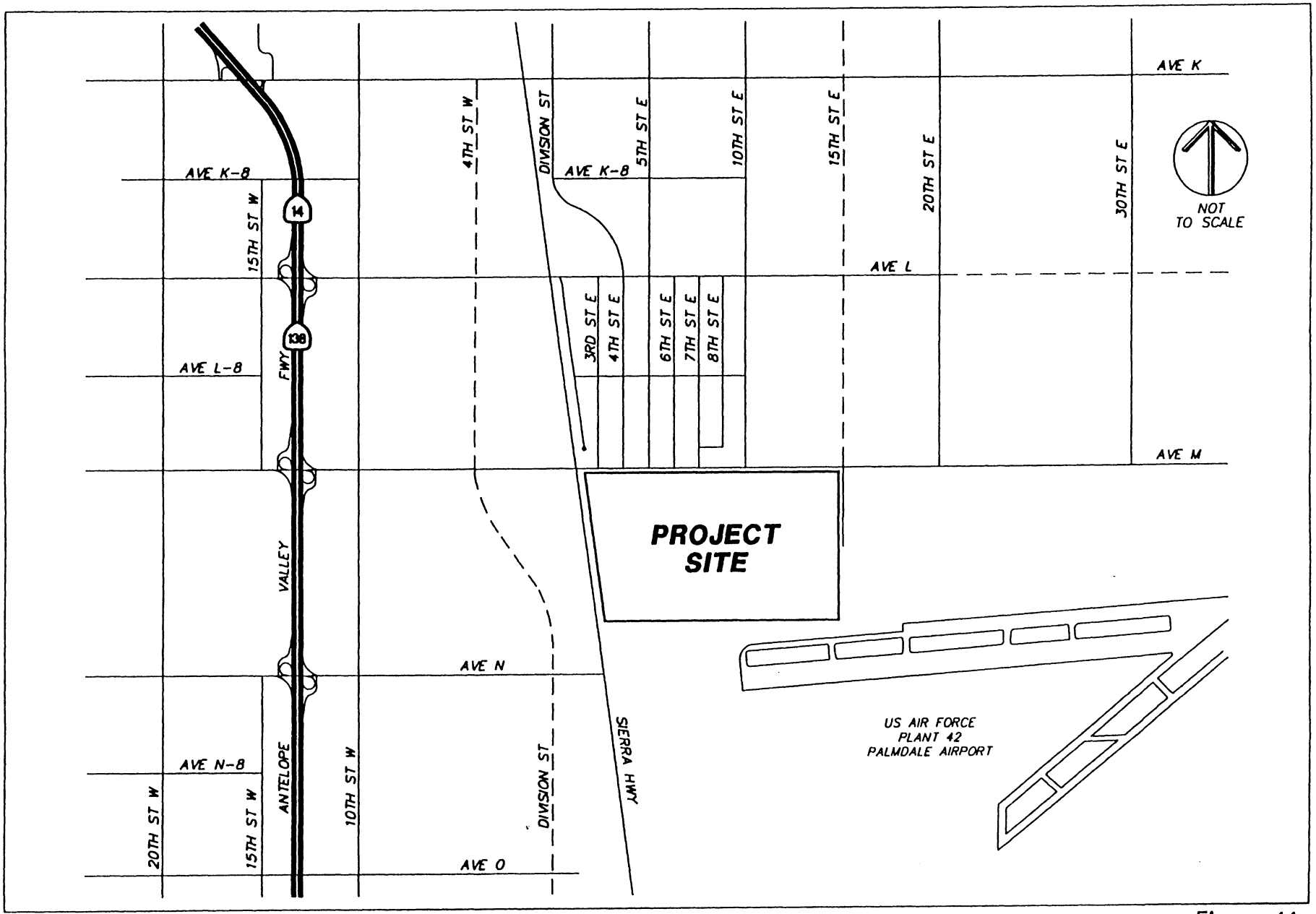


Figure 1.1
PALMDALE BUSINESS PARK CENTER
PROJECT LOCATION

2.0 EXISTING CONDITIONS

2.1 Streets and Highways

This section describes the existing road system in the vicinity of the proposed Palmdale Business Park Center. All Average Daily Traffic (ADT) volumes mentioned in this report were derived from the City of Palmdale Public Works Department 1990 Traffic Flow Map.

2.1.1 East-West Roads

Avenue L is classified as a regional arterial within the project study area. It is discontinuous along its length, which extends from West of 70th Street West to the City of Palmdale limit line at 120th Street East. It has two lanes in each direction west of Sierra Highway and one lane in each direction east of Sierra Highway and carries less than 1000 vehicles per day near Challenger Way.

Avenue M is classified, in Palmdale, as a regional arterial from 30th Street West to 50th Street East and as a major arterial outside these limits, from 90th Street West to 120th Street East. In Lancaster's General Plan Avenue M is classified as a major arterial. This inconsistency is currently being reviewed by the City of Lancaster for potential change. It has two lanes in each direction in the vicinity of the project, with one lane in each direction near SR-14 and carries about 8,000 vehicles per day east of Challenger Way and about 18,000 vehicles to the west. Between 6th Street West and 10th Street West, Avenue M has a two-way left-turn lane.

Avenue N is classified as a major arterial discontinuous along its length which extends from 70th Street West to Sierra Highway, and from about 2,000 feet west of 40th Street East to east of 110th Street East. It has one lane in each direction and carries about 3,000 vehicles per day in the vicinity of the project.

2.1.2 North-South Roads

State Route 14 is a six lane freeway in the vicinity of the project which runs from I-5 in the Los Angeles County to US-395 near the Kern County limits. This freeway carries between 50,000 and 60,000 vehicles per day in the vicinity of the project.

10th Street West is a major arterial extending from north of Avenue G in the City of Lancaster to Barrel Springs Road. South of Palmdale Boulevard, 10th Street West changes its name to Tierra Subida Avenue. It has one lane in each direction in the vicinity of the project and carries about 12,000 vehicles per day.

Sierra Highway is classified as a regional arterial from Avenue P to Avenue M and as a major arterial south of Avenue P. Sierra Highway extends from the City of Mojave to the north in Kern County, through the City of Palmdale, and to the I-5/SR 14 interchange to the south. In the vicinity of the project Sierra Highway has two lanes in each direction and carries about 25,000 vehicles per day.

3rd Street East is an 40' wide unpaved road which runs between Avenue L and Avenue M. Currently, this roadway carries less than 1,000 vehicles per day.

4th Street East is classified as a minor arterial and a 40' wide road, with a pavement width of 25', and runs between Avenue L and Avenue M. Currently, this roadway carries about 2,000 vehicles per day.

5th Street East is a 40' wide unpaved road which runs from Avenue M to north of Avenue K. Currently, this roadway carries less than 1,000 vehicles per day.

6th Street East is a 40' wide unpaved road which runs between Avenue L and Avenue M. Currently, this roadway carries less than 1,000 vehicles per day.

7th Street East is a 40' wide unpaved road which runs between Avenue L and Avenue M. Currently, this roadway carries less than 1,000 vehicles per day.

10th Street East is a minor arterial discontinuous along its length which extends from north of Avenue K in the City of Lancaster to Avenue M, and from Avenue O-8 to Avenue S. It consists of one lane in each direction in the vicinity of the project and carries about 9,000 vehicles per day.

15th Street East currently serves as a driveway access into the existing US Air Force Plant 42 site. It is currently called Site 1 Road with restricted gated access into the existing property south of Avenue M. This segment of road carries about 4,000 vehicles per day.

20th Street East is classified as a major arterial in the vicinity of the project. It is discontinuous along its length which extends from north of Avenue K in the City of Lancaster to Avenue M, and from Avenue O-8 to Avenue S. It is classified as a minor arterial between Avenue O-8 and Avenue S. 20th Street East consists of one lane in each direction in the vicinity of the project and carries about 2,000 vehicles per day.

2.2 Study Intersections

This study analyzes eleven existing intersections and three future intersections. Seven out of the eleven existing study intersections are unsignalized. The study intersections were chosen by the City of Palmdale. The study intersections are as follows:

1) Avenue L/Sierra Highway (Signalized)
2) Avenue L/10th Street East (Unsignalized)
3) Avenue M/SR 14 southbound ramps (Unsignalized)
4) Avenue M/SR 14 northbound ramps (Unsignalized)
5) Avenue M/10th Street West (Signalized)
6) Avenue M/Sierra Highway (Signalized)
7) Avenue M/4th Street East (Unsignalized)
8) Avenue M/10th Street East (Unsignalized)
9) Avenue M/20th Street East (Unsignalized)
10) Avenue N/Sierra Highway (Signalized)
11) Avenue M/4th Street West (Unsignalized)

12) Avenue M/6th Street East (Future)
13) Avenue M/13th Street East (Future)
14) Avenue M/15th Street East (Future)

The intersections of 3rd Street East, 5th Street East, 6th Street East and 7th Street East along Avenue M are all currently unpaved and carry very little traffic. Therefore, these intersections were not analyzed for existing conditions.

The locations of the study intersections are shown in Figure 2.1.

2.3 Existing Intersection Levels of Service

2.3.1 Level of Service Definitions

In order to describe traffic performance at intersections the concept of level of service (LOS) is utilized. The LOS concept is a measure of operating conditions at intersections during a single peak hour. The service levels range from A through F. Service levels A, B, and C are considered acceptable operating conditions with only minor delays being experienced by motorists. LOS D conditions is the generally accepted standard for the planning and design of transportation facilities and is typical of urban peak hour conditions. LOS E is considered capacity operations and LOS F represents jammed conditions with excessive delays being experienced by motorists. Further details of level of service definitions for intersections are shown in Table 2.1.

2.3.2 Methodology

As directed by City staff, all intersection capacity analyses at the study intersections are based on the methods described in the Transportation Research Board's, *Interim Materials on Highway Capacity, Circular No. 212.*

The level of service analysis was prepared for both the morning and evening peak hours. Existing traffic turning movement counts for the existing study intersections are shown in Figures 2.2 and 2.3 and are contained in the appendix to this report.

2.3.3 Existing Traffic Conditions

Currently, all the study intersections operate at LOS A during the morning peak hour. During the evening peak hour, all the study intersections operate at LOS B or better with the exception of Avenue M and 10th Street West which operates at LOS D. The existing levels of service are shown in Table 2.2.

A signal warrant analysis was performed for the unsignalized study intersections in order to assess whether these intersections should be converted to signalized operation. The analysis is

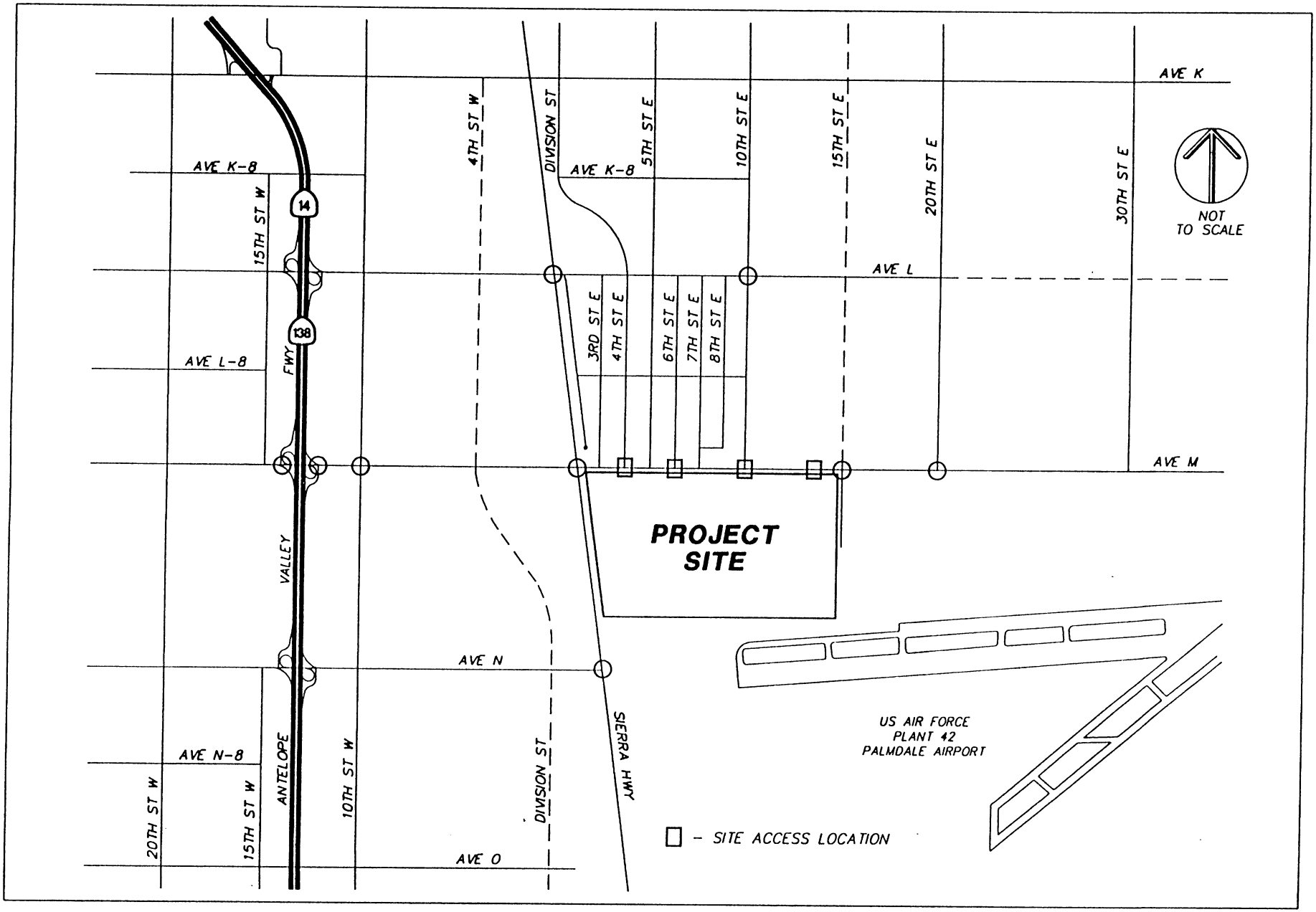


Figure 2.1
STUDY INTERSECTIONS

Table 2.1
Level of Service Interpretation

Level of Service	Volume to[1] Capacity Ratio	Description
A	0-.59	Excellent operation. All approaches to the intersection appear quite open, turning movements are easily made, and nearly all drivers find freedom of operation.
B	.60-.69	Very good operation. Many drivers begin to feel somewhat restricted within platoons of vehicles. This represents stable flow. An approach to an intersection may occasionally be fully utilized and traffic queues start to form.
C	.70-.79	Good operation. Occasionally drivers may have to wait more than 60 seconds, and back-ups may develop behind turning vehicles. Most drivers feel somewhat restricted.
D	.80-.89	Fair operation. Cars are sometimes required to wait more than 60 seconds during short peaks. There are no long-standing traffic queues. *This level is typically associated with design practice for peak periods.*
E	.90-1.00	Poor operation. Some long-standing vehicular queues develop on critical approaches to intersections. Delays may be up to several minutes.
F	Over 1.00	Forced flow. Represents jammed conditions. Backups from locations downstream or on the cross street may restrict or prevent movement of vehicles out of the intersection approach lanes; therefore, volumes carried are not predictable. Potential for stop and go type traffic flow.

Source: *Highway Capacity Manual*, Highway Research Board, Special Report No. 87, Washington, DC, 1965 and the update of the manual.

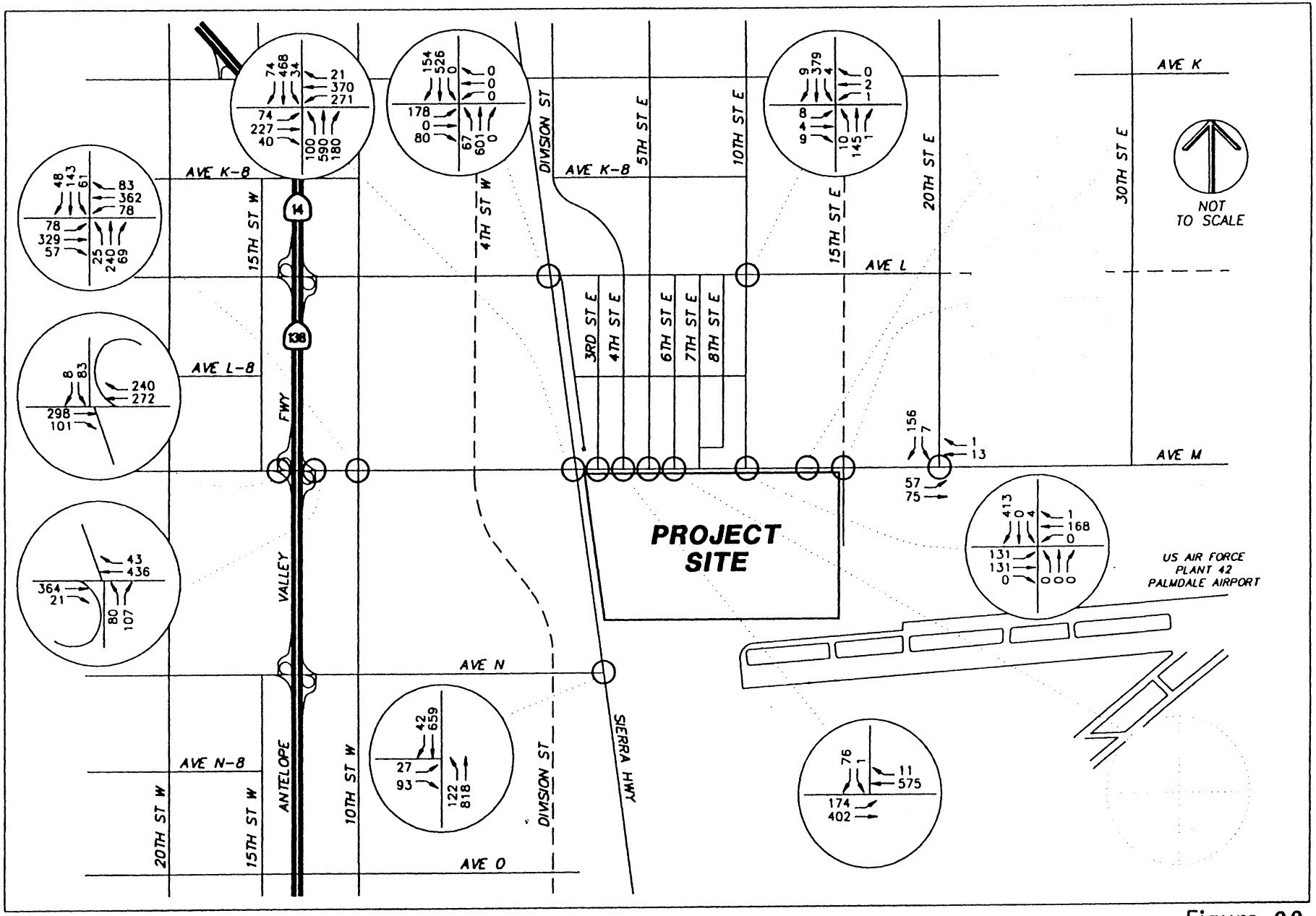


Figure 2.2
EXISTING AM PEAK HOUR VOLUMES

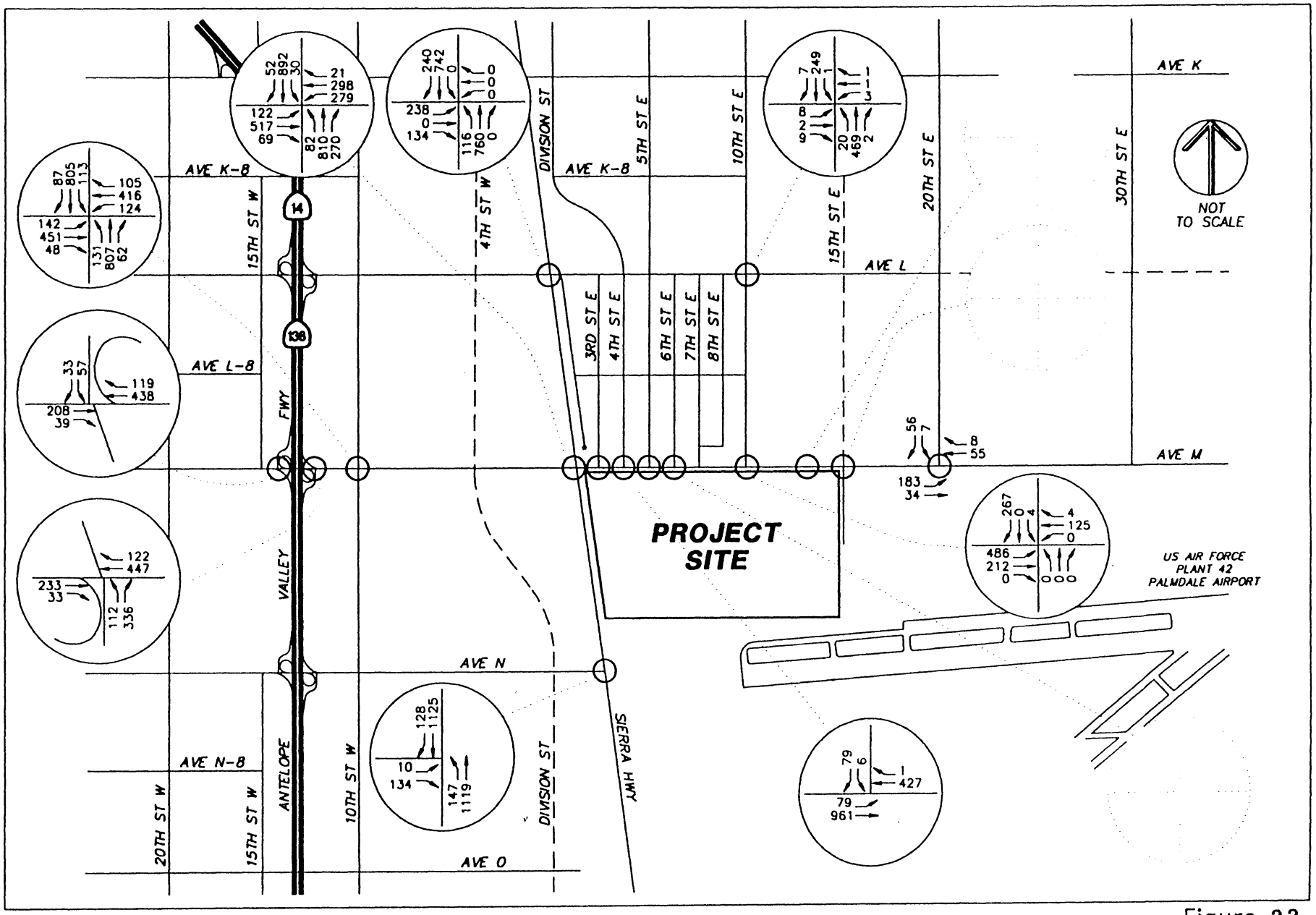


Figure 2.3
EXISTING PM PEAK HOUR VOLUMES

Table 2.2
Existing Conditions
Level of Service Analysis

Intersection	AM		PM	
	V/C	LOS	V/C	LOS
Avenue L/Sierra Highway	0.37	A	0.53	A
Avenue L/10th Street East	0.27	A	0.32	A
Avenue M/SR−14 SB Ramps	0.37	A	0.38	A
Avenue M/SR−14 NB Ramps	0.37	A	0.57	A
Avenue M/10th Street West	0.42	A	0.89	D
Avenue M/Sierra Highway	0.50	A	0.69	B
Avenue M/4th Street East	0.35	A	0.38	A
Avenue M/10th Street East	0.40	A	0.51	A
Avenue M/20th Street East	0.15	A	0.17	A
Avenue N/Sierra Highway	0.37	A	0.57	A

based on the procedures in the California Department of Transportation (Caltrans) Traffic Manual. An unsignalized intersections must meet at least one of the warrants or 80% of two warrants in order to qualify for signal installation.

Based on the existing peak hour volumes, one intersection satisfies the signal warrant analysis for at least one peak hour. The intersection is Avenue M and SR 14 northbound ramps. This intersection has a large proportion of right-turning vehicles (about 20%, 10% to 15% is typical), however, and might not need a signal to operate acceptably. The signal warrant calculations are included in the Appendix to this report.

2.4 Existing Public Transit Services

Bus service within the City of Palmdale is provided through the Antelope Valley Transit Authority (AVTA), a joint powers agency whose members also include the City of Lancaster and Los Angeles County. Recently AVTA awarded the bus service contract to DAVE Transportation Services. Weekday fixed-route service includes five lines, three of which operate in the vicinity of the project site. These routes are shown in Figure 2.4. The Orange Line operates north-south on 10th Street West, the Blue Line runs to the north along Avenue K, and the Red Line operates along Avenue L. Bus frequency is two bus trips per hour. Service hours on weekdays are from 5:30 a.m. to 8:00 p.m.

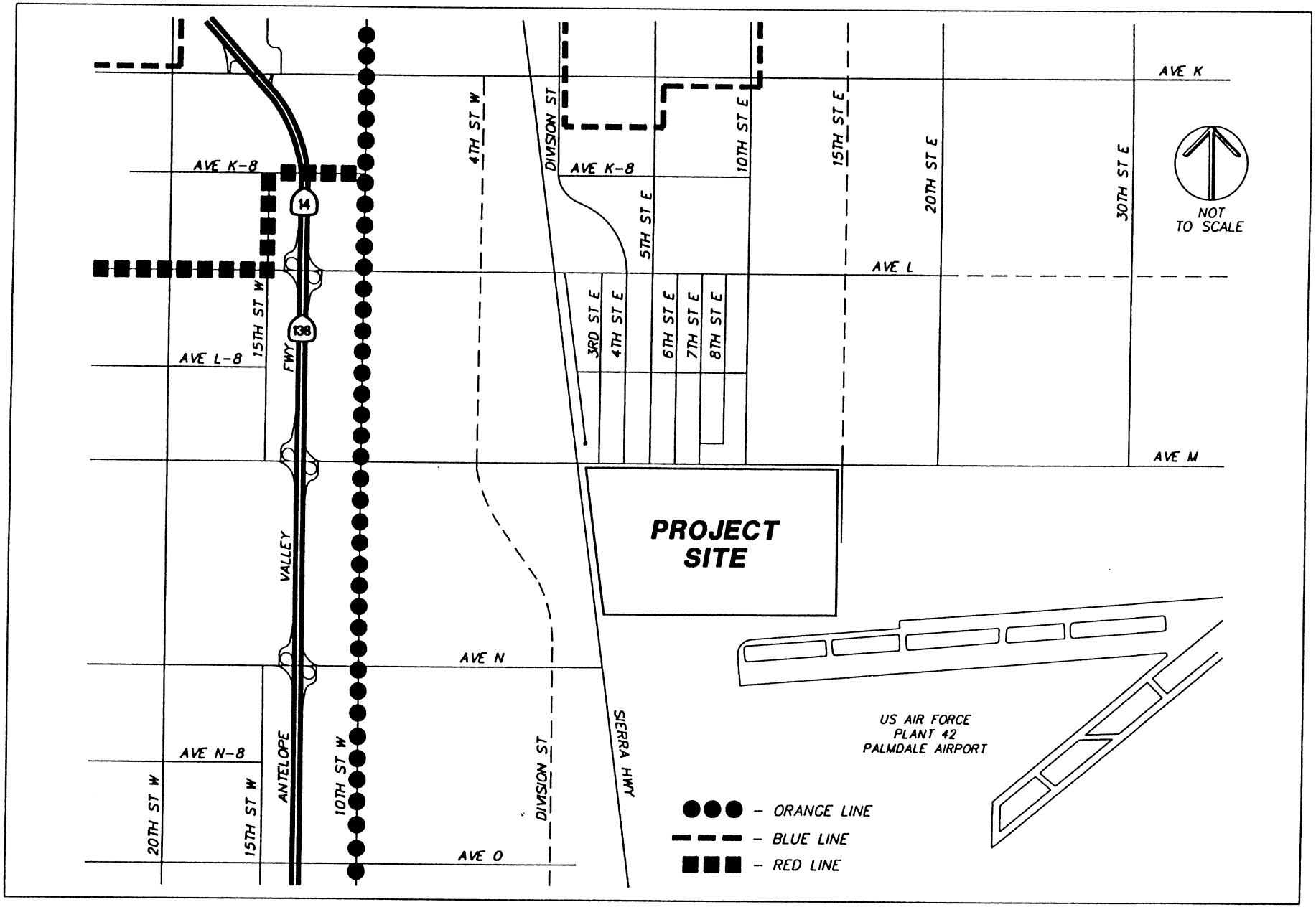


Figure 2.4
LOCAL BUS ROUTES

3.0 FUTURE CONDITIONS (2017)

3.1 Methodology

This scenario considers traffic conditions at buildout of the project site. The project would consist of 63.0 acres of Community Commercial, 26.2 acres of Business Park, 89.3 acres of Airport Related (Warehouse), 167.1 acres of Light Industrial, and a Golf Course. The project would generate approximately 53,700 daily vehicle trips and about 4,490 trips and 6,430 trips during the morning and evening peak hours, respectively. This is shown in Table 3.1 along with the trip generation for each phase of the project.

The project is planned to be built over a period of 25 years in eight phases. Phase 8 (the final phase) is planned to be completed around the year 2021. This is based on current market projections and is subject to change. A full description of each phase is contained in the Specific Plan document of which this Traffic Study is an Appendix.

By comparison, the land uses as assumed in the City's General Plan would generate approximately 61,800 daily vehicle trips and about 6,600 trips and 6,000 trips during the morning and evening peak hours, respectively. This is shown in Table 3.2. Due to the similarity in total trip generation for the two land use scenarios, it was decided in discussions with City staff that only the project land use alternative would need to be analyzed for peak hour conditions.

In order to estimate future traffic conditions, the Palmdale Traffic Model was used to estimate background peak hour turning movement volumes for the study area near the site of the project. The City's 2010 Traffic model was used to develop 2010 turning volumes which were then adjusted for 2021 conditions. Project-related traffic was then added to the 2021 background turning volumes.

The City's traffic model was used to determine the assignment of project-related traffic to the roadway network. This distribution is shown in Figure 3.1. As can be seen, 54 percent of the traffic is directed to/from the north, 15 percent is directed to/from the south, 19 percent is directed to/from the east, and 12 percent is directed to/from the west. The projected AM and PM peak hour turning movements are shown in Figures 3.2 and 3.3.

The traffic analysis assumes that most of the north-south roadways between Sierra Highway and 10th Street East will connect Avenue M with Avenue L. The City of Lancaster was contacted concerning this assumption and that condition was verified. In addition, the City of Lancaster has designated 4th Street East as an arterial. Left-turn access to/from Avenue M is not planned at 3rd Street East, 5th Street East, 7th Street East and 8th Street East.

Table 3.1
Trips Generated for Project Area
Palmdale Business Park Center Land Use

Land Use	Unit Size Acres	Unit Size KSF	AM Trips In	AM Trips Out	PM Trips In	PM Trips Out	Daily Trips
Phase I (1996)							
Golf Course	227.33	N/A	72	18	45	45	1,065
Phase II (1997)							
Community Comm.–1	24.35	254.56	115	68	387	387	8,237
Light Ind.–1	13.51	205.97	128	26	16	116	1,436
Phase III (2001)							
Community Comm.–2	9.59	100.26	67	39	214	214	4,601
Light Ind.–2	40.83	622.49	537	110	87	641	4,547
Light Ind.–3	2.49	37.96	29	6	4	33	182
Phase IV (2005)							
Community Comm.–3	29.05	303.70	128	75	433	433	9,198
Light Ind.–4	16.81	256.29	178	36	24	179	1,812
Phase V (2009)							
Business Park–1	10.61	138.65	185	33	50	177	1,985
Business Park–2	15.57	203.47	267	47	69	246	2,873
Phase VI (2013)							
Light Ind.–5	24.75	377.34	296	61	45	332	2,716
Light Ind.–6	29.88	455.55	373	76	59	431	3,300
Phase VII (2017)							
Light Ind.–7	38.85	592.31	507	104	82	603	4,321
Phase VIII (2021)							
Airport Related	89.19	1750.26	538	209	325	604	6,784
TOTAL			**3,421**	**909**	**1,841**	**4,440**	**53,058**

Note: A pass–by credit of 35% was applied for all Community Commercial land use.

Table 3.2
Trips Generated for Project Area
General Plan Land Use

Land Use	Unit Size		AM Trips		PM Trips		Daily
	Acres	KSF	In	Out	In	Out	Trips
Business Park	200	2,613.60	3,211	567	685	2,429	34,516
Office	120	1,568.16	1,684	208	288	1,408	13,314
Commercial	30	392.04	198	116	591	591	13,992
TOTAL			**5,093**	**891**	**1,564**	**4,428**	**61,822**

Note: A pass–by credit of 35% was applied for all Commercial land use.

DKS Associates

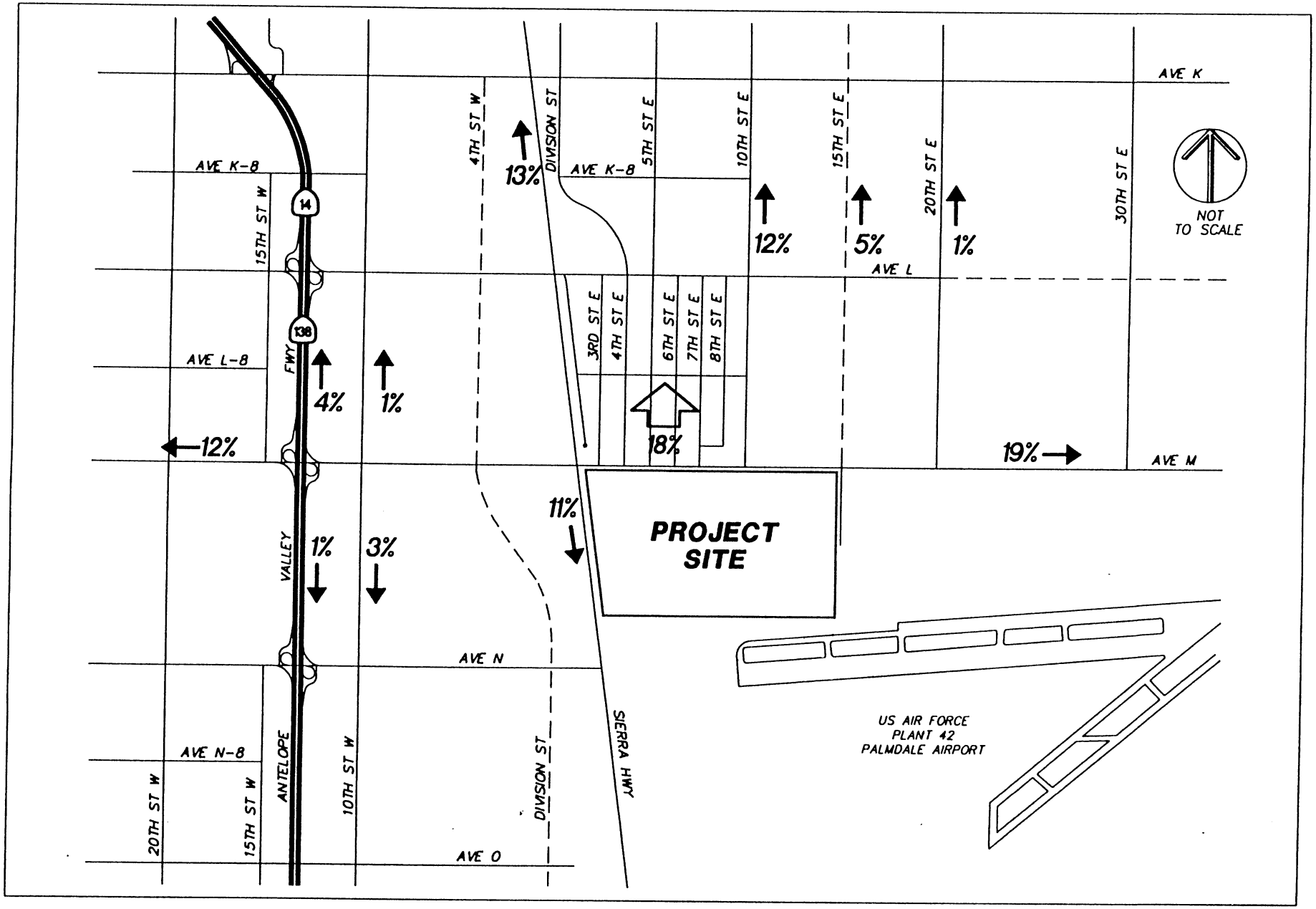


Figure 3.1
PROJECT TRAFFIC DISTRIBUTION

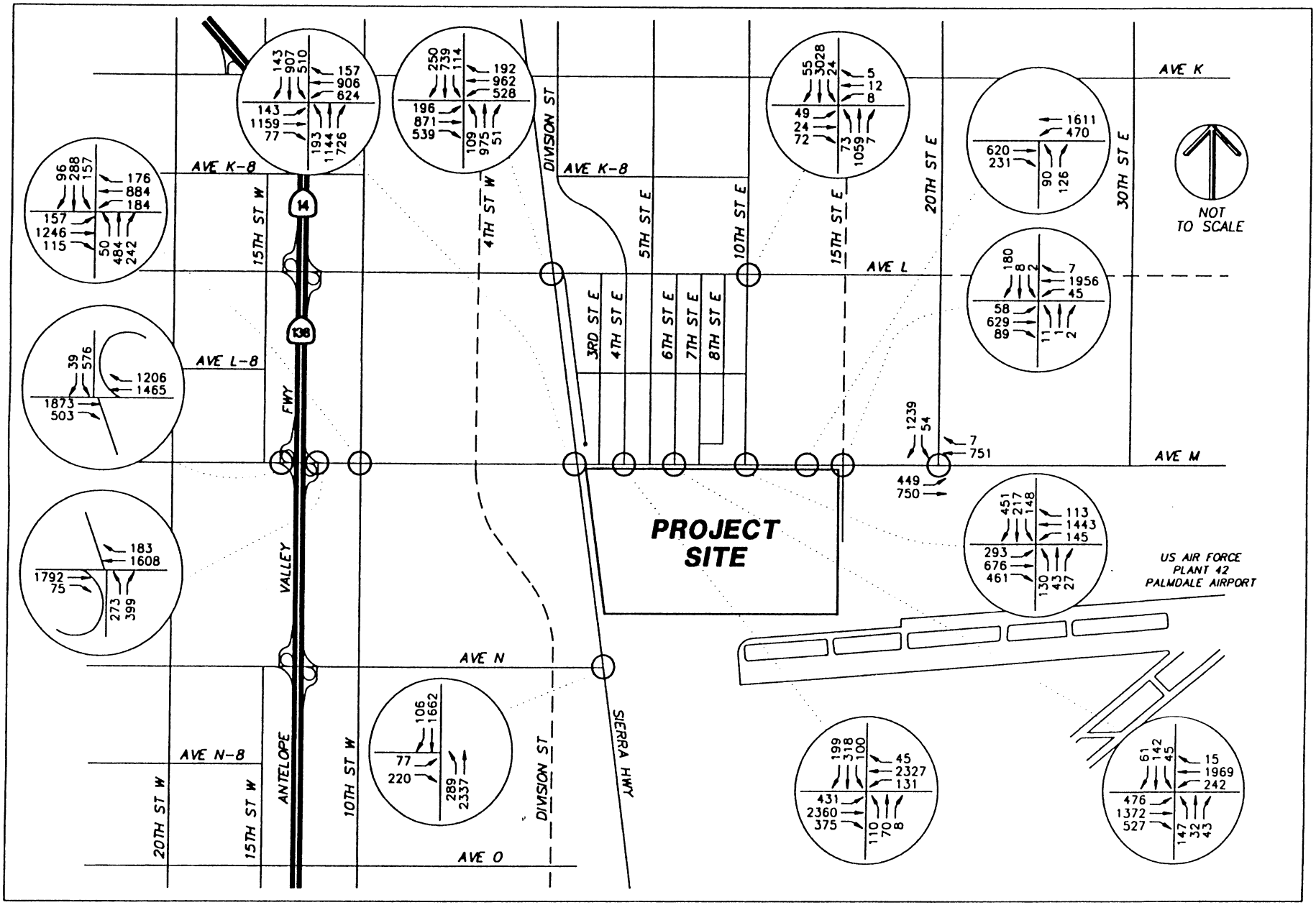


Figure 3.2
AM PEAK HOUR VOLUMES
PROJECT LAND USE
Year 2021 (Phase 8)

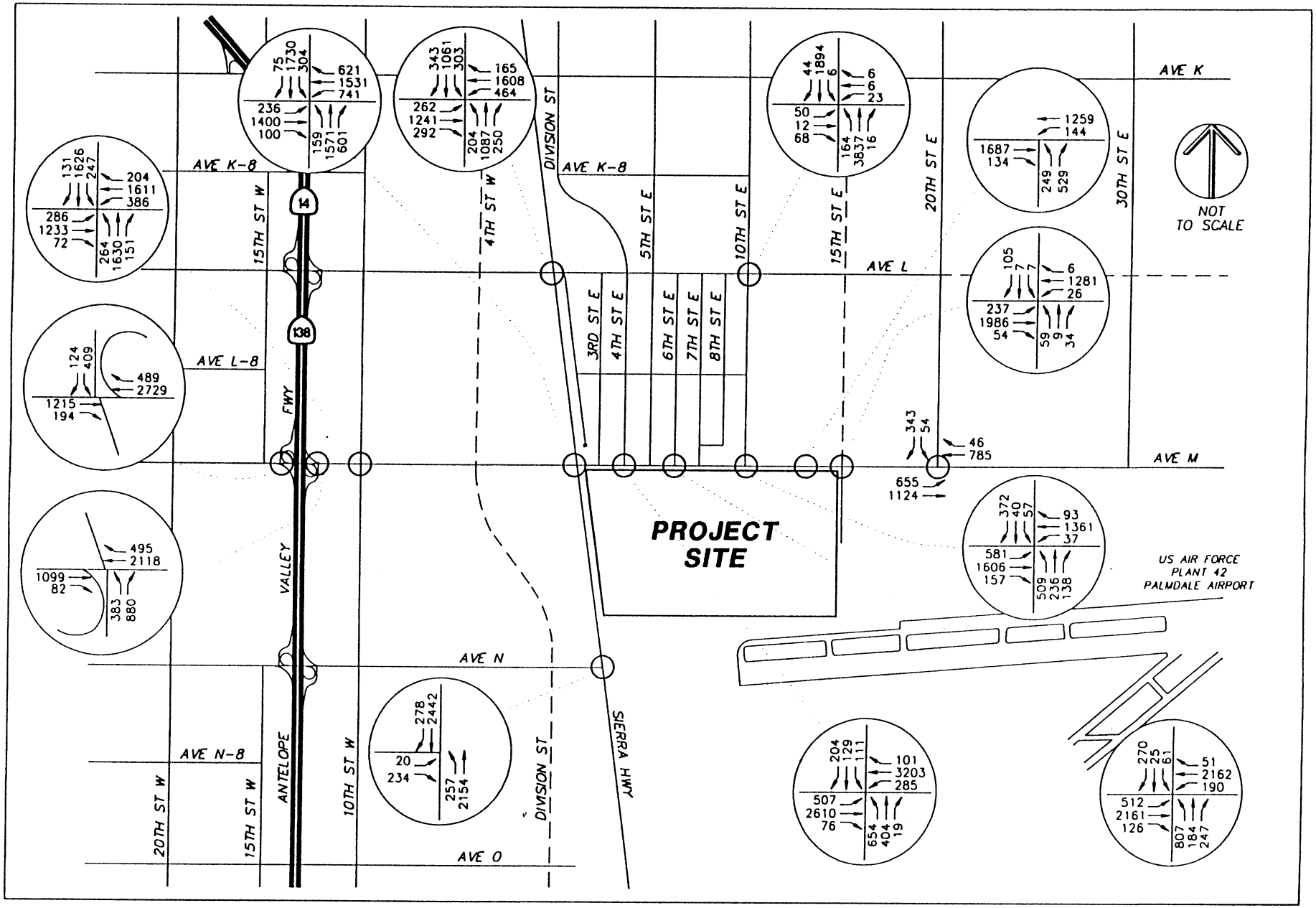


Figure 3.3
PM PEAK HOUR VOLUME
PROJECT LAND USE
Year 2021 (Phase 8)

3.2 Future Traffic Conditions

The number of through lanes anticipated at project completion (2021) is shown in Figure 3.4. Additional left and right turn lanes will be needed at various intersections. This Report identifies lane configurations in a schematic manner and does not necessarily indicate actual pavement geometrics. For example, traffic may require two left turn lanes in one direction but not in the opposite. The roadway would still require the same cross section and right-of-way needs. Post, Buckley, Shuh & Jurnigan, the civil engineers on the project team, will prepare standard geometrics and right-of-way needs for the project. It is anticipated that Avenue M will have a consistent cross section sufficient to accommodate the traffic needs. On Avenue M, between 5th and 6th Streets East, there may be a deficiency of right-of-way due to the existence of water storage tanks. In this case, additional right-of-way or design changes will be accomplished to meet the roadway needs.

An arterial progression analysis of Avenue M was performed using the Passer II software package to determine the impacts of the proposed signal spacing. Passer II simulates the flow of traffic along a signalized arterial (i.e. being stopped at intersections by the red signal and soon thereafter moving on the green signal). The traffic simulation model in Passer II is among the most realistic of those available in computerized traffic simulation models. Passer II simulates traffic flow in small time increments, so its representation of traffic is more detailed than other models that assume uniform distributions within the traffic stream.

The results of the original signal progression analysis for Avenue M indicated that good progression can be maintained during the AM peak hour and fair progression during the PM peak hour at completion of last phases. This analysis assumed signals at Avenue M and Loop Road West, 4th Street East, 5th Street East, 6th Street East, 7th Street East, Challenger Way, and Loop Road East. Several of the intersections, however, were projected to operate over capacity, which would make achieving smooth progression difficult. Subsequent to this analysis, the site configuration was changed to have signals at Loop Road West, 6th Street East, Challenger Way and Loop Road East. After discussions with city staff, the new signal locations were accepted without further progression analysis.

Further improvements, without removing any additional project signals, require a reduction in traffic on Avenue M of approximately ten to fifteen percent for Phases 7 and 8 of the project. Since this project will be responsible for about half of the future traffic on Avenue M, a goal of ten to fifteen percent reduction would require a reduction in project-related traffic of about 25 percent.

It is proposed that trips generated by the project be mitigated by a combination of roadway improvements and a pro-active Transportation Demand Management (TDM) program. The proposed TDM program includes reduction measures that are estimated to reduce trip generation by the necessary 25 percent.

The actual TDM program for the Palmdale Business Park Center should be prepared by a qualified TDM consultant. The purpose of this discussion is to give an estimate of the level of traffic reduction that could be achieved for each of the proposed TDM measures. The actual level of traffic reduction achieved may be more or less than indicated.

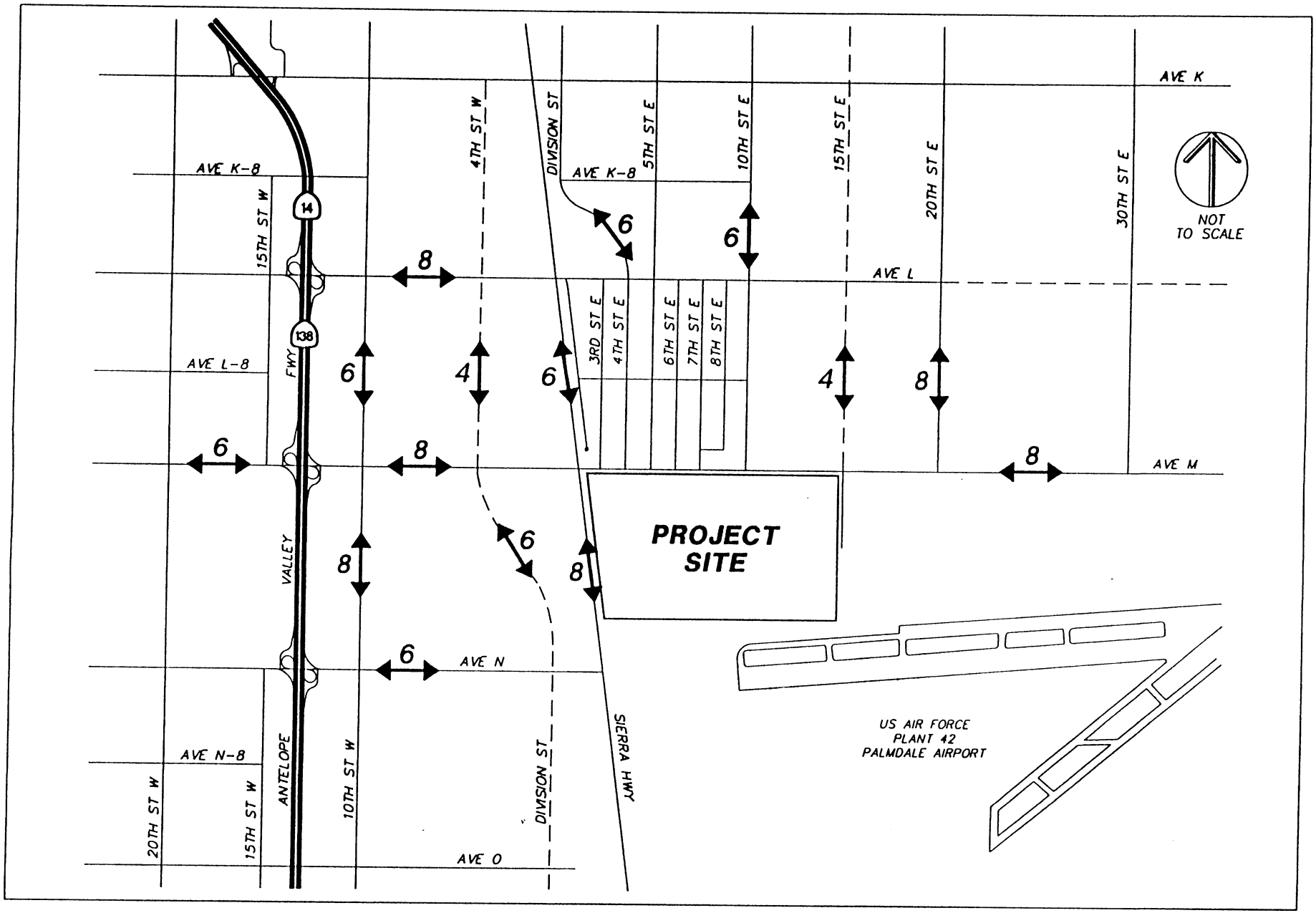


Figure 3.4
ULTIMATE PLANNED NUMBER OF LANES

It is the City's intention to require a traffic study for the project site every several years. The exact frequency will depend on the pace of site development. The actual effectiveness of any TDM programs and levels of traffic reduction achieved can be measured as part of these future traffic studies.

3.2.1 TDM Program

A TDM program is proposed for this project and it is recommended that a Transportation Management Association District be established for the project. In addition to the normal TDM measures the program also considers the potential for additional project access points. Other measures, such as overpasses were taken under advisement, but were considered impractical at this time. Although, given the long time frame for project build out, such measures, if needed, may become feasible in the future. Because of this, allowances have been provided in the site planning for an overpass at Avenue M and Sierra Highway. In all cases, however, all future project activities will be subject to the normal City approval processes.

A brief description of each TDM measure follows below with an estimate of the traffic reduction that could be achieved. The source of the traffic reduction estimates are several Transportation Research Board publications. Following this discussion there is a summary of proposed TDM mitigation measures for each phase of the project.

- Flexible work shifts (5%) - The purpose of this measure is to have fewer employees arrive at or leave the site during the AM and PM peak hours. This can be achieved by requiring the employer to establish staggered work hours, which have employees starting and ending work at different times. Flextime is such an option, in which the employee is required to be at work during a core period (e.g. 9:00 am to 3:00 pm), and can fulfill the rest of his time before or after those hours. Another option is to institute a 4-day work week, with different employees off on different days.

- Car/vanpooling (8%) - The purpose of this measure is to require employers to put more people in fewer cars. Carpooling is typically limited to those whose schedules are rigid, and therefore, must be carefully coordinated at sites that have flexible work shifts. The most successful car/vanpooling programs have computerized systems that match employees from different companies located at the same site.

  Average Vehicle Ridership (AVR) is the average number of persons per vehicle. The current AVR in Los Angeles County is 1.10. An eight percent decrease in traffic would require an increase in the AVR from 1.10 to 1.20.

- Transit subsidies (2%) - The purpose of this measure is to require employers to encourage employees to use public transit. Subsidies are most effective when they are limited to transit only and are not given to employees in the form of cash. The employer should either purchase the transit pass for the employee or provide a Transitcheck. Transitcheck is a voucher purchased from MTA that is redeemable for one transit pass. Two percent of all employees on the entire site was assumed. Individual employers would experience more or less than two percent. The relatively low traffic reduction achieved is due to the low attractiveness of transit over a person's own car.

- Parking restrictions (5%) - The purpose of this measure is to require employers to discourage employees from using their cars to get to work. Free parking is a tremendous incentive to drive alone. Charging employees for parking is the most effective form of parking restriction. Other forms include limiting the number of available parking spaces and providing parking closer to the buildings for carpools and vanpools.

  The ratio of parking spaces to office floor space has typically been set in suburban developments at one space per 250 sq. ft. of office space. This is consistent with City of Palmdale requirements. The ITE Parking Generation Manual contains actual parking ratios (occupancy rates for existing developments) based on national surveys. The majority of the data in this Manual is derived from suburban developments with little or no transit ridership. This is typical of the City of Palmdale. Actual ratios from the Manual are:

  - Community Commercial — one space per 310 sq. ft.
  - Airport Related (Warehouse) — one space per 1,000 sq. ft.
  - Business Park — one space per 400 sq. ft.
  - Light Industrial — one space per 650 sq. ft.

  Using ratios closer to values from the ITE Parking Generation Manual would make it easier to achieve the necessary reduction. Without surveying actual site use after the initial Phases open, it is not possible to recommended specific parking ratios to achieve a five percent reduction. Limiting parking will only be successful if employee parking is segregated from customer parking.

- Telecommuting (5%) - The purpose of this measure is to require employers to allow employees to work either at home or at remote work sites. The employee would be given a computer and modem and be able to do some of his work at home. Another option is to establish several centers closer to the homes of employees. Each center would have the necessary computer and office equipment to allow employees to do their work. The intent is to reduce the number of days each employee needs to go into the office. This measure only works effectively for office-type employees.

Phase	Necessary Reduction in Project Traffic		Cumm. Daily Trips Generated		TDM Measures
	Percent	Volume	w/o TDM	w/TDM	
1	- - -	- - -	1,065	- - -	None Required
2	- - -	- - -	10,738	- - -	None Required
3	- - -	- - -	20,068	- - -	None Required
4	- - -	- - -	31,078	- - -	None Required
5	5%[1]	- - -	35,936	35,936	Flexible work shifts

6	10%[2]	2,098	41,952	39,854	Above plus Step I Car/van pooling (1.15 AVR)
7	15%[2]	4,627	46,273	41,646	Above plus Step II Car/van pooling (1.20 AVR) Transit subsidies
8	25%[2]	10,749	53,743	42,994	Above plus Parking Restrictions Tele-commuting and/ or alternative access (subject to Air Force base conversion to public use)

[1]Daily trips would remain unchanged. Peak hour trips would be reduced by 5%.
[2]Less the 5% reduction from flexible work shifts which reduces peak hour trips exclusively.

An analysis to demonstrate compliance with the Congestion Management Plan has been provided in a separate document.

3.2.2 Analysis Results

The results of the intersection analysis at project buildout, both with and without the TDM program, are summarized in Table 3.3. All study intersections are projected to operate at an acceptable level of service during both peak hours. It is important to note that the analysis in this section assumes construction of four travel lanes in each direction on Avenue M as originally envisioned at conception of this study.

The results of the signal progression analysis are summarized in Table 3.4. It was decided in discussions with City staff that the signal progression analysis would not include the SR-14 ramps and 10th Street West. With the TDM program in place, all study intersections are projected to operate below capacity, which indicates that proper signal progression along Avenue M should be achievable. The Appendix to this report includes the time-space diagrams and delay and queue length reports for the original signal progression analysis discussed earlier.

The difference in results between the two Tables is due to the fact that the intersection analysis utilized the Circular 212 methodology as discussed in Chapter 2 and the signal progression analysis utilized the 1985 HCM (*Highway Capacity Manual, Special Report 209, 1985*) methodology. The 1985 HCM methodology calculates volume-to-capacity ratios differently and is more appropriate for operational studies such as signal progression, but is not suited to long-term projections at individual intersections. LOS results for the signal progression analysis are not shown in Table 3.4, since the intent is simply to indicate whether the intersections are over or under capacity.

A signal warrant analysis was performed for the unsignalized study intersections in order to assess whether these intersections should be converted to signalized operation in the future. Based on the future peak hour volumes, all study intersections satisfy the signal warrant analysis for at least

one peak hour. The appropriate signal warrant calculations are included in the Appendix to this report.

Table 3.3
Future Conditions With Project
Intersection Analysis

	< – – – – – – – – – PM – – – – – – – – – >			
	Without TDM		With TDM	
Intersection	V/C	LOS	V/C	LOS
Avenue L/Sierra Highway	0.85	D	0.81	D
Avenue L/10th Street East	0.85	D	0.81	D
Avenue M/SR–14 SB Ramps	0.83	D	0.78	C
Avenue M/SR–14 NB Ramps	0.71	C	0.68	B
Avenue M/10th Street West	0.82	D	0.79	C
Avenue M/Sierra Highway	0.92	E	0.85	D
Avenue M/4th Street East	1.01	F	0.90	E
Avenue M/6th Street East	1.00	F	0.89	D
Avenue M/10th Street East	0.80	D	0.70	C
Avenue M/13th Street East	0.70	C	0.58	A
Avenue M/15th Street East	0.46	A	0.39	A
Avenue M/20th Street East	0.44	A	0.43	A
Avenue N/Sierra Highway	0.80	D	0.76	C

Note: V/C ratios calculated using Circular 212 methodology

Table 3.4
Future Conditions With Project
Signal Progression Analysis

	< – – – AM – – – >		< – – – PM – – – >	
Intersection	Without TDM V/C	With TDM V/C	Without TDM V/C	With TDM V/C
Avenue M/Sierra Highway	1.02	0.98	1.05	0.97
Avenue M/3rd Street East	0.87	0.81	1.06	0.92
Avenue M/4th Street East	0.81	0.71	0.97	0.85
Avenue M/5th Street East	0.94	0.78	1.19	0.95
Avenue M/6th Street East	0.69	0.66	1.13	0.92
Avenue M/7th Street East	0.66	0.63	0.79	0.68
Avenue M/10th Street East	0.88	0.78	1.15	0.93
Avenue M/13th Street East	0.77	0.56	0.96	0.77
Avenue M/15th Street East	0.75	0.68	0.85	0.74
Avenue M/20th Street East	0.98	0.75	0.82	0.79
Efficiency	0.26	0.27	0.24	0.25
Progression Band Width EB (sec.)	23	21	23	24
Progression Band Width WB (sec.)	28	32	25	28

Note: V/C ratios calculated using 1985 HCM methodology

Efficiency: 0.00 – 0.12 Poor Progression
0.13 – 0.24 Fair Progression
0.25 – 0.36 Good Progression

3.3 On-Site Circulation

Access to the site will be provided along Avenue M with full intersections at Loop Road West (4th Street East), 6th Street East, 10th Street East and Loop Road East. All of these intersections will be signalized. In addition, driveways will be provided opposite 3rd Street East, and 7th Street East. A right-in/right-out movement will be provided at all unsignalized access points.

The internal roadway volumes were developed using the TRACS software package. Using TRACS, the project site was divided into separate zones (in this case, one for each parcel). Then trip generation and distribution was developed for each zone. The trips to and from each zone were then added at each of the study intersections to produce turning movements and intersection approach volumes. Projected AM and PM peak hour mid-block volumes on the internal roadways are shown in Figures 3.5 and 3.6. The volumes indicated on the Figures are average mid-block volumes, based on the approach and departure volumes at the intersections at either end of each link.

All internal intersections are projected to operate at LOS C or better during both peak periods with or without the TDM measures. From a traffic needs standpoint, all internal roadways are projected to operate at an acceptable level of service with one lane each way and a left-turn pocket at the intersection approaches. This is the case for all phases with one exception. The intersection of East/West Connector and Challenger Way will require two through lanes each way at completion of Phase 7. Though several of the internal four-legged intersections will have heavy right-turn movements none will require exclusive right-turn only lanes.

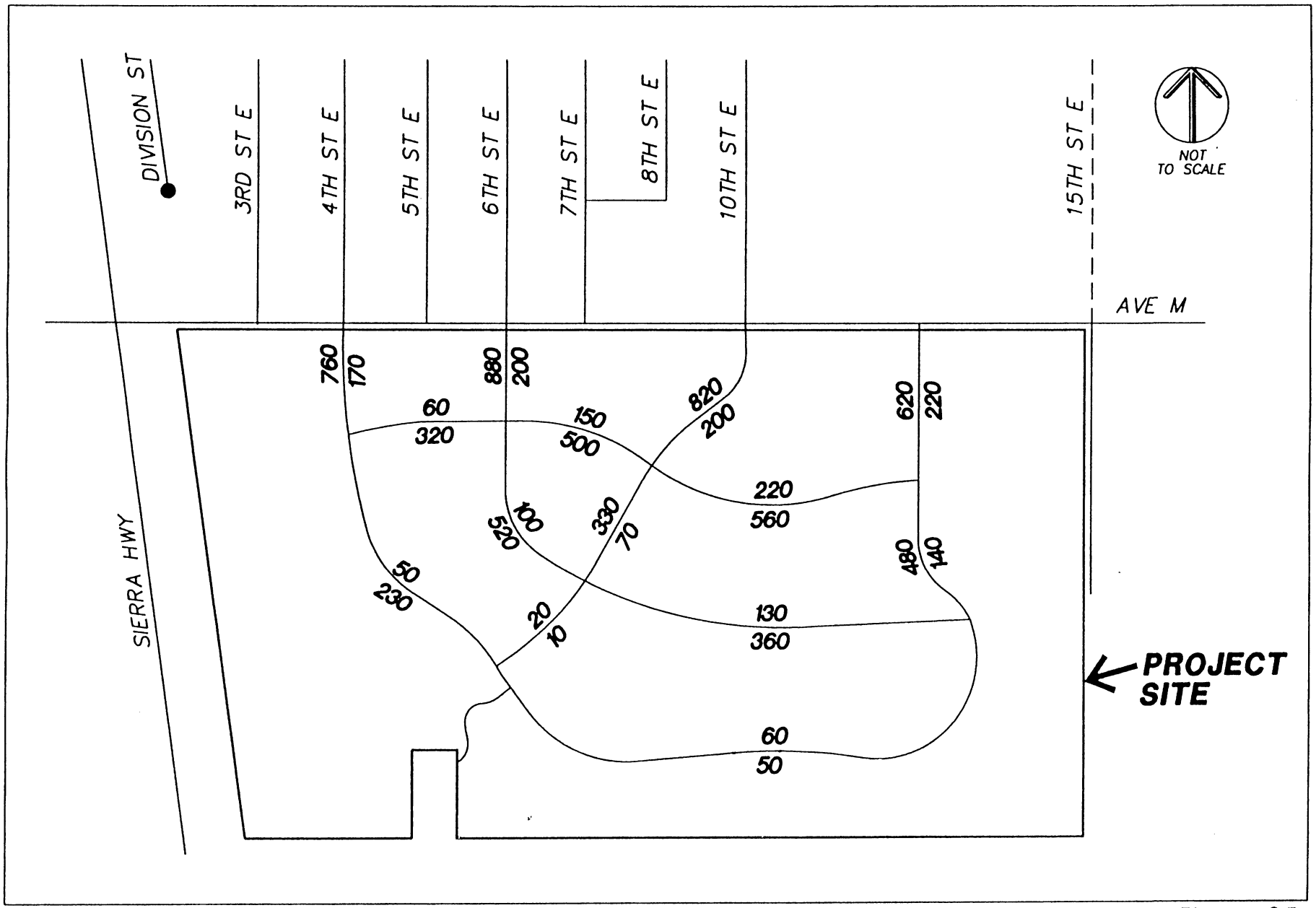


Figure 3.5
AM PEAK HOUR VOLUMES
PROJECT LAND USE
Year 2021 (Phase 8)

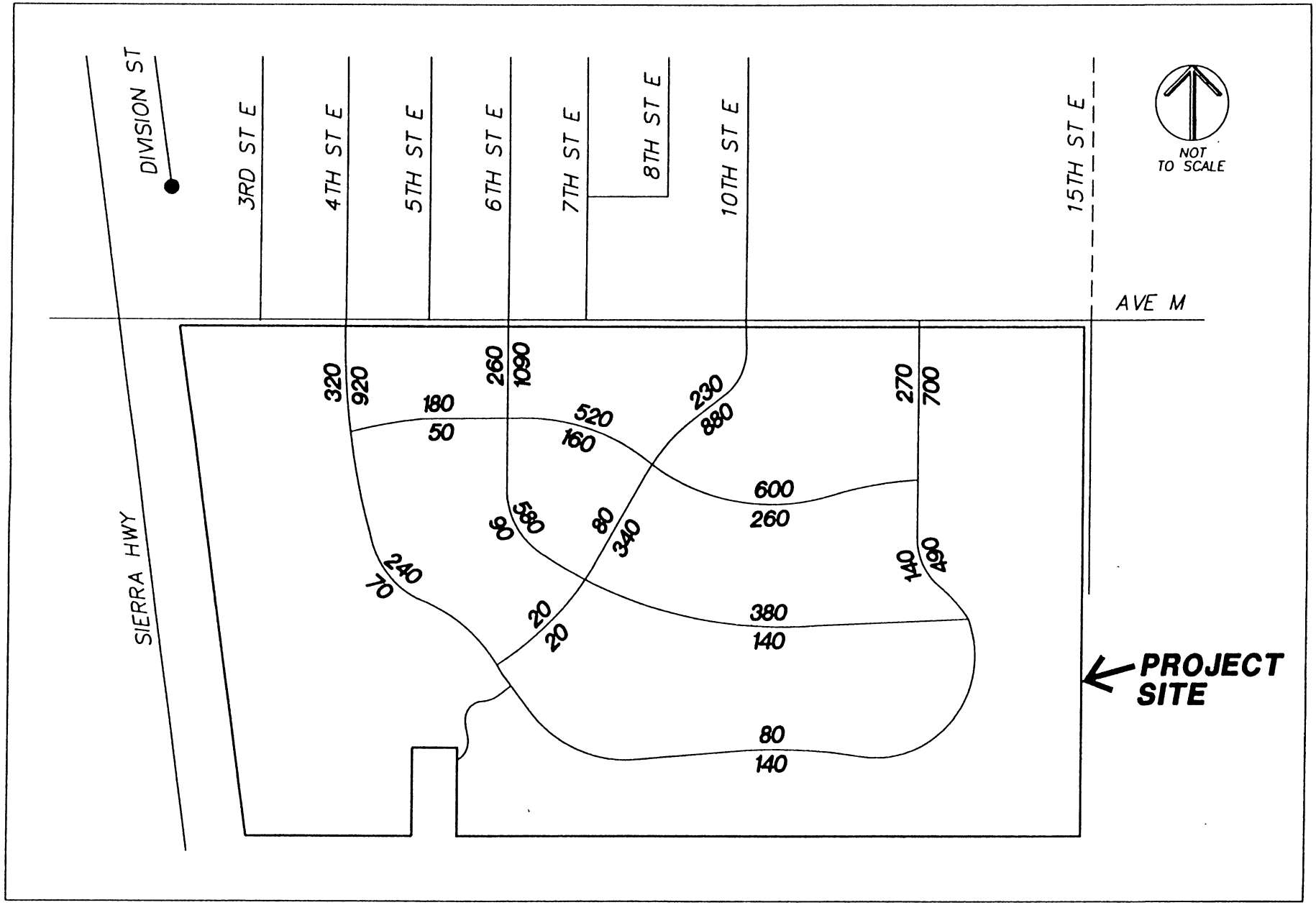


Figure 3.6
PM PEAK HOUR VOLUMES
PROJECT LAND USE

3.4 Project Phasing

As stated earlier, the project site is planned to be developed in eight phases over a period of 25 years. The land use planned for each of the eight phases is tabulated in Table 3.1. A detailed intersection analysis was not performed for Phases I through III. It is anticipated ,however, that with construction of Phase IV and background traffic growth, additional improvements could be necessary in the vicinity of the project site. In addition, original assumptions that Avenue M would be master planned as a eight-lane regional arterial are currently uncertain. Therefore, detailed intersection analysis was conducted for Phases IV through VIII. These analysis, which utilize TDM volumes, are made to provide an assessment of the anticipated schedule of roadway infrastructure improvements adjacent to the site. Signal warrant analysis was also performed.

3.4.1 Traffic Signal Needs

All of the future project-access locations are currently unsignalized or future intersections. The phasing of signalization of these locations and of the intersections internal to the project site are summarized below:

Phase 1 (1996)	No additional signals required
Phase 2 (1997)	No additional signals required
Phase 3 (2001)	Ave. M/Loop Road West
Phase 4 (2005)	Ave. M/6th Street East, Ave. M/Challenger Way
Phase 5 (2009)	No additional signals required
Phase 6 (2013)	Ave. M/Loop Road East
Phase 7 (2017)	East-West Connector/Challenger Way
Phase 8 (2021)	No additional signals required

Loop Road West is the extension of 4th Street East. Loop Road East is the extension of 13th Street East. East-West Connector is the internal roadway that will parallel Avenue M.

The appropriate signal warrant calculations are included in the Appendix to this report.

3.4.2 Roadway Infrastructure

At project completion (2021), Avenue M has been projected to require four through lanes in each direction. This is the ultimate planned width of Avenue M per the City's General Plan. Avenue M currently has one or two lanes each way in the vicinity of the project site. Between now and 2021, the widening of Avenue M should be phased as follows:

Phase 1 (1996)	Two lanes each way between Sierra Hwy. and 15th St. East
Phase 2 (1997)	No change

Phase 3 (2001)	No change
Phase 4 (2005)	No change
Phase 5 (2009)	Three lanes each way between Sierra Hwy. and 4th St. East Two lanes each way between 4th St. E and Challenger Way
Phase 6 (2013)	Three lanes each way between Sierra Highway and Challenger Way
Phase 7 (2017)	Four lanes each way between Sierra Highway and 5th St. East
Phase 8 (2021)	Four lanes each way between Sierra Hwy. and Challenger Way Three lanes each way between Challenger Way and Loop Road East

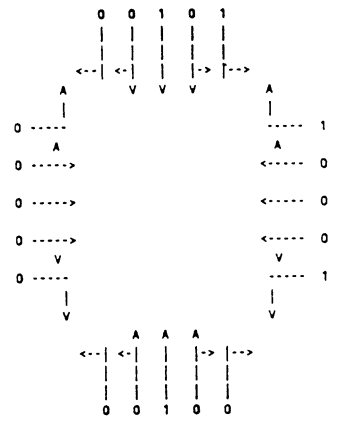
Because the analysis above is based more appropriately from a planning standpoint, intersection level of service improvements are addressed through the addition of travel lanes. Variations in trip generation and direction of approach as determined through this study may allow for mitigation of undesirable levels of service through additional turn lanes; either from the main street or side street.

From a traffic needs standpoint, all internal roadways are projected to operate at an acceptable level of service with one lane each way and a left-turn pocket at the intersection approaches. This is the case for all phases with one exception. The intersection of East/West Connector and Challenger Way will require two through lanes each way at completion of Phase 6. Though several of the internal four-legged intersections will have heavy right-turn movements none will require exclusive right-turn only lanes. The geometry of the internal intersections is represented schematically in Figure 3.7. As described earlier, these schematics do not reflect actual geometrics of the intersections.

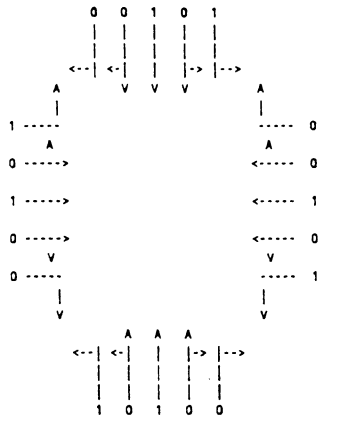
Most of the access roads will eventually need double left-turn lanes at the intersections with Avenue M, due to the heavy projected volume of traffic to/from the west. The phasing of these should be as follows:

Phase 1 (1996)	Single left-turn lanes sufficient
Phase 2 (1997)	Single left-turn lanes sufficient
Phase 3 (2001)	Single left-turn lanes sufficient
Phase 4 (2005)	Double left-turn lanes required at Loop Road West, 6th Street East
Phase 5 (2009)	Double left-turn lanes required at Challenger Way
Phase 6 (2013)	No additional locations require double left-turn lanes
Phase 7 (2017)	No additional locations require double left-turn lanes

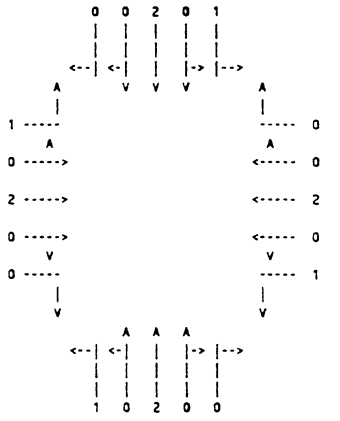
DKS Associates



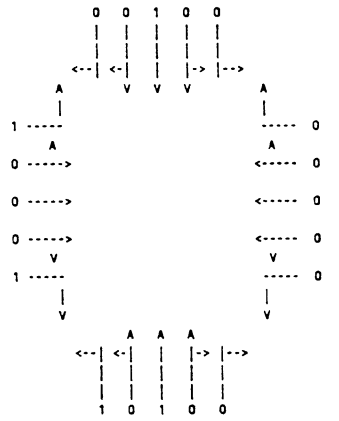
Loop Rd. West/E-W Connector



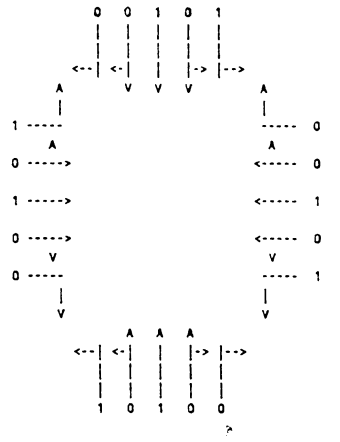
6th St. East/E-W Connector



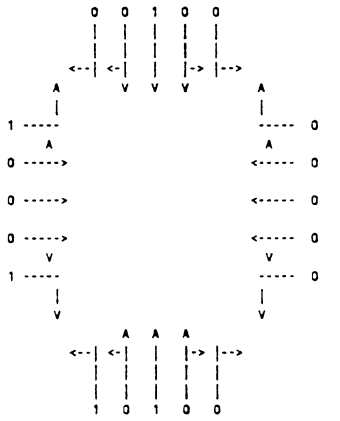
Challenger Way/E-W Connector



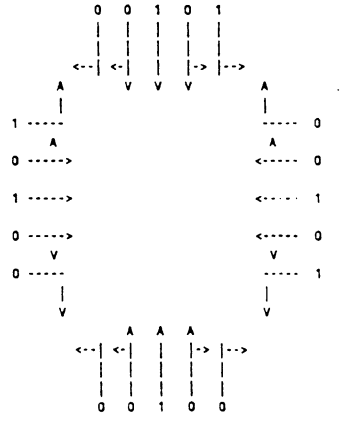
Loop Rd. East/E-W Connector



Challenger Way/6th St. East



Loop Rd. East/6th St. East



Challenger Way/Loop Rd. West

Figure 3.7
Proposed Geometry
Internal Intersections

Phase 8 (2021)	No additional locations require double left-turn lanes

3.4.3 Alternative Access

This section has been included to address the benefits on Avenue M should an alternative access be constructed. Currently there are two alternatives which are considered to be feasible. The first alternative represents an extension of the on-site East/West Connector Road to 15th Street East. This alternative is considered to provide measurable benefits to the access points along Avenue M but may not provide the necessary diversion of traffic to reduce the need for an eight-lane section early on in the project's life. This alternative will not be studied.

The alternative studied here has the potential to divert as much as 23% or more of the project traffic onto less congested roadways to the south and potentially remove the need for four travel lanes on Avenue M through the year 2021. This alternative would consist of the extension of Challenger Way to the southwest, crossing the Southern Pacific Railroad and intercepting Sierra Highway. The point at which Challenger Way intercepts Sierra Highway would be coincidental with or to the north of Avenue N. Access to Sierra Highway at this general location provides what is considered an attractive alternative to Avenue M. Access to land uses to the south of the project is more direct(assumed diversion, 12% of 15%). Freeway access and access to land uses west of the site are facilitated by Avenue N which is projected to maintain a level of service "A" per General Plan buildout as seen in Table 4.1(assumed diversion, 5% of 17%). It is also assumed that some project traffic (dependent on location relative to access points) from the north on Sierra Highway will use this access point rather than encounter additional delays on Avenue M(assumed diversion, 6% of 13%).

The refined schedule below indicates when infrastucture improvements can be anticipated to occur on Avenue M if the Challenger Way extension alternative access, as discussed, is constructed. This schedule assumes construction prior to Phase IV but it could be constructed at any time and still derive the same benefits. Other improvements such as additional left and right turn lanes have been included where necessary at isolated intersections.

Phase 4 (2005)	Two lanes each way between Sierra Hwy. and 15th Street East
Phase 5 (2009)	Three lanes each way between Sierra Hwy. and 4th St. east Two lanes each way between 4th St. E and Challenger Way
Phase 6 (2013)	Three lanes each way between Sierra Highway and Challenger Way
Phase 7 (2017)	Three lanes each way between Sierra Highway and 15th Street East. Add northbound right turn lane at 6th Street East and Avenue M.
Phase 8 (2021)	Four lanes each way between Sierra Hwy. and 7th Street East. Three lanes each way between 7th Street East and 15th Street East.

Tables 3.5 through 3.9 provide intersection analysis for intersections along Avenue M, both with and without the alternative access discussed in this section.

Table 3.5
Future Conditions With Project – Phase IV
Level of Service Analysis

Intersection	PM(1) V/C	LOS
Avenue M/SR–14 SB Ramps	0.60	B
Avenue M/SR–14 NB Ramps	0.49	A
Avenue M/10th Street West	0.57	A
Avenue M/Sierra Highway	0.60	B
Avenue M/4th Street East	0.89	D
Avenue M/6th Street East	0.74	C
Avenue M/10th Street East	0.47	A
Avenue M/13th Street East	0.29	A
Avenue M/15th Street East	0.33	A
Avenue M/20th Street East	0.25	A

(1) Two lanes each way on Avenue M

Table 3.6
Future Conditions With Project – Phase V
Level of Service Analysis

	Proposed Access Points(2)		With Alternative Access(2) (Challenger Way Extension)	
Intersection	PM V/C	LOS	PM V/C	LOS
Avenue M/SR–14 SB Ramps	0.51	A	0.47	A
Avenue M/SR–14 NB Ramps	0.43	A	0.41	A
Avenue M/10th Street West	0.56	A	0.53	A
Avenue M/Sierra Highway	0.60	B	0.52	A
Avenue M/4th Street East	0.86	D	0.74	C
Avenue M/6th Street East	0.79	C	0.77	C
Avenue M/10th Street East	0.52	A	0.52	A
Avenue M/13th Street East	0.36	A	0.36	A
Avenue M/15th Street East	0.39	A	0.39	A
Avenue M/20th Street East	0.30	A	0.30	A

(2) Three lanes each way between Sierra Hwy and 4th Street on Avenue M

Table 3.7
Future Conditions With Project – Phase VI
Level of Service Analysis

	Proposed Access Points(1)		With Alternative Access(1) (Challenger Way Extension)	
	PM		PM	
Intersection	V/C	LOS	V/C	LOS
Avenue M/SR–14 SB Ramps	0.59	A	0.55	A
Avenue M/SR–14 NB Ramps	0.51	A	0.48	A
Avenue M/10th Street West	0.66	B	0.63	B
Avenue M/Sierra Highway	0.69	B	0.60	B
Avenue M/4th Street East	0.83	D	0.74	C
Avenue M/6th Street East	0.77	C	0.75	C
Avenue M/10th Street East	0.56	A	0.53	A
Avenue M/13th Street East	0.39	A	0.38	A
Avenue M/15th Street East	0.34	A	0.34	A
Avenue M/20th Street East	0.32	A	0.32	A

(1) Three lanes each way between Sierra Hwy and Challenger Way on Avenue M

Table 3.8
Future Conditions With Project – Phase VII
Level of Service Analysis

	Proposed Access Points(2)		With Alternative Access(3) (Challenger Way Extension)	
	PM		PM	
Intersection	V/C	LOS	V/C	LOS
Avenue M/SR–14 SB Ramps	0.56	A	0.64	B
Avenue M/SR–14 NB Ramps	0.50	A	0.56	A
Avenue M/10th Street West	0.68	B	0.72	C
Avenue M/Sierra Highway	0.74	C	0.69	B
Avenue M/4th Street East	0.80	D	0.81	D
Avenue M/6th Street East	0.85	D	0.70	C
Avenue M/10th Street East	0.69	B	0.64	B
Avenue M/13th Street East	0.53	A	0.53	A
Avenue M/15th Street East	0.42	A	0.42	A
Avenue M/20th Street East	0.40	A	0.40	A

(2) Four lanes each way between Sierra Hwy and 5th Street on Avenue M
(3) Three lanes each way between Sierra Hwy and Challenger Way on Avenue M

Table 3.9
Future Conditions With Project – Phase VIII
Level of Service Analysis

	Proposed Access Points(1)		With Alternative Access(2) (Challenger Way Extension)	
	PM		PM	
Intersection	V/C	LOS	V/C	LOS
Avenue M/SR–14 SB Ramps	0.78	C	0.73	C
Avenue M/SR–14 NB Ramps	0.68	B	0.65	B
Avenue M/10th Street West	0.79	C	0.84	D
Avenue M/Sierra Highway	0.85	D	0.80	D
Avenue M/4th Street East	0.90	E	0.89	D
Avenue M/6th Street East	0.89	D	0.76	C
Avenue M/10th Street East	0.70	C	0.71	C
Avenue M/13th Street East	0.58	A	0.65	B
Avenue M/15th Street East	0.39	A	0.49	A
Avenue M/20th Street East	0.30	A	0.46	A

(1) Four lanes each way between Sierra Hwy and Challenger Way on Avenue M
(2) Three lanes each way between Sierra Hwy and Challenger Way on Avenue M

4.0 FUTURE CONDITIONS (BUILDOUT)

4.1 Methodology

This scenario considers traffic conditions at buildout of the City's General Plan. An Average Daily Traffic (ADT) analysis was performed for this scenario. This is more appropriate than peak hour analysis due to the fact that the traffic volumes are projected much farther into the future (2021 vs. General Plan buildout). The development of ADT volumes requires fewer assumptions than the development of peak hour volumes.

For consistency with the City's General Plan, trip generation for both the project land use and the General Plan land use was based on acreage values. Trip generation in the City's Travel Demand Model, upon which the General Plan is based, is performed using acreage. All work-related trip generation in the Travel Model already includes an overall 15 percent reduction for TDM measures. For this reason, specific TDM measures were not assumed for the project site.

4.2 Future Traffic Conditions

Table 4.1 contains a complete capacity analysis for all of the existing and planned major and minor arterials in the study area. The table identifies the planned geometrics, the facility type, the projected ADT, the planned capacity, the volume/capacity ratio and the service level. Street segments that operate at service levels D, E, or F are noted with an asterisk.

In general, the Palmdale Business Park Center land use alternative would provide better arterial operations than the land use proposed under the City's General Plan. Five arterial segments would operate at LOS D or worse with the General Plan land use alternative. Three arterial segments would operate at LOS D or worse with the project land use alternative.

4.3 Project Share

As stated earlier, Avenue M is ultimately planned at four lanes each way. The half street improvements adjacent to the project are to be constructed by the developer. Though the project fronts on Avenue M, between Sierra Highway and 15th Street East, it is not responsible for all the future traffic along this segment. The project, therefore, should only be responsible for the cost of widening the north half of Avenue M in direct proportion to the amount of traffic it contributes. However, the north half of Avenue M is within the City of Lancaster and there is no current mechanism to accomplish this contribution. The developer should work with the two Cities to determine a solution to this.

The technical method for determine a project's share of future traffic is called select-link analysis. A select-link analysis was performed using the City's Travel Demand Model to determine the percent of future traffic on Avenue M that is related to the project site. In a travel model, arterials are divided into a series of links; each segment between two adjacent intersections is one

Table 4.1
G.P. Buildout Conditions
ADT Level of Service Analysis

Roadway	From/To	Geometrics	Facility Type	Capacity	G. P. Land Use Volume	V/C	LOS	Palmdale BPC Land Use Volume	V/C	LOS
Avenue L	SR–14/4th St W	8 LANES	REG. ART.	80,000	67,000	0.84	D *	65,000	0.81	D *
	4th St W/Sierra Hwy	8 LANES	REG. ART.	80,000	65,000	0.81	D *	61,000	0.76	C
	Sierra Hwy/5th St E	8 LANES	REG. ART.	80,000	62,000	0.78	C	58,000	0.73	C
	5th St E/10th St E	8 LANES	REG. ART.	80,000	64,000	0.80	C	60,000	0.75	C
	10th St E/15th St E	8 LANES	REG. ART.	80,000	50,000	0.63	B	52,000	0.65	B
	15th St E/20th St E	8 LANES	REG. ART.	80,000	49,000	0.61	B	49,000	0.61	B
	20th St E/30th St E	8 LANES	REG. ART.	80,000	45,000	0.56	A	47,000	0.59	A
Avenue M	SR–14/4th St W	8 LANES	MAJOR	72,000	53,000	0.74	C	52,000	0.72	C
	4th St W/Sierra Hwy	8 LANES	MAJOR	72,000	51,000	0.71	C	48,000	0.67	B
	Sierra Hwy/5th St E	8 LANES	MAJOR	72,000	80,000	1.11	F *	72,000	1.00	F *
	5th St E/10th St E	8 LANES	MAJOR	72,000	60,000	0.83	D *	54,000	0.75	C
	10th St E/15th St E	8 LANES	MAJOR	72,000	45,000	0.63	B	41,000	0.57	A
	15th St E/20th St E	8 LANES	MAJOR	72,000	41,000	0.57	A	38,000	0.53	A
	20th St E/30th St E	8 LANES	MAJOR	72,000	47,000	0.65	B	44,000	0.61	B
Avenue N	SR–14/4th St W	6 LANES	MAJOR	54,000	22,000	0.41	A	22,000	0.41	A
	4th St W/Sierra Hwy	6 LANES	MAJOR	54,000	26,000	0.48	A	26,000	0.48	A
10th St W	Ave L/Ave M	8 LANES	MAJOR	72,000	37,000	0.51	A	35,000	0.49	A
	Ave M/Ave N	8 LANES	MAJOR	72,000	36,000	0.50	A	35,000	0.49	A
4th St W	Ave L/Ave M	4 LANES	MINOR	24,000	12,000	0.50	A	11,000	0.46	A
Division St	Ave M/Ave N	6 LANES	MAJOR	54,000	31,000	0.57	A	30,000	0.56	A
Sierra Hwy	Ave K/Ave L	6 LANES	MAJOR	54,000	21,000	0.39	A	19,000	0.35	A
	Ave L/Ave M	6 LANES	MAJOR	54,000	24,000	0.44	A	23,000	0.43	A
	Ave M/Ave N	6 LANES	MAJOR	54,000	48,000	0.89	D *	47,000	0.87	D *
	Ave N/Ave O	6 LANES	MAJOR	54,000	39,000	0.72	C	38,000	0.70	B
5th St E	Ave K/Ave L	6 LANES	MAJOR	54,000	22,000	0.41	A	20,000	0.37	A
	Ave L/Ave M	6 LANES	MAJOR	54,000	25,000	0.46	A	20,000	0.37	A
10th St E	Ave K/Ave L	6 LANES	MAJOR	54,000	27,000	0.50	A	26,000	0.48	A
	Ave L/Ave M	6 LANES	MAJOR	54,000	14,000	0.26	A	13,000	0.24	A
15th St E	Ave K/Ave L	4 LANES	MINOR	24,000	4,000	0.17	A	4,000	0.17	A
	Ave L/Ave M	4 LANES	MINOR	24,000	2,000	0.08	A	2,000	0.08	A
20th St E	Ave K/Ave L	6 LANES	MAJOR	54,000	15,000	0.28	A	14,000	0.26	A
	Ave L/Ave M	6 LANES	MAJOR	54,000	10,000	0.19	A	9,000	0.17	A

link. In addition, the City is divided into a series of zones, each zone containing several hundred acres. A select-link analysis indicates the proportion of traffic on any link due to each zone. For purposes of this study, the project site was modelled as a separate zone.

The analysis was performed using land use acreage values for both the project site and the remainder of the City. This was done to maintain consistency with the City's General Plan, which is based on the City's Travel Demand Model. The City's Travel Model contains land use in acreage.

The percentage of buildout traffic on Avenue M due to the project is indicated in Table 4.2 below.

Table 4.2
Select Link Analysis for Avenue M
Based on Two - Way ADT Volumes

From	To	% of Buildout Traffic Due to Palmdale B.P. Ctr.
Sierra Highway	3rd Street East	9.5
3rd Street East	5th Street East	8.5
5th Street East	10th Street East	8.0
10th Street East	15th Street East	7.0

4.4 Avenue M Grade Separation

There is currently an at-grade crossing of the Southern Pacific Railroad and Avenue M, just east of Sierra Highway. It may be desirable at some future time to grade separate this crossing. Because of this, site planning will provide the opportunity for a future grade separation. A summary of the feasibility and practicality of constructing this grade separation, from an earlier report, is discussed below.

A number of factors are considered pertinent to a grade separation evaluation. The primary factors are:

- Traffic volume
- Train volume
- Train crossing delay

- Accident history
- Geometric constraints
- Environmental constraints
- Engineering feasibility
- Traffic circulation needs
- Cost effectiveness
- Funding potential

The roadway geometry at the Avenue M crossing is primarily straight, with an existing roadway of 84 feet within a 100-foot right-of-way. It is classified as a regional arterial in the City's General Plan. This roadway currently carries an estimated 15,000 vehicles per day. The railroad averages 21 trains per day at this crossing. The vehicular delay due to a freight pre-emption of 4-minute duration during the evening peak period is estimated to be approximately 10,000 vehicle seconds.

Adjacent land use is primarily open land, with some commercial land use. There are currently no sensitive noise receptors within 500 feet of this crossing. Air quality benefits due to grade separation at this location are estimated to be average.

The major access concern is the lack of alternative routes within 1/2-mile of this crossing. This may lead to long detours to traffic to and from Sierra highway that currently crosses this railroad crossing at-grade. There would be no visual impacts due to an overpass at this location.

The cost of grade separation is estimated to be in the range of $7 to $11 million, depending on the complexity of the engineering design. Funding potential is poor as determined from the relative low number of road traffic/railroad conflicts.

Another concern at this location is that the City limit of Palmdale and Lancaster is at the centerline of Avenue M. Any grade separation scheme would require a cooperative effort by the two cities.

5.0 ACCESS BY OTHER MODES

5.1 Bus Access

As discussed in Chapter 2.0, three bus lines operate in the vicinity of the project site. These routes are shown in Figure 2.2. The Orange Line operates north-south on 10th Street West, the Blue Line runs to the north along Avenue K, and the Red Line operates along Avenue L.

Based on a study by URS Consultants, this site can be expected to employ between 9,000 and 10,000 people. Consistent with the City's plans to utilize bus service as part of its comprehensive vehicle trip reduction strategy, the transit routes in the area should be expanded/modified to serve this site once it has a practical number of occupants. All bus stops should be provided with attractive weather-resistant benches and/or shelters. Bus transit directories should be provided at each bus stop and placed at a height readable by wheelchair users. Meeting general transit needs this action will also help implement the TDM measures described earlier.

5.2 Bicycle Access

The City has recently adopted a Citywide Bikeway Plan. Arterials near the project site that are part of the Bikeway plan include Sierra Highway, Avenue M, 5th Street East, 10th Street East and Avenue L-8. Figure 5.1 indicates all the arterials in the vicinity of the project site that are part of the Bikeway Plan. On-site circulation should be designed to accommodate and encourage bicycle use. This could be done by providing on-street bicycle lanes and secured off-street bicycle parking and storage areas. These improvements will help in implementing the TDM measures describe earlier.

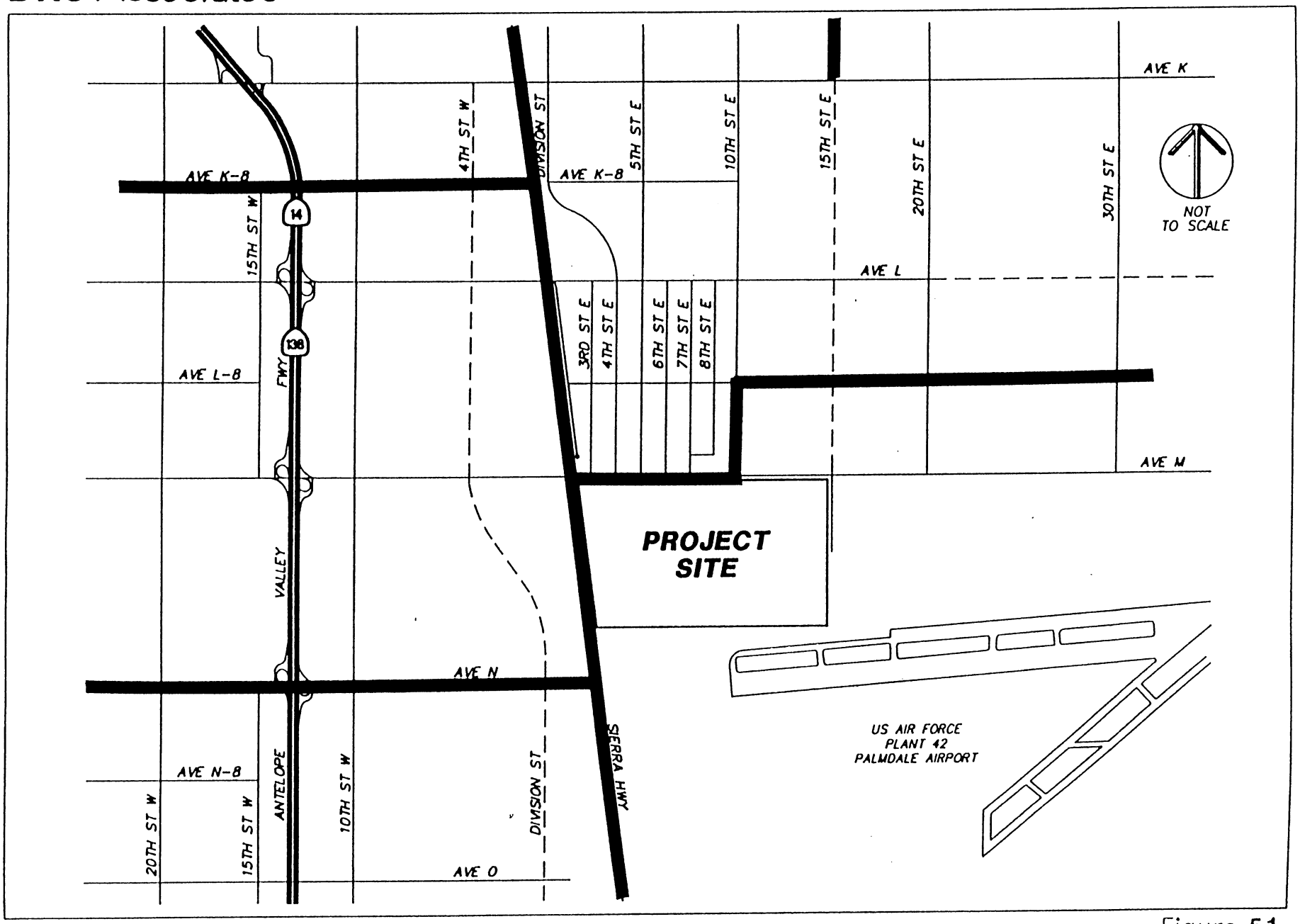


Figure **5.1**
CITY'S BIKEWAY PLAN

6.0 REVISED SUMMARY

6.1 Introduction

This project considers the development of the Palmdale Business Park Center in the City of Palmdale. The project site is bounded by Avenue M to the north, 15th Street East to the east, Sierra Highway to the west, and the US Air Force Plant 42 property to the south.

The project would consist of 63.0 acres of Community Commercial, 26.2 acres of Business Park, 89.3 acres of Airport Related (Warehouse), 167.1 acres of Light Industrial, and a Golf Course. The project is planned to be built over a period of 25 years in eight phases. Phase 8 (the final phase) is planned to be completed around the year 2021. This is based on current market projections and is subject to change. A full description of each phase is contained in the Specific Plan document of which this Traffic Study is an Appendix.

The City of Palmdale's General Plan assumed that the land use for the project site would consist of 150 acres of Office Commercial and 200 acres of Business Park space.

6.2 Existing Conditions

The study intersections are as follows:

1) Avenue L/Sierra Highway (Signalized)
2) Avenue L/10th Street East (Unsignalized)
3) Avenue M/SR 14 southbound ramps (Unsignalized)
4) Avenue M/SR 14 northbound ramps (Unsignalized)
5) Avenue M/10th Street West (Signalized)
6) Avenue M/Sierra Highway (Signalized)
7) Avenue M/4th Street East (Unsignalized)
8) Avenue M/10th Street East (Unsignalized)
9) Avenue M/20th Street East (Unsignalized)
10) Avenue N/Sierra Highway (Signalized)
11) Avenue M/4th Street West (Unsignalized)
12) Avenue M/6th Street East (Future)
13) Avenue M/13th Street East (Future)
14) Avenue M/15th Street East (Future)

The intersections of 3rd Street East, 5th Street East, 6th Street East and 7th Street East along Avenue M are all currently unpaved and carry very little traffic. Therefore, these intersections were not analyzed for existing conditions.

Currently, all the study intersections operate at LOS A during the morning peak hour. During the evening peak hour, all the study intersections operate at LOS B or better with the exception of Avenue M and 10th Street West which operates at LOS D.

Based on the existing peak hour volumes, one intersection satisfies the signal warrant analysis for at least one peak hour. The intersection is Avenue M and SR 14 northbound ramps. This

intersection has a large proportion of right-turning vehicles (about 20%, 10% to 15% is typical), however, and might not need a signal to operate acceptably.

6.3 Future Conditions (2021)

This scenario considers traffic conditions at buildout of the project site. The project would consist of 63.0 acres of Community Commercial, 26.2 acres of Business Park, 89.3 acres of Airport Related (Warehouse), 167.1 acres of Light Industrial, and a Golf Course.

At project completion (2021), the future number of lanes as indicated in the City's General Plan will be necessary for each study area roadway to accommodate projected traffic volumes. Additional lanes for left- and right-turning vehicles will be needed at the intersections.

An early arterial progression analysis of Avenue M was performed to determine the impacts of the proposed signal spacing. The results of the signal progression analysis for Avenue M indicated that good progression can be maintained during the AM peak hour and fair progression during the PM peak hour at completion of Phase 8. Several of the project intersections, however, are projected to operate over capacity, which would make achieving smooth progression difficult. The site configuration was subsequently changed to reduce the signalized intersection to four and received acceptance by city staff without additional progression analysis.

However, further improvements without removing any additional project signals would require a reduction in project-related traffic of about 25 percent. It is proposed that trips generated by the project be mitigated by a combination of roadway improvements and a pro-active Transportation Demand Management (TDM) program. The proposed TDM program includes reduction measures that are estimated to reduce trip generation by the necessary 25 percent. In addition, it is recommended that a Transportation Management Association District be established to initiate and manage the TDM program.

The actual TDM program for the Palmdale Business Park Center should be prepared by a qualified TDM consultant. The purpose of this discussion is to give an estimate of the level of traffic reduction that could be achieved for each of the proposed TDM measures. The actual level of traffic reduction achieved may be more or less than indicated. Table 6.1 contains a summary of the proposed geometric and TDM mitigation measures for the project. All study intersections are projected to operate at an acceptable level of service.

A signal warrant analysis was performed for the unsignalized study intersections in order to assess whether these intersections should be converted to signalized operation in the future. Based on the future peak hour volumes, all study intersections satisfy the signal warrant analysis for at least one peak hour.

Table 6.1
Schedule of Traffic-Related Improvements and Mitigation Measures

Phase	Geometric Improvements to Ave. M	Project Access Signalization	Total Reduction in Project Traffic Necessary %(Daily Reduction)	Measures Necessary to Achieve Traffic Reduction Target
1 (1996)	Ave. M remains @ 4 lanes	None required	---	None required
2 (1997)	No change	None required	---	None required
3 (2001)	No change	Loop Rd. W.	---	None required
4 (2005)	No change	6th St. E. Challenger Way	---	None required
5 (2009)	6 lanes, Sierra Hwy. to 4th St. E. 4 lanes, 4th St. E. to 15th St. E.	No add'l. req'd.	5%(0)	Flexible work shifts
6 (2013)	6 lanes, 4th St. E. to Challenger Way 4 lanes, Challenger Way to 15th St. E.	Loop Rd. E.	10%(2,098)	above plus Step I Car/vanpooling (1.15 AVR)
7 (2017)	8 lanes, Sierra Hwy. to 5th St. E. 6 lanes, 5th St. E. to Challenger Way. 4 lanes, Challenger Way to 15th St. E.	No add'l. req'd.	15%(4,627)	above plus Step II Car/vanpooling (1.20 AVR) Transit subsidies
8 (2021)	8 lanes, Sierra Hwy. to Challenger Way 6 lanes, Challenger Way to Loop Rd. E. 4 lanes, Loop Rd. E. to 15th St. E.	No add'l. req'd.	25%(10,749)	above plus Parking restrictions Telecommuting and/or alternative. access

Access to the site will be provided along Avenue M with full intersections at Loop Road West (4th Street East), 6th Street East, 10th Street East and Loop Road East. All intersections will be signalized. In addition, driveways will be provided opposite 3rd Street East and 7th Street East. A right-in/right-out only movement will be provided at all unsignalized access points.

All internal intersections are projected to operate at LOS C or better during both peak periods with or without the TDM measures.

From a traffic needs standpoint, all internal roadways are projected to operate at an acceptable level of service with one lane each way and a left-turn pocket at the intersection approaches. This is the case for all phases with one exception. The intersection of East/West Connector and Challenger Way will require two through lanes each way at completion of Phase 7. Though several of the internal four-legged intersections will have heavy right-turn movements none will require exclusive right-turn only lanes.

Construction of an alternative access from the intersection of Challenger Way and Loop Road West to Sierra Highway in the vicinity of Avenue N, if constructed, has the potential to divert a significant amount of project traffic away from Avenue M. This diversion of traffic results in reduced turning movements and through street volumes along Avenue M. Through this reduction of traffic on Avenue M, the necessity of constructing a eight lane roadway section can be reduced to a six lane section through project buildout.

6.4 Future Conditions (Buildout)

This scenario considers traffic conditions at buildout of the City's General Plan. An Average Daily Traffic (ADT) analysis was performed for this scenario. This is more appropriate than peak hour analysis due to the fact that the traffic volumes are projected much farther into the future (2021 vs. General Plan buildout). The development of ADT volumes requires fewer assumptions than the development of peak hour volumes.

In general, the Palmdale Business Park Center land use alternative would provide a better arterial operations than the land use proposed under the City's General Plan. Five arterial segments would operate at LOS D or worse with the General Plan land use alternative. Three arterial segments would operate at LOS D or worse with the project land use alternative.

As stated earlier, Avenue M is ultimately planned at four lanes each way and the project is responsible for constructing the south half of Avenue M adjacent to the site. Though the project fronts on Avenue M, between Sierra Highway and 15th Street East, it is not responsible for all the future traffic along this segment. The project, therefore, should only be responsible for the cost of widening the north half of Avenue M in direct proportion to the amount of traffic it contributes (and a mechanism needs to be found to accomplish that). The project contributes between seven and ten percent of the future traffic projected along Avenue M.

Avenue M is currently a low-priority candidate for grade-separation. Funding potential is poor as determined from the relatively low number of road traffic/railroad conflicts. Even though the current probability of construction is low, project site adjustments will be provided which would allow for the future construction of an Avenue M grade separation.

6.5 Access by Other Modes

Three bus lines operate in the vicinity of the project site. The Orange Line operates north-south on 10th Street West, the Blue Line runs to the north along Avenue K, and the Red Line operates along Avenue L.

Based on a study by URS Consultants, this site can be expected to employ between 9,000 and 10,000 people. Consistent with the City's plans to utilize bus service as part of its comprehensive vehicle trip reduction strategy, the transit routes in the area should be expanded/modified to serve this site once it has a practical number of occupants. All bus stop facilities that are provided as part of the project should meet current City design standards.

The City has recently adopted a Citywide Bikeway Plan. Arterials near the project site that are part of the Bikeway plan include Sierra Highway, Avenue M, 5th Street East, 10th Street East and Avenue L-8. On-site circulation should be designed to accommodate and encourage bicycle use. This could be done by providing on-street bicycle lanes and secured off-street bicycle parking and storage areas.

APPENDIX G

ENVIRONMENTAL ASSESSMENT

ENVIRONMENTAL ASSESSMENT
LOCKHEED 613-ACRE PARCEL
PALMDALE, CALIFORNIA

OCTOBER 10, 1991

McLaren Hart

October 10, 1991

Mr. Fred Reed
Lockheed Corporation
4500 Park Granada Boulevard
Calabasas, California 91302

Dear Mr. Reed:

ENVIRONMENTAL ASSESSMENT, LOCKHEED 613-ACRE PARCEL, PALMDALE, CALIFORNIA

This report presents the environmental assessment for Lockheed's 613-acre parcel in Palmdale, California. The parcel is bounded by Avenue M, Air Force Plant 42, and the Sierra Highway, and it is located approximately one mile north of Lockheed Plant 10. The report describes the results of a site inspection, aerial photograph review, and regulatory agency file review for the subject property.

Should you have any questions or comments on the report, please contact us.

Very truly yours,

Gary B. Taggart, C.E.G. #1061
Managing Principal

clm

Enclosure

11101 White Rock Road, Rancho Cordova, CA 95670 (916) 638-3696 FAX (916) 638-2842

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ENVIRONMENTAL ASSESSMENT
LOCKHEED 613-ACRE PARCEL
PALMDALE, CALIFORNIA

INTRODUCTION

This report presents the Phase I environmental assessment (EA) for a 613-acre parcel of land owned by Lockheed Corporation in Palmdale, California. The EA was completed at the request of Mr. Fred Reed of Lockheed Corporation. Activities conducted for the Phase I environmental assessment included review of aerial photographs, on-site inspection of the property, and review of regulatory agency files. The objective of these activities was to identify potential areas of environmental concern at the site, or areas of concern at neighboring facilities that have the potential to impact soil and/or groundwater conditions at the subject property. This report summarizes the observations noted during the site inspection as well as the results of the reviews of aerial photographs and agency files. This report has been subdivided into the following sections:

- Site Description
- Aerial Photograph Review
- Site Inspection
- Regulatory Agency File Review
- Conclusions and Recommendations

SITE DESCRIPTION

The subject 613-acre parcel is located approximately one mile north of Lockheed Plant 10 in Palmdale, California and is undeveloped. The location of the parcel is presented on Figure 1, and a plot plan of the 613-acre parcel is presented on Figure 2. The roughly rectangular parcel is bounded on the north by Avenue M, which forms the boundary between Palmdale and Lancaster west of 10th Street East; by Air Force Plant 42 on the east and south; and by Southern Pacific railroad tracks and the Sierra Highway on the west. There are no paved roads on the parcel. There are several dirt roads traversing the property. Although unnamed, several appear to be extensions of adjacent paved and unpaved streets, including Valley Line Road, 5th Street East, 10th Street East, Avenue M-8 and Avenue M-12. A narrow dirt track, shown as a single dashed line on Figure 2, parallels the eastern and southeastern property boundary. A second dirt track traverses the western portion of the property between Avenue M and Avenue M-8.

FIGURE 1
LOCATION MAP
OF 613-ACRE PARCEL
PALMDALE, CALIFORNIA

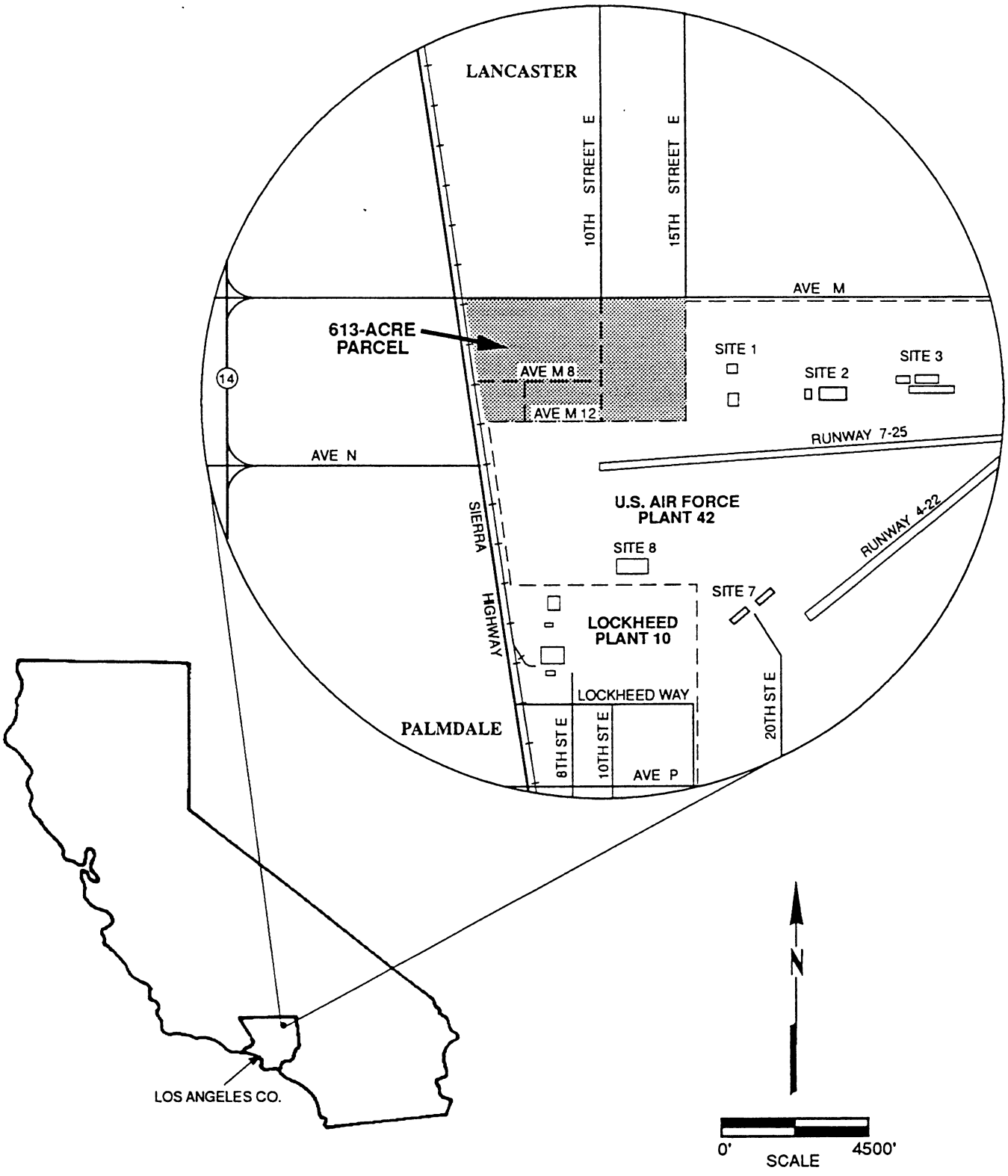
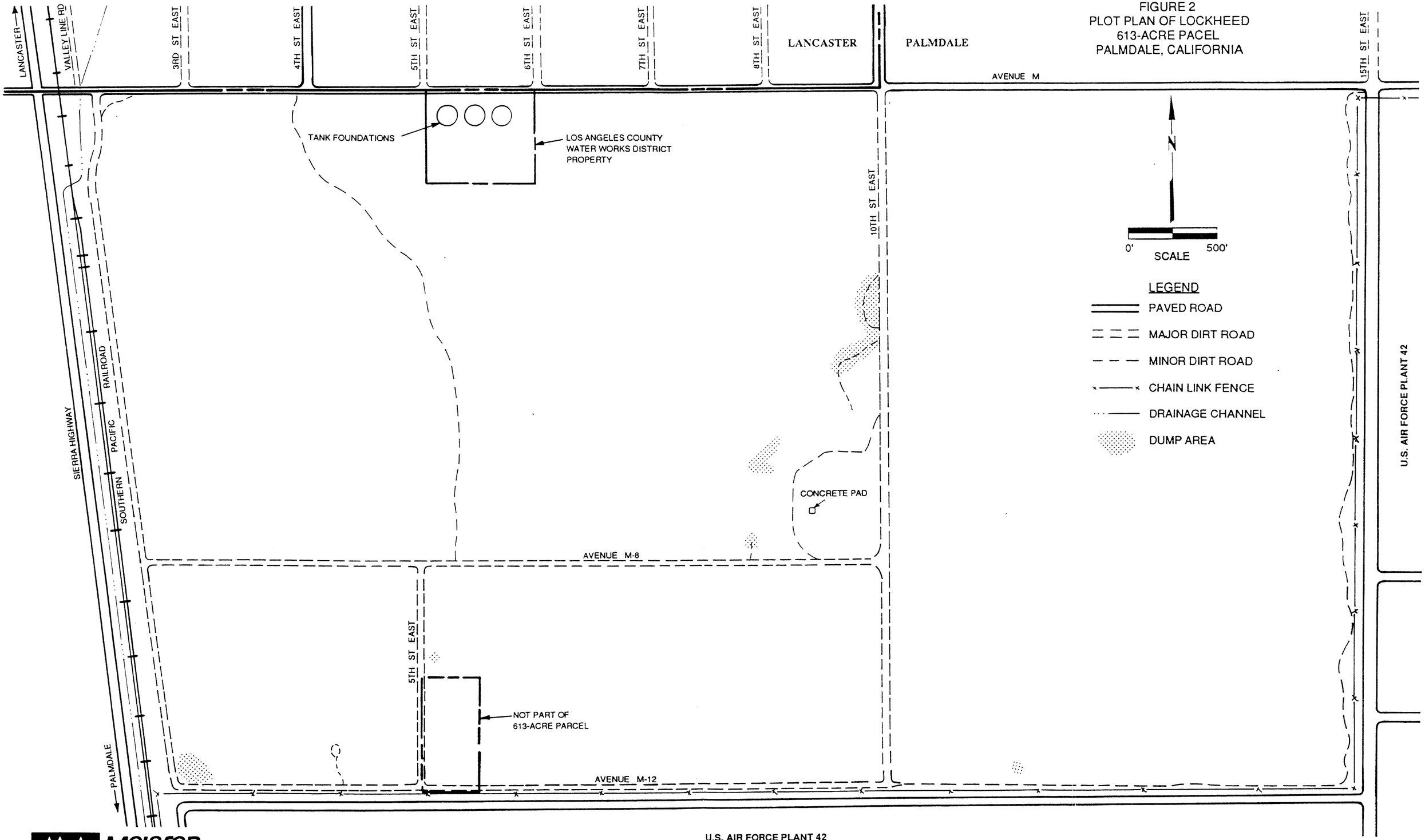


FIGURE 2
PLOT PLAN OF LOCKHEED
613-ACRE PACEL
PALMDALE, CALIFORNIA



Two small parcels within the area bounded by Avenue M and Avenue M-12 are excluded from the Lockheed property, as shown on Figure 2. The seven-acre parcel located south of Avenue M between 5th and 6th Streets East was sold recently by Lockheed to the Los Angeles County Water Works District. The five-acre parcel located on the south boundary of the subject property, at the northeast corner of the 5th Street East and Avenue M-12 extensions, belongs to a private party and has never been a part of the Lockheed parcel. Lockheed Corporation acquired the Palmdale property in 1984.

In general, the property slopes gently to the northeast, with a high point of approximately 2,550 feet above mean sea level (MSL) at the southwest corner and a low point of approximately 2,485 feet MSL at the northeast corner of the parcel. There is a well-defined drainage channel in the northwest corner of the parcel, and there are two drainage swales in the eastern portion of the property. Soils on the property are sandy alluvial soils of the Cajon and Adelanto series (USDA, 1970).

AERIAL PHOTOGRAPH REVIEW

Aerial photographs of the Lockheed Palmdale 613-acre parcel were reviewed to provide a history of land use practices and to identify past potential source areas of environmental concern. Aerial photograph coverage for this parcel was limited to three oblique photographs (dated 1951, 1958, and 1969) from the Spence collection at the University of California at Los Angeles and two vertical photographs (1970 and 1983) from the private collection of Brewster Pacific Corporation. The Fairchild Aerial Photograph Collection at Whittier College, the private aerial photograph companies of I. K. Curtis and American Aerial, the Los Angeles County Assessor and Department of Public Works, and the City of Palmdale Department of Planning and Engineering photograph collections did not include coverage of the Lockheed Palmdale 613-acre parcel. Supplemental information has been obtained from a 1968 aerial photograph presented in the United States Department of Agriculture Soil Conservation Service (SCS) soil survey report and a 1958 topographic map, which was photorevised in 1974, compiled by the United States Geological Survey.

The scale of the 613-acre parcel in the oblique photographs is such that details smaller than small buildings cannot be distinguished. The scale of the 1968 vertical photograph permits details as small as an automobile to be identified, while the scale of the 1970 and 1983 vertical photographs permits the identification of details as small as a building roof vent or a pick-up truck bed.

The 1951 oblique aerial photograph shows evidence of 10th Street East crossing the property from north to south. Avenue M and Avenue M-12 are present on the north and south perimeters of the property, respectively. Avenue M-8 and the short section of 5th Street East are not present on the photograph. Dense stands of Joshua trees

are present in the southwest and northeast portions of the 613-acre parcel on the 1951 photograph. Lighter-toned, rectangular areas of differing vegetation density in the northwestern and southeastern portions of the parcel suggest that portions of the parcel may have been fenced at one time and subjected to grazing in the past. Areas that are heavily grazed may appear lighter-toned on aerial photographs. However, fences were not distinguishable on the photograph. An irregularly-shaped, lighter-toned area is present on the west side of 10th Street East, approximately half way between Avenue M and Avenue M-12. No structures are visible on the photograph. The 1951 photograph does not show evidence of any structures immediately across Avenue M north of the subject property, although there appears to be a structure on the southwest corner of the intersection of the Sierra Highway and Avenue M. No structures were noted to the east of the parcel, and 15th Street East is not present. A runway that trends from southwest to northeast is present on the Air Force Plant 42 site, southeast of the subject property.

The 1958 photograph of the Palmdale 613-acre parcel shows evidence of the same road pattern that was present at the time of the site inspection. Avenue M-8 and 5th Street East are present in the southwestern portion of the parcel, and 15th Street East is present at the east end of the property. The vegetation patterns noted on the 1951 photograph are also visible on the 1958 photograph. No structures or fences are distinguishable at the site on this photograph. The southwest to northeast-trending runway (Runway 4-22) noted on the 1951 photograph and a newer runway that trends west to east (Runway 7-25) at Air Force Plant 42 are present south and southeast of the subject property. Large buildings at Air Force Plant 42 Sites 1 and 8 are visible east and south of the subject property, respectively. Numerous small buildings are present across Avenue M north of the subject property.

The 1968 photograph included in the SCS report indicates that there is a rectangular pattern of narrow dirt roads northwest of the Avenue M-8 and 10th Street East intersection. There is a small structure approximately 300 feet north and 400 feet west of the intersection, along a narrow dirt road that parallels 10th Street East. The use of the structure is unknown. A paved road is present parallel to Avenue M-12 on Air Force Plant 42 just south of the subject property. The vegetative patterns noted in 1951 and 1958 are still present in 1968, although the pattern is less distinct in the southeastern portion of the site.

A photograph dated November 24, 1969 shows no evidence of changes on the subject property from the 1968 photograph. The road patterns remained constant, and the small structure near the Avenue M-8 and 10th Street East intersection is still visible. Significant development has occurred at the Lockheed Plant 10 site, approximately one mile south of the subject property, since the 1968 photograph was taken. The site is undeveloped in the 1968 photograph, while in the 1969 photograph the site is graded, large buildings are present on the western portion of the Plant 10 site, and a taxiway is present connecting Plant 10 with the west end of Air Force Plant 42 Runway 7-25.

The 1970 vertical aerial photograph shows evidence of minor developments since 1969. A narrow dirt road or path runs from Avenue M near 4th Street East and travels south to Avenue M-8 near 5th Street East. Two additional small paths are noted on the west side of 10th Street East and one connects 10th Street East with the rectangular pattern of roads near the intersection with Avenue M-8, noted on the 1968 photograph. The small structure along a dirt road northwest of the intersection of 10th Street East and Avenue M can be identified as a concrete pad in this 1970 photograph. Trash and debris can be identified in the vicinity of the rectangular road pattern, the concrete pad, and along the minor dirt roads on the west side of 10th Street East. The rectangular vegetation pattern noted on all photographs since 1951 is present in the northwestern portion of the photograph only.

The 1958 topographic map and 1974 photorevision indicate that there are no significant structures on the 613-acre parcel. The concrete pad identified near the intersection of Avenue M-8 and 10th Street East on the 1970 aerial photograph is not shown on the topographic map. The topographic map shows approximately 45 small buildings within one-half mile of the north boundary of the parcel. Approximately one-third of the buildings were added in the 1974 photorevision. No structure is shown on the southwestern corner of the Sierra Highway and Avenue M. A long, narrow building at the northeast corner of the Avenue M and Valley Line Road was added in the 1974 photorevision. The two large buildings on Air Force Plant 42 Site 1 are shown; the northernmost was added in the 1974 photorevision. The large building at Air Force Plant 42 Site 8 is shown on the 1958 map, and Lockheed Plant 10 to the south of it is shown on the 1974 photorevision. No structures are shown within one mile west of the subject property.

The 1983 vertical aerial photograph, which is the same scale as the 1970 photograph, shows evidence of two minor differences. The narrow dirt road between Avenue M and Avenue M-8 is more distinct on the 1983 photograph, suggesting continued use from 1970 through 1983. The long, narrow building at the northeast corner of the intersection of Avenue M and Valley Line Road, as shown on the 1974 photorevised topographic map, is present on the 1983 photograph.

SITE INSPECTION

On August 28, 1991, McLaren Hart conducted a site inspection of the 613-acre Palmdale parcel shown on Figure 2. The perimeter of the parcel and the three dirt roads within the parcel were driven during the site inspection. The trail from Avenue M-8 near 5th Street East was driven to Avenue M near 4th Street East. Transects were made away from the roads on foot approximately every quarter-mile to examine the property more closely and to verify features noted on aerial photographs. There were no buildings on the parcel. Vegetation consisted of desert grasses, shrubs (creosote bush, rabbit brush, mormon-tea, cholla, buckwheat, etc.) and Joshua trees.

The parcel is generally free of signs of development or environmental disturbance. However, the site is not fenced or posted to prevent access from Avenue M and some minor dumping of trash was noted. The scattered trash and debris are mainly confined to the western quarter of the parcel, where the prevailing wind has blown paper and plastic onto the parcel from the Sierra Highway and points west. Areas more than 100 feet from paved and dirt roads have little or no debris, while areas near paved or dirt roads are lightly to moderately littered with debris and contained some distinct dump sites. Some of these dump sites appear to be over 20 years old, based on debris noted on the 1970 aerial photograph and the apparent age of some of the contents examined during the site inspection. Some debris appears to have been deposited recently, but there is no indication that littering or dumping has increased in recent years. Contents of the individual dump sites noted on the parcel are described below, and locations of the more concentrated dump areas are shown on Figure 2. The results of the site inspection are presented beginning in the northwest corner of the parcel and proceeding to the south and east.

An unlined, surface drainage channel approximately 2 feet deep is located in the northwest corner of the parcel and runs from under the railroad tracks approximately 500 feet north to Avenue M. The channel passes under Avenue M through culverts. Plastic and glass bottles, metal cans, and paper were noted in the channel during the site inspection. Empty motor oil, antifreeze, transmission oil, pool chlorine, spray paint, spray grease, and "D-encapsulant" (components include castor oil and wax) containers were noted in the channel. A small pile of asphalt was noted near the culverts.

There is debris along the portion of Valley Line Road that extends from Avenue M south to Avenue M-8. The debris consists mostly of paper, styrofoam, cardboard, and cans. Porcelain and glass insulators, fiberglass insulation, wood, scrap metal, and empty motor oil and starting fluid containers were also noted during the site inspection. Short sections of Valley Line Road are paved with asphalt. However, the road is mostly surfaced with dirt. Buried utilities are located along the road at the west edge of the parcel and include an Antelope Valley-East Kern (A.V.E.K.) water conveyance pipeline and telephone cables belonging to Pacific Bell, GTE Sprint, and AT&T. The water pipeline was indicated by three manholes located just east of Valley Line Road approximately 50 yards north of the intersection with Avenue M-8. A concrete vault inscribed with the date June 17, 1988 was located adjacent to one of the A.V.E.K. manholes. The locations of the buried telephone cables were indicated by signs that gave warning regarding excavating in the area. The cables are buried between the railroad tracks and Valley Line Road.

The portion of Valley Line Road from Avenue M-8 south to the southwest corner of the property at Avenue M-12 is littered with debris similar to the northern portion of the road. More concentrated debris was noted in a dump area at the intersection of Valley Line Road and Avenue M-12, as shown on Figure 2. The debris included wood, paper, cardboard, plastic, styrofoam, foil, and empty anti-freeze and muriatic

acid containers. An open one-gallon container of graphite lubricant (components include naphtha, methylene chloride, and petroleum distillates) was noted. There was approximately one pint of dried lubricant in the bottom of the container. No stains or evidence of spillage were noted on the soil surface near the container.

The amount of paper, cardboard, and plastic debris along Avenues M-8 and M-12 decreases as the roads approach 5th Street East. A short loop road that runs north from Avenue M-12 approximately 500 feet west of 5th Street East, as shown on Figure 2, was littered with debris including cans, concrete rubble, wood, and glass. An area on the north side of Avenue M-12 approximately 200 feet west of 5th Street East contained minor amounts of debris including cans, cardboard, glass, window blinds, pea gravel, and a few cinder blocks. As previously mentioned, a five-acre parcel at the northeast corner of Avenue M-12 and 5th Street East is excluded from the 613-acre Palmdale parcel. A small debris dump was noted north of this parcel, east of 5th Street East and approximately 500 feet south of Avenue M-8, as shown on Figure 2. Debris in the dump area included cans, glass, cloth, box springs, and empty motor oil, STP gas and oil treatment containers. An empty can that was labelled "Shell...35 lbs." appeared to be a grease container.

A narrow dirt road or path that runs from Avenue M near 4th Street East south to Avenue M-8 near 5th Street East was inspected. There were no cans or bottles along the road, and virtually no paper or plastic debris was noted during the site inspection. Transects were made on foot to the east and west of the path. No evidence of past fencing was found to explain the pattern of vegetation noted on photographs from 1951 to 1983.

The seven-acre parcel of land belonging to the Los Angeles County Water Works District (LACWWD) along Avenue M between 5th and 6th Streets East has been graded for the construction of above ground water storage tanks. Construction of three 120-foot diameter, circular, perimeter footings for the water storage tanks has been started. The footings are 3 feet deep and 7 feet wide. Two of the concrete footings have been poured, while the excavation for the westernmost footing was completed but the concrete had not been poured at the time of the site inspection. The initials LACWWD were noted on manhole covers located near Avenue M and east of the storage tank footings. Construction materials and debris, consisting mainly of lumber and iron reinforcing bar, are stored near the easternmost tank footing. An adjacent 200- by 450-foot area to the east of the LACWWD site has been cleared of vegetation. However, no construction activity was noted in this area.

Avenues M-8 and M-12 are virtually free of debris east of 5th Street East. A dump area at the end of a short road on the north side of Avenue M-8 approximately 800 feet west of 10th Street East contains paper, concrete, an empty 55-gallon drum with no top or bottom, cans, bottles, tires, sheet metal, and several empty plastic oil containers. A discarded oil filter was noted in this area, and there was a minor oil stain on the surface soil under the filter. No other stains or evidence of chemical use

or disposal were noted in this area. An area north of Avenue M-12 approximately 500 feet west of 10th Street East contains cans, cement, wood, glass, and a degraded plastic anti-freeze container.

The largest dump areas on the 613-acre Palmdale parcel were noted along the minor dirt roads west of 10th Street East between Avenue M and Avenue M-8, and northwest of the rectangular road pattern at the intersection of 10th Street East and Avenue M-8, as shown on Figure 2. Dumped debris in these areas consisted of paper, cardboard, plastic, styrofoam, glass, cans, sheet metal, pottery, furniture, televisions, clothes, toys, bicycles, phonograph records, carpet, linoleum tiles, lumber, bricks, concrete, shingles, fluorescent and incandescent light bulbs, tires, oil filters, empty bleach, lighter fluid, motor oil, coolant, and car wax containers, and other miscellaneous debris. An area extending approximately 200 feet east of 10th Street East across from this littered area contained lesser amounts of similar debris. Paper, plastic, styrofoam, and cardboard east of 10th Street East appeared to be mostly blown in from the west side of the road. A minor oil stain was noted on the surface soil beneath a discarded oil filter approximately 700 feet south of Avenue M on the west side of 10th Street East. No other stains or evidence of significant chemical disposal were noted in this area of the parcel.

Several small piles of asphalt were noted in a grassy area northwest of the intersection of 10th Street East and Avenue M-8. A 16- by 20-foot concrete pad, which was identified on 1970 and 1983 photographs, is located approximately 400 feet northwest of the same intersection. As previously discussed, a structure, which may have been a building or a concrete pad, was noted in this area on a 1968 photograph. The use of the concrete pad is unknown, however small extensions on the northeast and southwest sides of the pad appear to be entrances to a shed or residence. Minor amounts of cans and concrete rubble were noted near the concrete pad.

Cans and glass debris were noted along 10th Street East from Avenue M-8 to the southern parcel boundary at Avenue M-12. Debris in an area on the west side of 10th Street East approximately 300 feet south of Avenue M-8 included approximately 20 pounds of broken transite shingles.

Avenue M-12 is virtually free of litter from 10th Street East to the southeastern corner of the property. However, a minor dump area was noted on the north side of Avenue M-12 approximately 700 feet east of 10th Street East that contains cans, pottery, glass, and less than five pounds of transite shingles.

No distinct dump areas were noted along the narrow dirt road at the eastern property boundary, parallel to 15th Street East. Transects were made on foot to the west of the narrow road, and virtually no debris was present. There are high voltage

lines just east of the Air Force Plant 42 fence line from the southeast corner of the parcel to a point approximately one-quarter mile north, where the lines cross to the east over 15th Street East. No pole-mounted transformers were noted in this area.

A neighborhood drive-through survey was conducted within a half mile to the north of Avenue M from the Sierra Highway to 15th Street East and south on the Sierra Highway to a point one-half mile south of the subject property. There are no structures in the area north of Avenue M between 10th Street East and 15th Street East. Facilities located in the area north of Avenue M from Valley Line Road to 10th Street East consisted of construction/contractor yards, a mini-storage facility, a metal stamping company, a concrete batch plant, vehicle and equipment yards, a dog kennel, a small engine repair shop, a used tire storage yard, a portable toilet storage yard, welding yards, an insurance office, an automotive repair shop, a bar & grill, and residences. A contractors yard located approximately one-half mile north of the subject property between 8th Street East and 10th Street East contained three overfilled waste oil drums that were discharging oil to the soil. Underground fuel tanks and dispensers were noted in a yard behind Cates Construction Company at the northeast corner of Avenue M and Valley Line Road. No evidence of fuel leaks at this location were found during the regulatory agency file review discussed below. The Cates Construction Company building is the long, narrow structure shown on a 1974 photorevised topographic map, but not visible on a 1970 vertical aerial photograph, indicating that it was constructed in the early 1970s.

Businesses on the Sierra Highway north of Avenue M include a pool and spa shop, a carburetor shop, a batch plant, a motorcycle shop, a rental yard, a liquor store, a motel, a restaurant, a realty office, and a mini-mart/gas station. The Sierra Gateway Center, which includes a paint store, radio station, and gym, is located west of the subject property. All of the above facilities are on the west side of the Sierra Highway. The railroad tracks are located east of the highway.

REGULATORY AGENCY FILE REVIEW

The subject 613-acre Palmdale parcel is undeveloped land. As such, regulatory agency files do not exist for the parcel. A search of federal, state and local government databases was conducted for the area within approximately one-half mile of the parcel by Vista Environmental Information, Inc. (Vista). The databases searched by Vista included the following:

- U.S. Environmental Protection Agency (EPA)

  Comprehensive Environmental Response Compensation and Liability Act Information System (CERCLIS)

  National Priority List (NPL)

Federal Superfund Liens

- Governor's Office of Planning and Research

  Hazardous Waste and Substance Sites List (Cortese List)

- Department of Toxic Substances Control, California Environmental Protection Agency (TSC)

  1989 Bond Expenditure Plan (BEP)

  Hazardous Waste Property and Border Zone Property Act Sites (HWP)

  Abandoned Sites Program Information System (ASPIS)

  Hazardous Waste Information Systems (HWIS)

- California Waste Management Board

  Solid Waste Information System (SWIS)

- California Regional Water Quality Control Boards

  Leaking Underground Storage Tanks (LUST)

- California County Departments of Health

  County Environmental Health Department Data

The purpose of the database search was to identify locations of environmental concern in the vicinity of the subject property. The database search was supplemented by a drive-through survey of the neighborhood surrounding the 613-acre parcel and a review of material collected during a previous McLaren/Hart environmental assessment for four Lockheed-owned parcels located approximately two miles south of the subject property (McLaren, 1990). Files for the identified locations of environmental concern were obtained from the appropriate agencies to assess potential impacts on soil and groundwater at the subject property. Additional agencies, such as the Los Angeles County Department of Public Works, Hazardous Materials Division, and the California Department of Fish and Game, were contacted for environmental information on the general area surrounding the Palmdale parcel that was not necessarily tied to a specific location of environmental concern. The following agencies were contacted:

- U.S. Environmental Protection Agency (EPA)
- Department of Toxic Substances Control, California Environmental Protection Agency (TSC)
- California Regional Water Quality Control Board - Lahontan Region (RWQCB)
- Los Angeles County Department of Public Works, Hazardous Materials Division (LACDPW)
- Los Angeles County Water Works District (LACWWD)
- Los Angeles County Fire Department, Hazardous Materials Unit
- Los Angeles County Environmental Health Department
- South Coast Air Quality Management District (SCAQMD)
- California Department of Fish and Game

The regional groundwater aquifer in the vicinity of the 613-acre parcel occurs at a depth of approximately 350 feet to 450 feet below ground surface, and has lowered in past years due to pumping for agricultural and municipal use in the area. The regional groundwater flow direction is northerly to northeasterly, and is reportedly northeasterly in the vicinity of Air Force Plant 42 and the 613-acre Palmdale parcel. However, the regional groundwater flow direction can be significantly altered by groundwater pumping in local areas of the Palmdale-Lancaster region. Of the facilities discussed below, Air Force Plant 42 Site 8 and Lockheed Plant 10 are located south (up gradient) of the subject facility. The remaining facilities are located down gradient or cross gradient from the subject parcel. The direction of surface water flow in the area of the subject property is northerly to northeasterly, according to the review of aerial photographs, topographic maps and the site inspection.

Relevant information obtained for locations of environmental concern and for the general area of the subject property is discussed below by agency. A certain amount of duplication of records on file was noted between the different agencies. The information is presented according to the agency that generated the documents.

U.S. Environmental Protection Agency (EPA)

The CERCLIS list of contaminated properties is maintained by the EPA under the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA), commonly known as the federal "Superfund" program. Air Force Plant 42, located directly south and east of the subject property, is included on the CERCLIS list. Once a site is included on the CERCLIS list, an environmental hazard investigation is performed and the site is ranked according to priority for remedial funding. Sites which present the greatest risk are listed on the National Priority List (NPL). Air Force Plant 42 is not an NPL site. A preliminary assessment investigation is currently underway at the plant, and a Phase II Stage 1 Report and Phase II/IVA Stage 2 Draft Work Plan have been completed. The California Department of Toxic Substances Control is the lead agency for the investigation, and the results to date are discussed below.

Department of Toxic Substances Control, California Environmental Protection Agency (TSC)

The TSC was formerly the Toxic Substances Control Division of the California Department of Health Services (DHS). TSC was expanded to a full department independent of the DHS when the California Environmental Protection Agency was formed in July 1991. As used in this report, TSC refers to both the present department and the former division of DHS.

The HWIS list is a register maintained by TSC of hazardous waste generators and treatment, storage and disposal facilities in the state. The Rockwell facility at Site 1 of Plant 42 is included on the HWIS list as a hazardous waste generator. Air Force Plant 42 is discussed below.

Air Force Plant 42 is included on the ASPIS, Cortese, and Bond Expenditure Plan (BEP) lists. The ASPIS list identifies sites that may have become impacted with hazardous constituents by past practices. The ASPIS list has been developed primarily from information gathered during a preliminary survey conducted in the early 1980s. Each listed site has been ranked according to priority for further action required. The ASPIS list indicates that Air Force Plant 42 is currently a BEP site. Air Force Plant 42 is also registered in the Cortese list of potential and confirmed hazardous waste sites because of its inclusion on the BEP list.

The BEP is a TSC plan for abatement of verified hazardous waste sites under the Hazardous Substance Account and Hazardous Substance Cleanup Bond Act of 1984. According to the BEP, Air Force Plant 42 is scheduled to be in the site characterization phase until April 1994, and the remedial action plan is scheduled to be certified by December 1996. According to the TSC case manager for Air Force Plant 42, a Remedial Action Order scheduled for July 1991 has not been issued yet,

and further site investigation work may be needed before it is issued. In addition, TSC and the RWQCB are currently negotiating to determine which agency will be the lead agency for the continuing work at Air Force Plant 42.

In order to obtain more information concerning the site investigations at Air Force Plant 42, the files and reports pertaining to the plant were reviewed at the TSC Burbank office. A Preliminary Site Assessment-Phase I investigation report identified 23 areas of potential contamination at the Plant 42 site, where past and present activities, including aircraft maintenance, fuel storage, industrial and domestic waste disposal, building maintenance, and discharge of miscellaneous combustible materials during fire training activities, may have resulted in discharge of chemicals. The initial assessment identified the potential for soil contamination with fuel, oils, solvents, paint, acids, heavy metals, and polychlorinated biphenyls (PCB). Three additional potential contamination areas were later identified at two vehicle washracks and an underground storage tank location. Engineering Sciences, Incorporated (ESI) completed Phase II Stage 1 soil boring and sampling activities at a total of 26 sites by February 1988. As a result of the soil investigations, contamination was identified at six sites, located more than one-half mile from the subject property. Further investigation was recommended at four of the sites and remedial action was recommended at two of the sites. The ESI report states that no apparent contamination was found at the other 17 sites identified in the initial assessment. No significant contamination was found at the two vehicle washracks. Limited contamination was found at the underground storage tank location, which is discussed more fully below in the RWQCB section of this report.

The two areas recommended for remedial action consist of a fuel-contaminated ditch and an engine run-up area. Both areas are approximately 5,000 feet directly east (cross gradient) of the subject site. The Stage 1 Report states that petroleum hydrocarbons and volatile organics were detected in 10 of 12 soil borings drilled at the fuel-contaminated ditch, and that concentrations of petroleum hydrocarbons exceeded 1,000 mg/kg in five of the borings at depths up to 50 feet. The report states that petroleum hydrocarbons were detected in 4 of 7 soil borings drilled at the engine run-up area. Concentrations of petroleum hydrocarbons exceeding 3,000 mg/kg were detected at depths up to 30 feet in these four borings. Petroleum hydrocarbon concentrations over 3,000 mg/kg were detected in soil samples from depths up to 150 feet in one of the soil borings at the engine run-up area.

Two of the areas recommended for further investigation are an abandoned fire training area and a new fire training area located approximately 3,500 feet southeast of the southeast corner of the subject 613-acre parcel. The Stage 1 Report characterized the abandoned fire training area as contaminated with oil and grease at concentrations exceeding 1,000 mg/kg to a depth of 30 feet. Volatile organic compounds were also detected in soils in this area. The report states that no contaminants were detected in soil samples from one location at the new fire training

area. However, the report concluded that the presence and extent of contaminants was not determined at other locations near the new fire training area where evidence of possible contamination was observed during field activities.

Further investigation was also recommended at a triethyl borane (TEB) disposal area located approximately 5,000 feet east of the subject 613-acre parcel. The ESI report states that petroleum hydrocarbons were detected in a soil sample from a depth of 10 feet at one location in concentrations exceeding 3,500 mg/kg.

The fourth area recommended for further investigation is the original fire training area located approximately 8,000 feet southeast of the subject site. The ESI report states that oil and grease and volatile organics were detected in one location, and concentrations of oil and grease exceeded 1,000 mg/kg to a depth of 10 feet.

In addition to soil investigations, seven existing potable water supply and fire protection wells on the Air Force Plant were sampled in early 1986 and analyzed for purgeable halocarbons (EPA method 601) and purgeable aromatics (EPA method 602). Two of the sampled wells were also analyzed for total nickel and total cyanide. Laboratory analyses of the groundwater samples did not detect the presence of any of the compounds analyzed, with the exception of 1.6 μg/l 1,1,1-trichloroethane detected in a sample from one well, but not confirmed in a duplicate sample taken from the well.

California Regional Water Quality Control Board - Lahontan Region (RWQCB)

Although TSC is currently the lead agency for the site investigation at Air Force Plant 42, the RWQCB may assume that role in the future. Personnel at the RWQCB have stated that the groundwater sampling to date has been inconclusive in determining whether groundwater has been impacted at the Air Force Plant 42 site because only deep water supply wells have been sampled. The wells were sampled five years ago, and five of the seven wells sampled are located one-half mile or more from the areas of identified soil contamination at the site. The RWQCB sent a letter dated August 28, 1991 to the Air Force indicating that the Remedial Investigation Work Plan for Plant 42 was not adequate because it did not provide for adequate groundwater characterization. A Cleanup and Abatement Order has not yet been issued by the RWQCB for the site, but the RWQCB indicated that a requirement for installation of monitoring wells to characterize groundwater quality beneath the site will be part of the Order when it is issued.

The California Water Resources Control Board maintains a list of all known leaks of hazardous substances from underground storage tanks within the state. The RWQCB maintains Leaking Underground Storage Tank (LUST) lists on leak cases in its jurisdiction. Review of the LUST list compiled by the RWQCB indicated that the following facilities, located in the vicinity of the 613-acre parcel, are the subjects of current or past RWQCB investigations:

- Air Force Plant 42

- 42142 North Valley Line Road

Air Force Plant 42 was included on the LUST list as a suspected leak site. The RWQCB files and reports pertaining to Air Force Plant 42 were reviewed at the agency's Victorville office. The ESI Phase II Stage 1 investigation of the plant identified two leaking underground storage tanks located approximately 8,000 feet southeast of the subject site. The Stage 1 investigation report concluded that the location and amounts of contaminants detected at the tanks were not sufficient to pose a threat to human health or the environment.

The unnamed site at 42142 North Valley Line Road, approximately 1,000 feet north of the northwest corner of the subject property, is designated as requiring no further action by the RWQCB or local agency. A file for the site was found at the Los Angeles County Department of Public Works and is discussed below.

Los Angeles County Department of Public Works, Hazardous Materials Division (LACDPW)

In order to obtain additional information pertaining to the underground storage tank located at 42142 Valley Line Road in Lancaster, records were reviewed at the Los Angeles County Department of Public Works (LACDPW) Hazardous Materials Division office in Alhambra. A 10,000-gallon underground diesel tank, located approximately 1,000 feet north of the northwest corner of the subject site, was removed on February 15, 1989. The tank removal report concluded that "...no significant petroleum hydrocarbon contamination underlies the tank pit." A closure letter issued by LACDPW for the site on March 12, 1990 stated "no further action required at this time."

Los Angeles County Water Works District (LACWWD)

As described above in the Site Inspection section of this report, construction activity was noted on the 7-acre LACWWD parcel located at the northern edge of the subject site. The district was contacted to determine if any facilities of environmental concern were planned for the area. LACWWD personnel stated that the current phase of construction calls for four three-million gallon water storage tanks at the northern end of the parcel. Subsequent stages of construction will include eight water storage tanks to the south of the initial four tanks and an electrically-operated pump station at the northwestern corner of the property. A 24-inch water main, a 48-inch transmission line, and a 30-inch A.V.E.K. supply line serving the storage tanks are located beneath Avenue M.

Los Angeles County Fire Department, Hazardous Materials Unit

The Hazardous Materials Unit of the Los Angeles County Fire Department was contacted in writing for information regarding hazardous materials incidents in the vicinity of the 613-acre Palmdale parcel. As of this writing, the County Fire Department has not replied.

Los Angeles County Environmental Health Department

The Los Angeles County Environmental Health Department database includes listings of active and inactive landfills and a Site Mitigation log. No active or inactive landfills were listed in the vicinity of the 613-acre Palmdale parcel. Air Force Plant 42 is listed in the County Site Mitigation log based on the potential contamination of soils with oils, solvents, paint, heavy metals and PCBs. Plant 42 is discussed above.

South Coast Air Quality Management District (SCAQMD)

The South Coast Air Quality Management District provided wind roses for Lancaster, the nearest station to the 613-acre Palmdale parcel. The information provided by SCAQMD indicated that the wind direction in the vicinity of the subject property is west-northwesterly to south-southwesterly approximately 80 percent of the time. No significant information was provided by SCAQMD on potential sources of airborne contaminants on the subject property or within one-half mile of the property.

California Department of Fish and Game

The California Department of Fish and Game maintains a Natural Diversity Database that contains information on rare and endangered plants, animals, and natural communities in the State of California. Information from the database was requested for the Lancaster West and Lancaster East Quadrangles. No information had been received as of this writing.

The California Native Plant Society (CNPS) publishes an inventory of rare and endangered plants in California (CNPS, 1988). There are no state or federally listed rare, threatened, or endangered plants in the vicinity of the Palmdale parcel.

CONCLUSIONS AND RECOMMENDATIONS

No evidence of significant chemical use, storage or disposal was found at the 613-acre Palmdale parcel based on the aerial photograph review, the site inspection, and the regulatory agency file review. A small concrete pad, dirt roads, and electrical, telephone and water utilities were the only evidence of development on the parcel.

No significant potential sources of contamination were noted at any of these features. Although small amounts of household debris were noted on the property, no evidence was found to suggest the disposal of significant quantities of chemicals to soils on the subject property. Based on the review of aerial photographs and agency files and the neighborhood drive-through survey, there is minimal potential for contamination of the soil at the 613-acre parcel from off-site sources.

Investigations are being conducted at the adjoining Air Force Plant 42 site to further characterize areas of potential soil contamination and to determine whether contaminants detected in soils have impacted underlying groundwater. Since available information indicates that the general direction of groundwater flow in the area is northeasterly, and since the areas of identified soil contamination are located over 4,000 feet east and 3,500 to 8,000 feet southeast of the 613-acre parcel, it is considered unlikely that the groundwater beneath the subject site has been impacted by these areas of contamination. However, if results of groundwater investigations detect the presence of contamination beneath Plant 42 and if localized flow directions are found to vary from the regional northeasterly trend, a potential would exist for groundwater beneath the site to become impacted.

It is recommended that the results of continuing groundwater investigations at the Air Force Plant 42 site be reviewed as they become available to further assess the potential for groundwater contamination beneath the subject property. However, no further investigations are recommended at the 613-acre parcel at this time, based on the results of the Phase I environmental assessment.

REFERENCES

California Native Plant Society. 1988. "California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California." Special Publication No. 1, Fourth Edition. September 1988.

McLaren Environmental Engineering Corporation (currently McLaren/Hart). 1990. "Environmental Assessment, Lockheed Corporation, Parcels 1 through 4, Palmdale, California." March 6, 1990.

United States Department of Agriculture, Soil Conservation Service. 1970. "Soil Survey, Antelope Valley Area, California." January 1970.

APPENDIX H

PRELIMINARY GEOTECHNICAL INVESTIGATION

PRELIMINARY
GEOTECHNICAL INVESTIGATION
Located Southerly Adjacent to M Street
Easterly of Sierra Highway
of Lockheed 613 Acre Parcel
City of Palmdale
COUNTY OF LOS ANGELES, CALIFORNIA

****

PACIFIC SOILS ENGINEERING, INC.

October 30, 1992
Work Order 101849

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TABLE I - Log of Test Pits

PLATES A-1 through A-31: Log of Borings
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APPENDIX III - Percolation Test Results

FIGURES

1 - Vicinity Map	following page 1
2 - Land Use Analysis	following page 1
3 - Percolation Rates	following page 5
4 - Geologic Setting	following page 6

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Mr. Kendl Philbrick
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c/o Mr. Bill Stevenson
Harrison Price Company
970 West 190 Street, Suite 580
Torrance, CA 90502

October 30, 1992

Work Order 101849

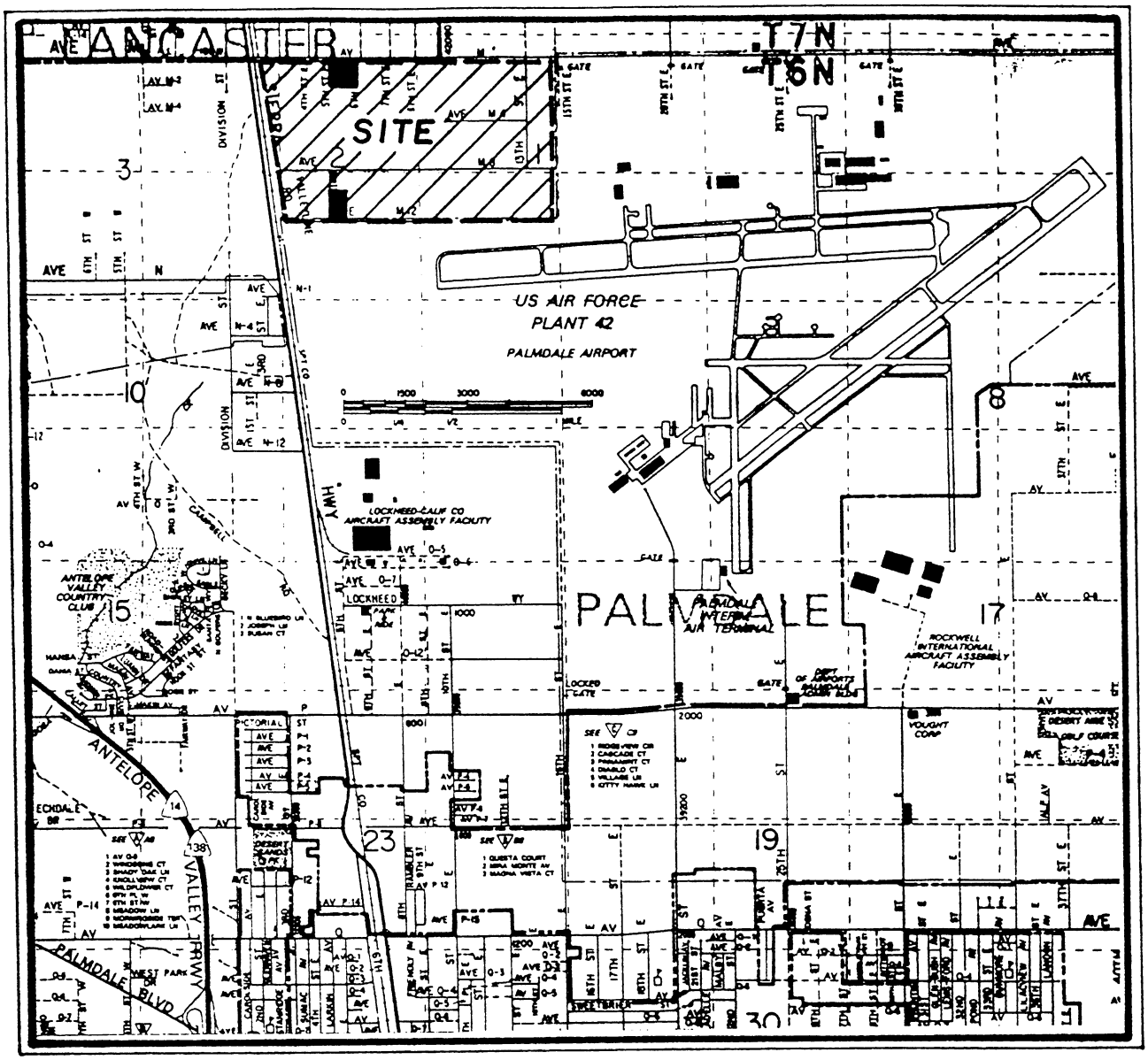
Subject: **PRELIMINARY**
GEOTECHNICAL INVESTIGATION
Located Southerly Adjacent to M Street
Easterly of Sierra Highway
of Lockheed 613 Acre Parcel
City of Palmdale
COUNTY OF LOS ANGELES, CALIFORNIA

References: See Appendix I

Gentlemen:

As per your authorization, Pacific Soils Engineering, Inc., has performed a preliminary geotechnical investigation of the subject site relative to development of a proposed retail/commercial/ office business park and companion golf facility. The site location is shown in Figure 1. The tentative development is shown on Figure 2, "Land Use Analyses - Palmdale Site Plan", prepared by David A. Price Associates. Enclosed with this report is a topographic map of the site at a scale of 1" = 200', with contour intervals of 2 to 10 feet prepared by Church Engineering, Inc.

Included in this study was a site reconnaissance, excavation, logging and sampling of 40 exploratory test pits to depths of about 10 feet, drilling, logging and sampling of 15 exploratory borings to depths of 40 feet and the conversion of the borings to percolation test wells, field testing of the wells to determine absorption rates, and laboratory analyses of the samples obtained



VICINITY MAP

NO SCALE

FIGURE 1

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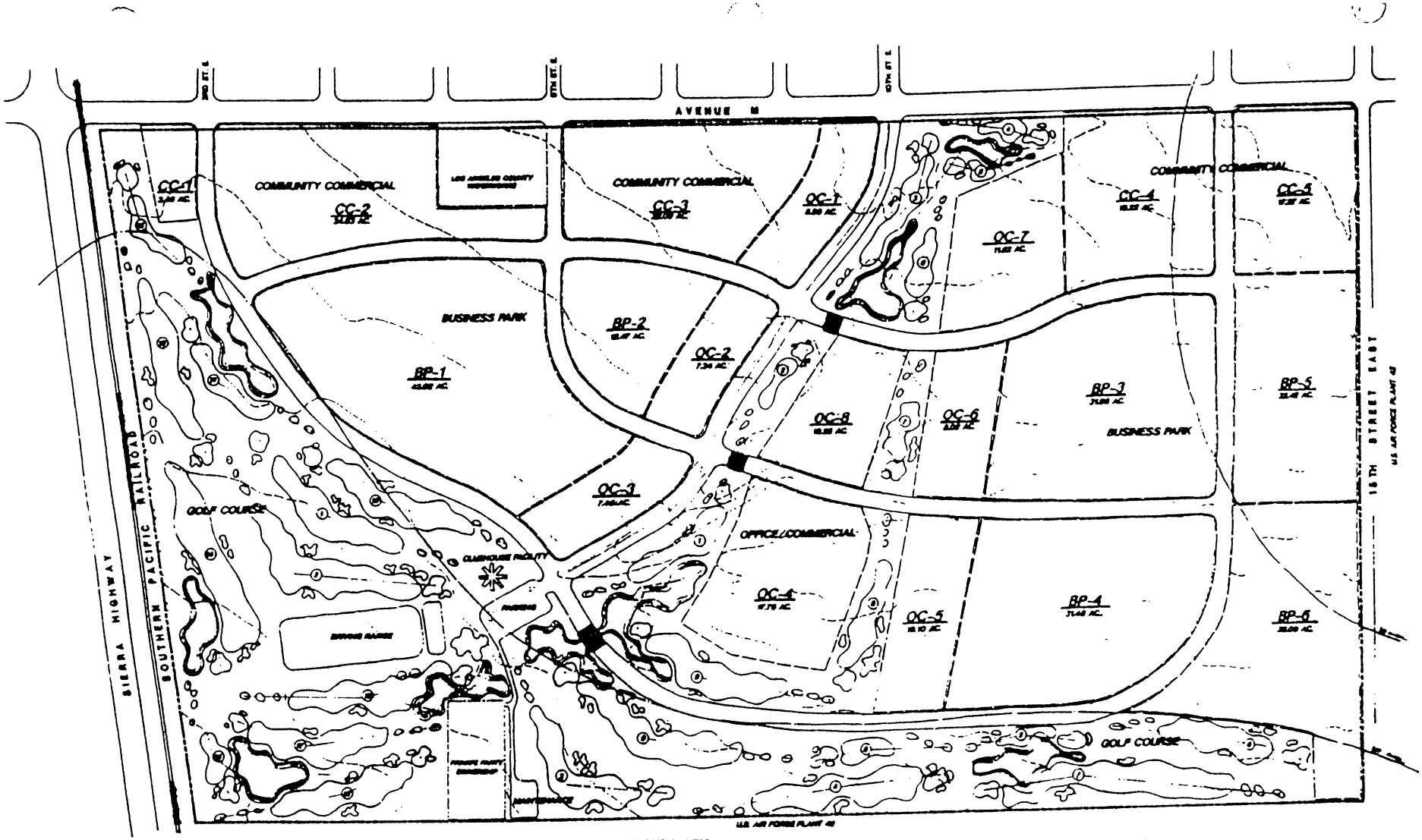

PROJECT SUMMARY

LAND USE ANALYSIS

PALMDALE SITE PLAN

PALMDALE, CALIFORNIA

LOCKHEED CORPORATION
4500 PARK GRANADA BLVD
CALABASAS, CA. 91399-0220
(818) 8762212

David A. Price
ASSOCIATES

FIGURE 2

PACIFIC SOILS ENGINEERING, INC.
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from the pits and borings and a seismotectonic evaluation based on published and unpublished geologic reports. Based on this preliminary geotechnical study, the subject site appears suitable for the intended development. Owing to the proximity of the site to the San Andreas fault, intense ground shaking and related phenomenon may be expected at the site during a major earthquake on that fault but the potential for tectonic ground rupture is considered low.

SITE CONDITIONS

The 613-acre parcel is roughly rectangular in shape, bounded by Avenue M on the north, Avenue M-12 on the south, 15th Street East on the east and the Southern Pacific Railroad right-of-way on the west. Within the above boundaries are two parcels which are not a part (NAP): one is an 7± acre plot on the south side of Avenue M between 5th Street East and 6th Street East (Los Angeles County Water Works District); and the other a 5± acre plot at the north-east corner of Avenue M-12 and 5th Street East.

Several dirt roads and trails traverse the site. Except for the concrete pad and cleared area in the vicinity of Avenue M-8 and 10th Street East, the site is devoid of signs of past usage and is essentially in a native state. Stands of Joshua trees are present, particularly in the northeast and southwest portions of the site. Native chaparral and grasses are ubiquitous. The ground is flat to slightly rolling terrain with a high elevation

in the southerly corner of 2551 feet and a low in the northeasterly corner of 2487 feet (64 foot differential). The major "land feature" is a large north to northeasterly draining draw in the central part of the site. Lesser drainage draws are present within the northeasterly and northwesterly property boundaries. To the south and east are U.S. Air Force Plant 42 properties. To the west is the Southern Pacific Railroad. To the north is Avenue M, a major east-west artery. The 7 acre NAP parcel accommodates 3 large water storage tanks and a producing water well with flat pad area for future expansion. Several commercial developments exist along the north side of Avenue M.

PROPOSED DEVELOPMENT

Based on the site plan furnished by David A. Price Associates, two golf courses are to be included within this development. An 18-hole course will occupy the westerly and southerly property limits and a 9-hole course will extend diagonally northeasterly through the proposed office/commercial areas. The land use analyses shows five (5) "community commercial" areas adjacent to Avenue M, eight (8) office/commercial sites in the central portion of the parcel and six (6) business parks over the remainder of the site. Internal loop and through streets will serve the various improvements.

To date, the plans furnished are primarily conceptual. Specifics as to grading or structures are not known at this time. It is

assumed that development will be achieved by conventional cut and fill grading techniques and that specifics as to foundation design will be deferred until structure types, loadings and locations are known.

FIELD INVESTIGATION

A total of 40 exploratory test pits were dug to depths of 10± feet with a rubber tired backhoe. Additionally, 15 exploratory borings were drilled to depths of 40 feet with either a hollow-stem auger drill rig or a rotary bucket drill rig (Borings 4 and 7, only). The pits and borings were logged by a staff engineer using visual and tactile methods to classify the materials encountered.

The logs of the Exploratory Borings are shown on Plates A-1 through A-31. The logs of the Test Pits are presented in Table I of this report. The approximate location of the boring and test pits are shown on the enclosed topographic map.

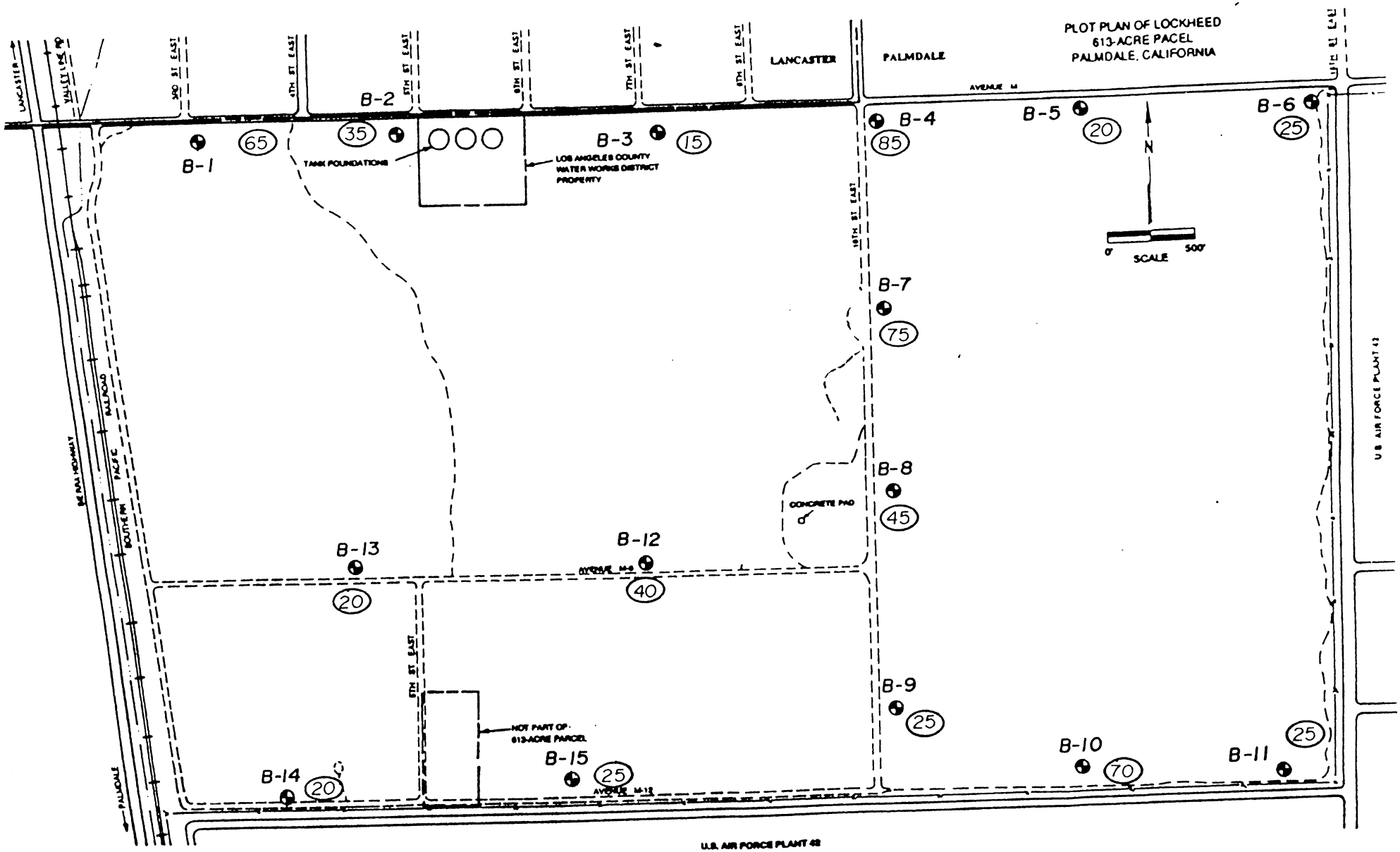
Undisturbed (ring) samples of the soil deposits were obtained by driving a split-barrel sampling tube lined with 2.5-inch I.D. brass rings into the ground with repeated blows of either a 140 lb. weight or the drill rig kelly bar (Borings 4 and 7, only). The number of blows were recorded as a relative indication of driving resistance. These ring samples were sealed in air tight con

tainers. Bulk (large bag) samples were obtained of the representative near surface soils in both the test pits and borings. The samples obtained were transported to our laboratory for testing. Details of the laboratory testing are presented in Appendix II.

After drilling, logging and sampling, each exploratory boring was converted to a percolation test well by means of inserting a 3-inch diameter slotted/perforated plastic pipe in the center of the hole and surrounding the pipe with gravel (No. 4 rock). Each well was then filled with water to the ground surface several times the day prior to testing (24 hours). Testing consisted of refilling the well and monitoring the water level as a function of time. This process was repeated three or more times until the rate of change became relatively constant. After the rate of change stabilized, the percolation rate was then calculated for the lower portion of the boring. The approximate well (boring) locations and the calculated rates are shown on Figure 3. The percolation test data and calculations are presented in Appendix III.

LIMITED SITE SEISMIC INVESTIGATION

This firm has reviewed available geologic and seismotectonic literature relative to anticipated development of the subject site which is located in the north-central area of the City of Palmdale, California. Primarily, the objectives were to deter-



LEGEND: B-14 APPROXIMATE LOCATIONS OF EXPLORATORY BORING / PERC. WELL

(40) PERC. RATE IN GALS./DAY/FT.^{2}

FIGURE 3

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mine regional and local geology, assess potential for ground rupture resultant from faulting, and to provide possible acceleration data for design purposes.

The study consisted of review of published and unpublished reports on local and regional geology, including analyses of local faults and the potential for and possible magnitude of future seismic events along those faults. Articles that empirically relate postulated earthquakes to possible on-site ground accelerations were reviewed. It should be noted that no site specific spectral analyses nor shear wave velocity determinations were done for this study.

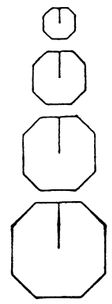
Also, stereo-pair aerial photographs of the site and its environs were studied to determine if fault related topographic lineaments exist on or near-site.

GEOLOGIC SETTING

The site is in the southeast margin of the Antelope Valley and is northeasterly of Ritter Ridge -- a northeasternmost element of the San Gabriel Mountains. The Antelope Valley occupies a portion of the western 'wedge' of the Mojave structural block (see Figure 4, following page) that is separated from the San Gabriel Mountains structural block by the San Andreas fault zone, whose main traces are about 2.5 miles southwest of the site (Barrows

RELATIONSHIPS OF EARTHQUAKE EPICENTERS TO FAULTS IN SOUTHERN CALIFORNIA

MAGNITUDE



..... 5.0 TO 5.9

..... 6.0 TO 6.9

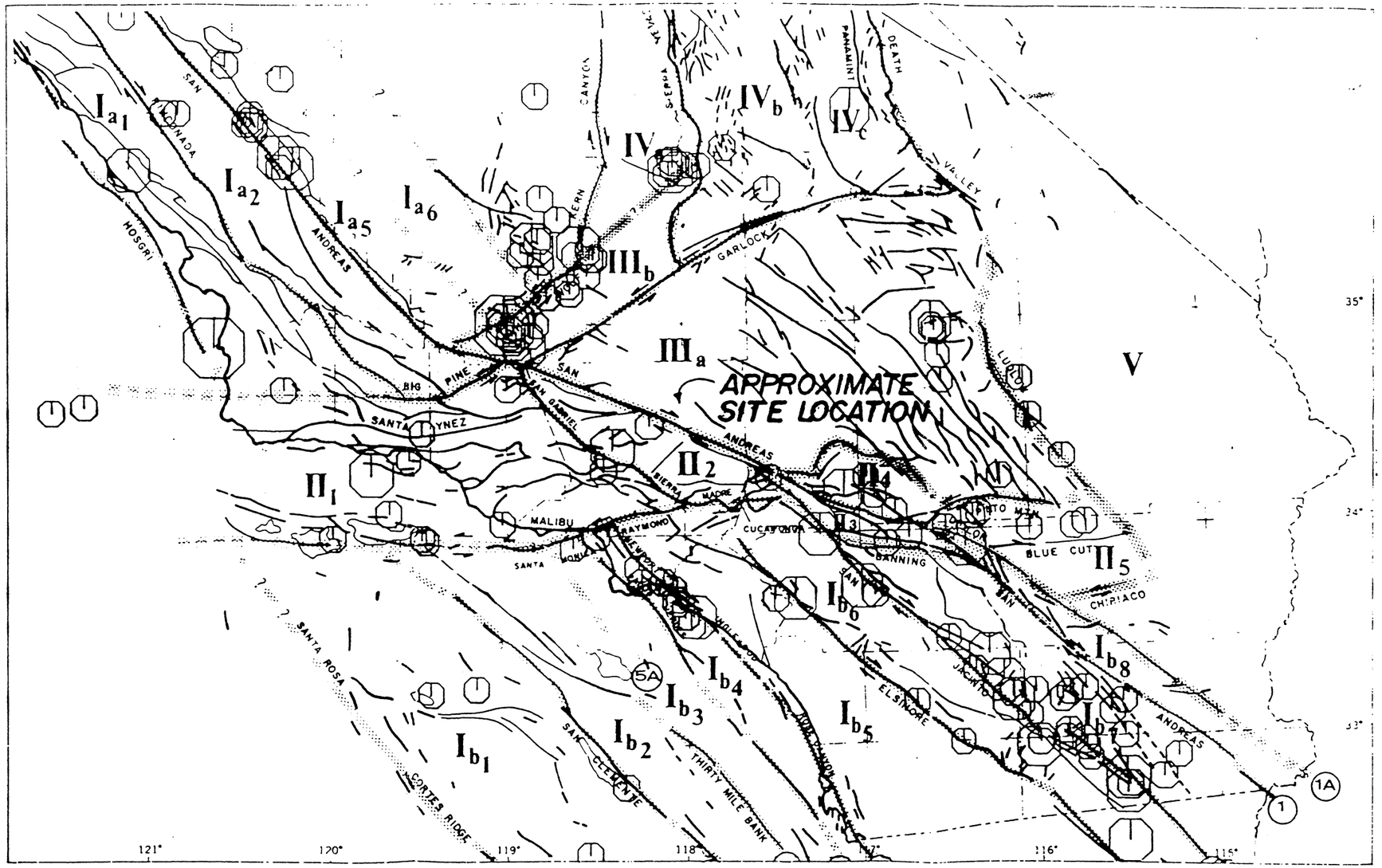
..... 7.0 TO 7.9

..... 8.0 OR GREATER

FAULT PATTERNS

(Defining Blocks and Subblocks)

Structural Province	Predominant Fault Trend	Blocks		Sub-block	
I	NW (San Andreas trend)	a	Coast Ranges	1	Santa Lucia
				2	Gabilan
				3	San Francisco
				4	Berkeley
				5	Diablo
				6	Great Valley
				7	Stonyford
		b	Peninsular Ranges	1	San Clemente
				2	Catalina
				3	Palos Verdes
				4	Inglewood-San Diego
				5	Santa Ana
				6	Riverside
				7	San Jacinto
				8	Indio Hills-Mecca Hills
II	E-W (transverse trend)		Transverse Ranges	1	Santa Ynez
				2	San Gabriel
				3	Banning
				4	San Bernardino
				5	Pinto Mtns
III	NE (Garlock trend)	a	Mojave		
		b	Tehachapi		
IV	N-S (Owens Valley trend)	a	Kern Canyon		
		b	Panamint		
		c	Death Valley		
		d	Warner		
		e	East Sierra		
		f	Cascade		
		g	Gorda		
V	Multiple		Sonoran Desert		
VI	Complex		Sierra Nevada		
VII	Thrusts		Klamath		
VIII	Complex		Modoc	1	Alturas
				2	Eagle Lake
				3.	Diamond Mtns.
				4	Medicine Lake



BOUNDARIES

(Segmented where projected, queried where very speculative)

Boundary defined by	Major Structural Block	Structural Sub-block
Quaternary fault	?	?
Pre-Quaternary fault *	?	?
Minor Pre-Quaternary fault * (fault not shown)	?	?

* Pre-Quaternary faults may include a fault whose age is unknown or has not been evaluated; it may in fact, be Quaternary

0 50 100 MILES

0 50 100 KILOMETERS

AFTER JENNINGS (1985)

FIGURE 4

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and others, 1985). The Garlock fault comprises the northern margin of the Mojave block.

The Antelope Valley, as part of the "lowland" Mojave block, has received alluvial sediments distributed mainly from the southerly adjacent San Gabriel Mountains. Deposition probably began in the Tertiary and has continued into the present, with probable periods of "relative landscape stability". Immediately underlying the modern ground surface are about one to several hundred feet (Duell, 1987; Smith, 1979) of Quaternary (Pleistocene and Holocene) alluvium deposited as fans emanating from the San Gabriel Mountains. Although generally dense, these deposits are not cemented as are the subjacent Tertiary sedimentary rocks.

As should be expected, the Quaternary sediments are generally medium- to coarse-grained sands and gravels whose constituents reflect rocks composing the San Gabriel Mountains. Local thin fine-grained units occur in the sediments. Such are probably the result of soil-forming processes (Ponti, 1985) or localized lacustrine environments (Duell, 1987) active during periods of "landscape stability."

Ground water inventories (e.g., Duell, 1987) suggest that the Quaternary sediments of the Antelope Valley are host to a considerable volume of ground water that is recharged from runoff

from nearby mountains and by irrigation. As noted by Duell (1987) and Leroy Crandall and Associates (1985) the depth of the water table in the general site environs is on the order of 100 to 400 feet below ground surface. However, those authors' works are of a general nature.

The aforementioned San Andreas fault zone is the major regional structure. This northwest-trending, right-lateral fault zone is the boundary between the North American Continental Plate and the Pacific Ocean Plate. The fault is the predominant structural element in western California. The fault is active. More detailed discussions of this fault zone are presented elsewhere in this report.

LOCAL GEOLOGY

Stratigraphy

The local geology reflects the regional in that Quaternary alluvium immediately underlies the site. Nine borings, to 46± feet in depth, encountered predominantly clean to silty, fine- to coarse-grained sand, with scattered to concentrated gravel. Smith (1979) indicates total depth of alluvium in the area to be about 600 feet. Generally, except for a near-surface disturbed horizon, the deposits were relatively dense.

Occasional reddish fine-grained beds, one to several feet thick, were encountered. These, based on color, lithology and relation-

ships with surrounding sediments, most likely are paleosols that developed during periods of "landscape stability."

Ground water, or evidence of recent accumulations thereof, was not encountered in any boring. As noted, Duell (1987) shows water table contours near-site as being at roughly elevation 2,200; about 300 to 400 feet below ground surface. Likewise, general Reference 3 (1991) indicates water at a depth of 400± feet.

Geologic Structure

San Andreas Fault: Of most importance is the proximity of the San Andreas fault zone. As mapped by Barrows and others (1985) and as shown on the Ritter Ridge 7-1/2 minute quadrangle on which the State of California (1979) has plotted Alquist-Priolo Special Studies (ground rupture hazards) Zones, the site is about 2-1/2 miles northeast of the fault zone.

A major structural element of California, this fault zone can be traced continuously for 620 miles from Point Arena in northern California to the eastern side of the Salton Sea, where its trace is concealed by alluvium. Earthquake epicenters from the Salton Sea south to the Gulf of California suggest that the fault zone continues into the Gulf (Richter, 1958). Thus, the fault zone is over 700 miles long.

North and south of the Transverse Ranges, the strike of the fault is approximately northwest; in the Transverse Ranges the strike is west-northwest. The dip of the fault is approximately vertical and the sense of motion is right lateral. The total amount of horizontal displacement on the fault appears to be 160-175 miles since the Oligocene according to Crowell (1962). However, Barrows and others (1985) suggest total cumulative movement to be about 60 miles, which illustrates the complex geology associated with the fault.

The frequency of seismic activity along the entire fault system segment from the Carrizo Plain to near Cajon Pass (Allen and others, 1965; Bolt and others, 1968; Bolt and Miller, 1971) is low. A micro-earthquake survey of the fault system supports this view (Brune and Allen, 1967). However, the great 1857 Fort Tejon Earthquake (Magnitude 8±) ruptured the ground surface from the Carrizo Plain to somewhere between Cajon Pass and San Gorgonio Pass (Wood, 1955; Allen, 1968). Further, Sieh (1984) reports subsurface evidence indicating 12 earthquakes along the proximal segment of the fault between about 260 and 1857 A.D. That author also notes five of those events may have had lateral slip comparable to the 1857 earthquake.

Offset stream channels in the Carrizo Plain indicate the horizontal offset associated with the 1857 break may have been as much as 33 feet (Wallace, 1968). That segment of the fault is near

Palmdale, and has commonly been considered a likely source for another great earthquake (Allen, 1968; Sieh, 1984; Working Group, 1988). Thus, because of its potential for a great earthquake, say magnitude 8 to 8.5 accompanied by surface rupture, (Working Group on California Earthquake Probabilities, 1988), and its proximity to the subject site, this fault zone is of prime importance in assessing site seismic parameters. A seismic event of these magnitudes would, in all probability, cause on-site ground accelerations approaching 0.8g. Both the 400± ft. depth to ground water and the prevailing coarse grained nature of the underlying alluvial sediments suggest the liquefaction potential to be remote.

As noted, in 1857 ground rupture occurred along elements of the San Andreas fault zone at Palmdale. A search of published information (Ross, 1969; Sieh, 1984; Barrows and others, 1985), suggest, that surface rupture associated with the 1857 event did not extend northeasterly near the subject site. Further, Barrows and others (1985) did not observe evidence of recent lateral displacement over 50 meters away from the "main" traces near Palmdale.

Hitchbrook Fault: The Hitchbrook fault approximately 1-1/2 to the southwest is the closest mapped structural element to the site. This fault was identified by Wallace (1949) and later

refined by Dibblee (1960; 1967). It was recognized as an east-southeast trending fault that juxtaposed Portal Schist against granitic rocks near Elizabeth Lake. At that location, a shear zone about 300 feet wide (Barrows and others, 1985) exists. Dibblee (1960; 1967) inferred it beneath the alluvium along the northeast flank of Ritter Ridge. Thus, it has been mapped as being near the subject site. Robert Stone and Associates (1973) concluded the Hitchbrook fault was northerly of Dibblee's location but did not disturb the upper alluvial sediments.

Smith (1979), during an investigation on a nearby project located five 650-feet long seismic traverses over the projected trace of a portion of the fault. The locations were selected based on the mapping of Stone (1973) and Dibblee (1960). Smith (1979) identified several possible faults at depth that affected bedrock and possibly the lowermost alluvium. That author concluded that the fault mapped by Dibblee (1960) approximated the locations of features identified on the seismic lines. Further, Smith's (1979) work did not indicate faults northerly of that zone identified on the Ritter Ridge quadrangle prepared by the State of California Division of Mines. He further concluded that the fault is buried by a relatively thick section (about 60± to 80± feet) of undisturbed alluvium.

This firm reviewed that work in detail and agrees, in substance, with that interpretation. If, indeed, the anomalies at the bedrock-alluvium contact are faults, and not erosional irregularities, they would only appear to affect the lowermost older alluvium.

In sum, various lines of "circumstantial" evidence suggest that the Hitchbrook fault may exist southerly of the subject area and that it has not disrupted Holocene sediments (Barrows and others, 1985; Leroy Crandall and Associates, 1985; Smith, 1979). Also, the site is outside the limits of a "restricted use zone" Smith (1979) suggested for critical structures.

DISCUSSION

As observed in the exploratory borings, and in the test pits, soil conditions underlying the property are relatively uniform to the depths explored. The soils consist of alluvial deposits ranging from clayey silts to gravelly, coarse-grained clean sands. Silty sands were predominate. More than 90 percent of the soils encountered were sands with less than 10 percent classified as silts or clays.

Generally, the near surface soils were loose and granular becoming moderately dense to dense below a depth of about 3 feet. Nearly all the soils encountered were significantly on the dry

side of optimum moisture content. Caving was experienced to some degree in nearly all the test pits and borings. No significant cemented layers, "caliche beds", or "hard pan" were encountered. The near surface soils are subject to some degree of hydro-consolidation. Susceptibility to hydro-consolidation generally diminished with depth.

The on-site near surface granular soils are considered in the low range of expansiveness. Moderately expansive characteristics were noted in the finest grained soil encountered. No artificial fill was encountered during the field investigation and, based upon site topography, is not anticipated to occur on the site. Neither bedrock nor ground water were encountered and are not anticipated to be factors in the project design or construction.

CONCLUSIONS AND RECOMMENDATIONS

The site is generally well suited by the type of development proposed. Tentatively, it is anticipated that in development of the site: a) in the structural areas the loose near surface soils (3± feet) will require removal and replacement as compacted fill in order to mitigate the affects of settlement and potential hydro-consolidation; b) the preponderance of soils are granular and possess limited cohesion and will require precautionary measures for protection from erosion by wind and water; and c) the deeper soil strata appear sufficiently permeable for

construction of dry wells for the disposal of nuisance waters; the design percolation rates are provided in this report.

A. Geology Considerations:

1. The subject site, is underlain by about 600 feet of alluvium (General Reference 3).

2. Based upon available preliminary data, the ground water table is at a depth of 400± feet below present ground surface (General Reference 3).

3. The site is about 2-1/2 miles northerly of the San Andreas fault zone. As alluded to elsewhere is this transmittal, this zone appears capable of producing a great 8.0 to 8.5 magnitude earthquake within the life of the project. During such an event, very intense ground motion would be produced on-site.

   Based upon interpolation and/or extrapolation of various predictive curves (Joyner and Fumal, 1985; Schnabel and Seed, 1972), on-site peak horizontal ground accelerations, in event of a great earthquake along proximal segments of the San Andreas fault could approach .8± g. Because of the lack of near-field records for such an event, such numbers are somewhat speculative.

Ploessel and Slosson (1974) noted: "Although the maximum (peak) ground or bedrock acceleration is one of the factors for computing ground response at a site, it generally is not the same as design acceleration. Thus, the maximum acceleration should not necessarily be utilized in empirical engineering formulas currently in use to determine earthquake resistant structural design." Page and others (1972) have noted that a single peak of intense motion (maximum or peak acceleration) may contribute less to cumulative damage potential than several cycles of less intense shaking. Therefore, repeated high ground acceleration appears to be of greater concern in structural design than the single peak of maximum acceleration. Typically, the repeatable high ground acceleration averages 65 percent of the peak ground acceleration for sites within 20± miles of the epicenter (Ploessel and Slosson, 1974). Local subsurface conditions at the site, nature of alluvium and rock and depth of basement between the site and the fault systems may induce variations.

Certainly, major earthquakes along other regional faults could induce strong ground motion on-site. However, because of the prevailing importance of possible near-site magnitudes of postulated events along the San Andreas, possible acceleration values for events along other faults are not given.

4. Based upon available literature, the potential for ground rupture as a direct result of faulting (i.e. fault offset of the surface) is no higher than for most other areas of Palmdale. No faults have been mapped on-site. It appears that the nearest inferred fault, the Hitchbrook, has not displaced at least Holocene (last 11,000± y.b.p.) sediments. Likewise, studies by others indicate no recognizable evidence of on or near-site ground rupture resultant from the San Andreas fault zone. Aerial photographs also depict no feature that could positively be related to ground rupture.

Further, the site is not within an Alquist-Priolo Special Studies Zone. However, because of the proximity to a very major structural zone (San Andreas), the possibility of sympathetic movement along as yet unknown minor faults during a major event along the San Andreas cannot be categorically ruled out. The potential, though, is considered low.

The potential for on-site liquefaction during an earthquake is considered low to nil, considering the depth to ground water and the composition and density of the underlying sediments. It may be anticipated that low-density surficial soils will be densified prior to construction.

B. Site Clearing and Preparation

1. Precautions should be taken during the performance of all

work, especially if construction is performed during the rainy season, approximately October 15 to April 15, to protect the work site, particularly excavated areas, from flooding, ponding, and inundation due to poor or improper temporary surface drainage. During periods of impending inclement weather, temporary provisions should be made to direct surface waters from all sources away from and off the work site and to provide adequate pumps and sumps to handle any flow into the excavations.

2. All site preparation as indicated below should be made under the periodic observation of the project soils engineer.

3. Prior to the start of the required earthwork and grading, all surface vegetation, trash, debris, and other deleterious materials should be removed and wasted away from the site.

4. Pipelines or conduits, if encountered, should be relocated and be completely removed from the construction area, or be cut and plugged according to the applicable Code requirements but not less than 10 feet outside the perimeter of the proposed construction area, or as property line considerations dictate.

5. Cesspools or septic tanks or similar facilities, if encountered, shall be removed entirely or that portion above the mini-

mum depth specified for removals should be removed. The portion remaining shall be pumped of its contents and filled with clean granular soils and be thoroughly flooded and jetted into place.

6. All abandoned wells shall be cut off to a minimum depth of 10 feet below the existing ground surface or proposed finished grade, and sealed or plugged in accordance with the requirements of the governing agency.

C. Overexcavation and Recompaction

1. After approval of the site clearing, the upper loose soils should be removed to a minimum depth of three (3±) feet. within proposed structural fill areas.

Overexcavation to a minimum of 3 feet below the proposed finish grade should be anticipated in the proposed cut areas planned for structural support. (Note: It is the intent of the above recommendations that all building pads shall consist of a minimum of 3 feet of compacted fill.

A large portion of the site will accommodate golf course fairways, greens and open space. In these non-structural areas, no removals are anticipated. However, beneath the embankments for retention/percolation basins in the golf course, a minimum of 3 feet of removals should be anticipated.

2. After approval of the overexcavations and/or removals and prior to placement of any compacted fill materials, the exposed surface should be thoroughly scarified to a minimum depth of 12 inches, watered or dried to slightly above the optimum moisture content and then rolled and compacted to the required relative compaction based on the laboratory maximum density determined in accordance with ASTM: Test Method D-1557-78. In areas within the influence of structures or structural fill, including embankments for retention/percolation basins in the golf course, 90 percent relative compaction will be required. In the golf course, outside the influence of structures or structural fill, the required minimum relative compaction could be lowered to say 85 percent (non-structural fill) if acceptable to the governing agency and golf course designer.

3. Approved stockpiled on-site or imported soils should then be spread in thin lifts, watered or dried to slightly above optimum moisture content, and then each lift rolled and compacted to the appropriate relative compaction until the desired grade is achieved.

4. Import soils, if required, should consist of clean, compactible materials similar to on-site soils and should be free of trash, debris or other objectionable materials.

PLANS AND SPECIFICATIONS SHOULD INDICATE THAT THE GRADING CONTRACTOR SHALL NOTIFY THE PROJECT SOILS ENGINEER NOT LESS THAN 72 HOURS, IN ADVANCE, OF THE LOCATION OF ANY SOILS PROPOSED FOR IMPORT. EACH PROPOSED IMPORT SOURCE SHALL BE SAMPLED, TESTED AND APPROVED PRIOR TO DELIVERY OF SOILS FOR USE ON THE SITE.

5. All of the above site preparation, overexcavation, and earthwork should be performed under the observation and testing of the project soils engineer. All fill should be tested at the time of placement to ascertain that the required compaction is achieved. The minimum basis of testing should be one (1) test per two (2) feet of fill depth or per each 500 cubic yards of fill placed.

6. Estimated overall shrinkage due to recompaction of near surface (0-5± feet) soils is on the order of 12 percent, assuming a minimum relative compaction of 90 percent, and 8 percent if placed to a minimum relative compaction of 85 percent. Deeper soil strata (below 10± feet) can be expected to shrink on the order of 8 percent (assuming 90 percent) and 5 percent (assuming 85 percent). Subsidence of an estimated 0.1 to 0.2 feet should be anticipated in the graded areas.

D. Preliminary Foundation Design

1. Recompacted on-site soils and similar approved import soils should be considered to generally possess adequate strength and consolidation characteristics to support significant foundation loads without detrimental settlement.

2. The preliminary design of continuous footings for the structures may be based upon a minimum bearing value of 1,500 psf for both dead and live loads. Spread footings may be designed for a minimum of 2,000 psf. A one-third increase may be taken for seismic or wind loading.

   The minimum width for continuous footings should be 12 inches. Spread footings should be a minimum 24 inches in width. The minimum embedment depth should be 12 inches below the lowest adjacent grade for 1-story structures and 18-inches for 2-story structure. Embedment depth may be measured from the top of slab for interior footings.

3. For preliminary design, lateral bearing of 250 psf per foot of depth to the allowable vertical pressure and a coefficient of friction of 0.35 may be used in the design for resisting lateral forces.

   Friction and lateral bearing may be combined provided the lateral resistance does not exceed 2/3 of the allowable bearing value. The above values may be increased one-third to resist seismic or wind loads.

4. The preponderance of near surface, on-site soils are considered to be non-expansive. While minor strata of expansive

materials are present, the "blending" associated with grading is expected to result in soils considered to be in the "low" range of expansion potential.

The need for special foundation or slab design due to expansive soil condition is not anticipated at this time. Design of foundations and on-grade slabs should be as structural requirements dictate but should include the following:

a) A designed bond beam should be placed across all large openings and tied into the adjacent footings.

b) A vapor membrane overlain with a two (2) inch thick sand cover should be used below all slabs-on-grade in areas to be tiled or carpeted or considered moisture sensitive. The membrane may be placed directly on approved subgrade.

c) All foundation excavations should be inspected and approved by the project soils engineer prior to the placement of forms, reinforcement or concrete. The excavations should be trimmed neat, level and square. All loose, sloughed or moisture-softened soils should be removed prior to the placement of concrete.

d) Excavated material from footing trenches should not be placed in slab-on-grade areas unless properly compacted and tested.

5. The preceding foundation recommendations should be considered preliminary and subject to revision, pending receipt and review of more detailed structure locations, loadings and foundation elements. Additional subsurface investigations may be needed at that time.

6. One of four of the soil samples tested by other shows a very low resistivity (See Appendix IIa, Sample TP-20). This soil would be highly corrosive toward ferrous metals. Corrosively of on-site soils should be verified by additional sampling and testing before final project design of underground conduits.

E. Drywell Design

1. It is anticipated that the design and placement of drywells will be in accordance with the City of Palmdale's "Storm and Nuisance Water Management Policy".

2. Absorption rates, as presented on Figure 3 and in Appendix III may be used to determine drywell size and capacity.

3. Based on the consolidation tests performed as part of this study, hydroconsolidation need not be considered a factor in design, location or functioning of dry wells. However, it should be noted that porous layers were encountered in Boring B-5 within the 5-foot thick stratum at a depth of 22 to 27 feet. A sample of this porous material exhibited 2.3% hydro-collapse (See Plate B-4). This stratum exhibited porous and non-porous layers, roughly 50-50. The calculated settlement would be about 2/3-inches (5 ft. x $\frac{12\text{-inch}}{\text{ft.}}$ x 0.023 x 1/2 = 0.65 inches). This is not considered significant, particularly since no similar stratum was encountered in this boring or any of the other 14 borings. Still, in future on-site exploratory work it would be prudent to keep a watchful eye for porous or potentially hydro-collapsible soil stratum.

F. Miscellaneous

1. In structural fill areas, utility trench and retaining wall backfill should be mechanically compacted to a minimum of 90% relative compaction. No jetting, ponding, or flooding should be permitted within the building area proper or where trenches are in the zone of influence of footing loads.

2. All roof and surface drainage should be directed away from the structures to approved disposal areas via non-erodible devices. Care should be taken to grade planters adjacent to

the structures to drain away from the foundations. Ponding of water should be prevented.

3. Temporary slopes should be sloped or braced in accordance with CAL-OSHA regulations.

4. No surcharge loads are permitted above unshored or unretained excavations. This includes, but is not limited to lumber, concrete trucks, concrete block or other materials or construction equipment.

5. The results of the observation and testing of all grading should be presented in a soils engineering report following the completion of earthwork and grading.

6. Pertinent recommendations contained in this report should be incorporated into the project development.

When available, the detailed development scheme and grading plans should be reviewed by this firm for additional comments and recommendations. The preceding recommendations should be considered tentative and subject to change pending review of the developmental plans.

The findings and recommendations contained in this report are based upon the specific excavations and observations as noted. The materials immediately adjacent to or beneath those observed may have different characteristics, and no representations are made as to the quality or extent of materials not observed.

This report is subject to review by the controlling authorities for the subject project.

Respectfully submitted,
PACIFIC SOILS ENGINEERING, INC.

Reviewed by:

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(2) Church Engineering, Inc., Attn: Mr. Dennis Ring/
Mr. Keith Osborne

CEL:DTM:RBL:SSN/js-wb-0002

TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-1	0.0- 2.0	Silty Fine Sand, (SM), brown, dry, loose, moderately porous, some small gravel size.
	2.0- 5.0	Silty to Slightly Silty Sand (SM to SP/SM), brown, dry, loose, some small gravel. Some caving at 4 ft.
	5.0- 6.0	Silty Fine Sand (SM), brown, damp, loose to moderately dense.
	6.0- 8.0	Silty to Slightly Silty Fine Sand (SM to SP/SM), brown, dry, loose, some gravel. Caving.
	8.0- 9.0	Silty Fine Sand (SM), brown, damp, moderately dense.
	9.0-11.0	Silty to Slightly Silty Sand (SM to SP/SM), brown, damp, moderately dense.
		End at 11 ft., no water, severe caving below 4 ft.
TP-2	0.0- 4.0	Silty Fine Sand (SM), brown, dry, moderately dense, no gravel.
	4.0-10.5	Slightly Silty Fine Sand (SP/SM), gray-brown, damp, moderately dense, somewhat cleaner w/depth.
		End at 10.5 ft., no water, moderate caving below 4 ft.
TP-3	0.0- 6.5	Silty Fine Sand (SM), brown, dry and loose to 2 ft., then damp and moderately dense. Slightly porous from 3 ft. to 5 ft. Interlayer (6 inches to 1 foot thick) of Slightly Silty Sand (SP/SM), brown, damp, moderate dense.
	6.5-10.0	Gravelly Slightly Silty Sand (SP/SM), brown, damp, moderately dense, caving.
		End at 10 ft., no water, moderate to severe caving below 6.5 ft.

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TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-4	0.0- 3.5	Silty Fine Sand (SM), brown, dry, loose.
	3.5- 7.0	Silty Very Fine Sand to Very Fine Sandy Silt (SM to ML), brown, dry to damp, moderately dense.
	7.0-11.0	Silty Sand (SM), red-brown, damp to moist, moderately dense, cleaner with depth.
		End at 11 ft., no water, no caving.
TP-5	0.0- 7.0	Silty Fine Sand (SM), brown, dry, loose, slightly to moderately porous to 2.5 ft. Below 2.5 ft., less porous, moderately dense, damp, red-brown.
	7.0-10.0	Slightly Silty Sand (SP/SM), red-brown, damp, moderately dense.
		End at 10 ft., no water, slight to moderate caving below 7 ft.
TP-6	0.0-11.0	Silty Fine Sand (SM), brown, dry to damp, loose and porous to 2 ft. Below 2 ft., more red-brown, damp to moist, moderately dense to dense, some gravel size.
		End at 11 ft., no water, no caving.
TP-7	0.0- 5.5	Silty Fine Sand (SM), brown, dry to damp, loose and porous to 2.5 ft. Below 2.5 ft., damp, moderately dense to dense, more red-brown, some gravel.
	5.5- 8.0	Silty to Slightly Silty Sand (SM to SP/SM), red-brown, damp, moderately dense.
	8.0-11.0	Gravelly Slightly Silty Medium to Coarse Sand (SP/SM), red-brown, damp, moderately dense.
		End at 11 ft., no water, moderate caving below 8 ft.

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TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-8	0.0- 2.0	Silty Fine Sand (SM), brown, dry, loose.
	2.0- 8.0	Very Fine Sandy Silt (ML), brown, dry, moderate dense, weakly cemented.
	8.0-11.0	Silty Fine Sand (SM), brown, dry to slightly damp, moderately dense, some gravel.
		End at 11 ft., no water, no caving.
TP-9	0.0- 6.5	Silty Sand (SM), brown, dry, loose to 2 ft., porous. Below 2 feet, Silty Fine Sand (SM), dry, moderately dense, weakly cemented, slightly porous, some gravel. Below 5 feet, sandier, non-cemented, damp.
	6.5-10.5	Gravelly Slightly Silty Sand (SP/SM), brown, damp, moderately dense, gravel to 1-inch size.
		End at 10.5 ft., no water, caving below 6.5 ft.
TP-10	0.0- 2.5	Silty Sand (SM), brown, dry, loose, some gravel.
	2.5- 5.0	Silty Fine Sand (SM), brown, dry to damp, moderately dense, slightly porous, some gravel, weakly cemented.
	5.0- 6.0	Silty Sand (SM), brown, damp, moderately dense, some gravel.
	6.0-10.0	Gravelly Slightly Silty Medium to Coarse Sand (SP/SM), brown, dry to damp, moderately dense, gravel to 3-inch size, caving.
		End at 10 ft., no water, caving below 6 ft.

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TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-11	0.0- 5.0	Silty Fine Sand (SM), brown, dry, loose, slightly porous. Below 3 ft., damp, slightly denser.
	5.0-10.0	Gravelly Slightly Silty Sand (SP-SM), red-brown, damp, moderately dense, gravel to 1.5-inch size.
		End at 10 ft., no water, caving below 5 ft.
TP-12	0.0- 3.0	Silty Fine Sand (SM), brown, dry, loose to moderately dense, minor gravel size.
	3.0- 5.0	Silty Very Fine Sand (SM), red-brown, damp, moderately, dense, weakly cemented.
	5.0- 8.0	Silty Fine Sand (SM), red-brown, damp, moderately dense, some gravel.
	8.0-10.5	Slightly Silty Sand (SP-SM), red-brown, damp, moderately dense, 10±% gravel to ½-inch size, caving.
		End at 10.5 ft., no water, caving below 8 ft.
TP-13	0.0- 4.0	Silty Sand (SM), brown, dry, loose, some gravel size.
	4.0- 7.0	Silty Fine Sand (SM), brown, damp, moderately dense, weakly cemented, some gravel size.
	7.0- 9.0	Silty Fine Sand (SM), brown, damp, moderately dense, some gravel size.
	9.0-11.0	Silty to Slightly Silty Sand (SM to SP/SM), brown, damp, moderately dense.
		End at 11 ft., no water, no caving.

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TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-14	0.0- 7.0	Silty Sand (SM), brown, dry, loose to 3 ft., some gravel. From 3 ft. to 6 ft. weakly cemented, damp, moderately dense.
	7.0-11.0	Silty to Slightly Silty Sand (SM to SP/SM), light red-brown, damp, moderately dense. 10±% gravel to 3/4-inch size, caving.
		End at 11 ft., no water, moderate caving below 7 ft.
TP-15	0.0- 3.0	Silty Sand (SM), red-brown, damp, loose, some gravel size.
	3.0- 6.0	Silty Fine Sand (SM), red-brown, damp to moist, moderately dense, weakly cemented.
	6.0- 9.0	Silty Sand (SM), red-brown, damp to moist, moderately dense, some gravel size.
	9.0-11.0	Slightly Silty Sand (SM), red-brown, damp, moderately dense, 10±% gravel to ½-inch size. Cleaner w/depth, caving - trench caved to 6 ft. depth.
		End at 11 ft., no water, severe caving below 9 ft. Trench caved to 6 ft.
TP-16	0.0-11.0	Silty Sand to Silty Fine Sand (SM), brown, dry and loose to 4 ft. Below 4 ft., damp, moderately dense, weakly cemented to 6 ft. Below 6 ft., more red-brown, damp, moderately dense, very little gravel size.
		End at 11 ft., no water, no caving.

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TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-17	0.0- 3.0	Silty Sand (SM), brown, dry, weakly cemented below 6-inch depth, porous.
	3.0- 7.0	Very Fine Sandy Silt to Silty Very Fine Sand (ML to SM), brown, damp, moderately dense, grades coarser with depth.
	7.0-10.0	Silty Sand (SM), brown, damp, moderately dense, some gravel size, moderate caving.
		End at 10 ft., no water, moderate caving below 7 ft.
TP-18	0.0- 4.0	Silty Sand (SM), brown, dry and loose to 2 ft. Below 2 ft., damp, moderately dense.
	4.0- 6.0	Silty Very Fine Sand (SM), brown, dry to damp, moderately dense, weakly cemented.
	6.0-10.0	Silty Sand (SM), brown, damp, moderately dense, some gravel (10±%), moderate caving.
		End at 10 ft., no water, moderate caving below 6 ft.
TP-19	0.0- 1.0	Silty Sand (SM), brown, dry, loose.
	1.0- 3.0	Silty Fine Sand (SM), brown, dry, loose, porous, weakly cemented.
	3.0- 6.0	Gravelly Silty Sand (SM), brown, dry to damp, moderately dense, gravel to ½-inch size.
	6.0-11.0	Silty Sand (SM), brown, damp, moderately dense. Interlayers of Silty Very Fine Sand (SM).
		End at 11 ft., no water, no caving.

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TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-20	0.0- 3.0	Silty Sand (SM), brown, dry, loose to 2 ft.; below 2 ft. damp, moderately dense, weakly cemented.
	3.0- 6.0	Silt (ML), brown, damp, moderately dense, weakly cemented.
	6.0-11.0	Silty Sand (SM) and Silty Fine Sand (SM), interlayered, brown, damp, moderately dense, weakly cemented throughout.
		End at 11 ft., no water, no caving.
TP-21	0.0- 4.0	Silty Sand (SM), brown, dry, loose to 2 ft.; below 2 ft., red-brown, damp, moderately dense, weakly cemented.
	4.0- 6.0	Silt (ML), brown, damp, dense, weakly cemented.
	6.0-10.0	Silty Sand (SM), red-brown, damp, moderately dense, weakly cemented. Interlayers of Silty Very Fine Sand (SM) to Silt (ML).
		End at 10 ft., no water, no caving.
TP-22	0.0- 2.0	Silty Sand (SM), brown, dry, loose, moderately porous.
	2.0- 7.0	Silty Fine Sand (SM), red-brown, moist, loose, no gravel size.
	7.0-10.0	Slightly Silty Medium to Coarse Sand (SP/SM), red-brown, damp, moderately dense, 10±% gravel to ½-inch size, moderate caving.
		End at 10 ft., no water, moderate caving below 7 ft.

cel:cp-0000

TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-23		(In bottom of main draw)
	0.0- 1.0	Silty Sand (SM), light brown, dry, loose.
	1.0- 2.0	Silty Fine Sand (SM), brown, dry, loose, weakly cemented.
	2.0- 7.0	Silty Sand (SM), brown, damp, loose to moderately dense w/depth. Occasional Silty Very Fine Sand (SM) interlayer.
	7.0-10.0	Silty Sand (SM), brown, damp, moderately dense, 10±% gravel to ½-inch size, moderate caving.
		End at 10 ft., no water, moderate caving below 7 ft.
TP-24	0.0- 4.0	Silty Sand (SM), brown, dry, loose, weakly cemented from 6-inches to 2.5 ft. Below 2.5 ft. minor gravel cement, damp.
	4.0- 6.0	Slightly Silty Gravelly Sand (SP/SM), gray-brown, damp, moderately dense, caving.
	6.0-10.0	Silty Sand (SM) w/interlayers of Silty Sand (SM), and occasional Slightly Silty Gravelly Sand (SP/SM), brown, damp, moderately dense, caving.
		End at 10 ft., no water, caving below 4 ft.
TP-25	0.0- 6.0	Silty Sand (SM), brown, dry and loose to 3 ft. Below 3 ft., damp, somewhat denser.
	6.0-10.0	Slightly Silty Gravelly Sand (SP/SM), w/occasional interbeds of Silty Sand (SM), brown, damp, moderately dense, caving.
		End at 10 ft., no water, caving below 6 ft.

cel:cp-0000

TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-26	0.0- 5.0	Silty Sand (SM), brown, dry, loose. Below 3 ft., damp, slightly denser, cleaner w/depth.
	5.0-10.5	Silty to Slightly Silty Sand (SM to SP/SM), brown, damp, moderately dense, minor caving, occasional stratum of Silty Fine Sand (SM).
		End at 10.5 ft., no water, minor caving below 5 ft.
TP-27	0.0- 4.0	Silty Sand (SM), brown, dry, loose; below 2 ft., damp and slightly denser.
	4.0- 5.0	Slightly Silty Gravelly Sand (SP/SM), gray-brown, damp, moderately dense, caving.
	5.0-10.0	Silty to Slightly Silty Sand (SM to SP/SM), brown, damp, moderately dense, gravelly in layers, caving.
		End at 10.0 ft., no water, caving below 4 ft.
TP-28	0.0- 4.0	Silty Sand (SM), brown, dry and loose to 1.5 ft. then damp, moderately dense.
	4.0- 7.5	Gravelly, Slightly Silty to Clean Sand (SP/SM to SP), gray-brown, damp, moderately dense, caving.
	7.5-10.0	Silty Sand (SM), red-brown, damp, moderately dense.
		End at 10 ft., no water, caving below 4 ft.

cel:cp-0000

TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-29	0.0- 3.0	Silty Sand (SM), red-brown, dry to 1 ft. then damp to moist, loose.
	3.0- 6.0	Silty Very Fine Sand (SM), red-brown, moist, moderately dense.
	6.0-10.0	Silty Sand (SM), red-brown, moist, moderately dense, occasional thin layer of Gravelly Slightly Silty Sand (SP/SM).
		End at 10 ft., no water, no caving.
TP-30	0.0- 9.0	Silty Fine Sand (SM), light brown, dry and running top 2 ft., then damp and slightly denser (blow sand).
	9.0-10.0	Very Fine Sandy Silt to Silty Very Fine Sand (ML to SM), red-brown, moist, moderately dense.
		End at 10 ft., no water, no caving but some ravelling.
TP-31	0.0- 8.0	Silty Medium to Coarse Sand (SM), brown, dry to 2 ft., then damp to moist, loose, gravelly in layers. Caving below 3 ft. Somewhat denser below 5 feet.
	8.0-10.0	Gravelly Slightly Silty Sand (SP/SM), gray-brown, damp, moderately dense.
		End at 10 ft., no water, moderate caving below 3 ft.

cel:cp-0000

TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-32	0.0- 4.0	Silty Medium to Coarse Sand (SM), brown, dry to 2 ft., then damp, loose top 1-foot, then moderately dense.
	4.0- 5.0	Silty Very Fine Sand (SM), brown, damp, moderately dense.
	5.0-10.0	Gravelly Silty Sand (SM), brown, damp, moderately dense, 10-15% gravel size, moderate caving.
		End at 10 ft., no water, moderate caving below 5 ft.
TP-33	0.0- 4.0	Silty Medium to Coarse Sand (SM), brown, dry to 2 ft., then damp, loose to 1.5 ft., then moderately dense.
	4.0-10.0	Gravelly Slightly Silty Sand (SP/SM), gray-brown, damp, moderately dense, interlayers of Silty Sand (SM), moderate caving.
		End at 10 ft., no water, moderate caving below 4 ft.
TP-34	0.0- 4.0	Silty Medium to Coarse Sand (SM), brown, dry to 2 ft., then damp, loose to 1.5 ft., then moderately dense.
	4.0- 9.5	Slightly Silty Sand (SP/SM), gray-brown, damp, moderately dense, occasional thin interlayers of Silty Sand (SM), caving.
	9.5-10.5	Silty Sand (SM), brown, damp, moderately dense, moderately cemented.
		End at 10.5 ft., no water, caving below 4 ft.

cel:cp-0000

TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-35	0.0-10.5	Silty Fine Sand (SM) (blow sand), brown, dry and loose to 1.5 ft., then damp and somewhat denser. At 8 ft., 9 ft., and 10 ft., 6 to 8-inch layers of Gravelly Slightly Silty Sand (SP/SM), gray-brown, damp, moderately dense, moderate caving below 7 ft.
		End at 10.5 ft., no water, moderate caving below 7 ft.
TP-36	0.0- 4.0	Silty Medium Sand (SM), brown, dry to 1.5 ft., then damp, loose and porous to 2 ft., then moderately dense, 10±% gravel size.
	4.0- 7.5	Silty Very Fine Sand (SM), brown, damp, moderately dense.
	7.5-10.0	Gravelly Slightly Silty Sand (SP/SM), gray-brown, damp, moderately dense, caving.
		End at 10 ft., no water, caving below 7 ft.
TP-37	0.0- 4.0	Gravelly Silty Sand (SM), dry to 2 ft., then slightly damp, loose to 1.5 ft., then moderately dense, gravel to 1-inch size.
	4.0-10.0	Gravelly Slightly Silty Sand (SP/SM) with thin interlayers of Silty Sand (SM), brown, damp, moderately dense, moderate caving.
		End at 10 ft., no water, moderate caving below 4 ft.
TP-38	0.0- 4.0	Gravelly Medium to Coarse Silty Sand (SM), brown, dry and loose to 2 ft., then damp and moderately dense.

cel:cp-0000

TABLE I

LOG OF TEST PITS

Pit No.	Depth (ft.)	Description
TP-38 (con't)	4.0-10.5	Gravelly Slightly Silty Sand (SP/SM) with interlayers of Silty Sand (SM), brown, damp, moderately dense, occasional thin (4-inch) layer of Very Fine Sandy Silt (ML), moderate caving throughout. End at 10.5 ft., no water, moderate caving below 4 ft.
TP-39	0.0- 4.0	Gravelly Silty Sand (SM), brown, dry and loose to 2 ft., then slightly damp and moderately dense.
	4.0-10.0	Interlayered Gravelly Slightly Silty Sand (SP/SM) and Silty Sand (SM), brown, slightly damp, moderately dense, caving. End at 10 ft., no water, caving below 4 ft.
TP-40	0.0- 4.0	Silty Sand (SM), red-brown, dry and loose to 1.5 ft., then damp and moderately dense, weakly cemented, some gravel.
	4.0-10.0	Gravelly Silty Sand (SM), red-brown, damp, moderately dense, gravel to 3-inch size, caving. End at 10 ft., no water, caving below 4 ft.

cel:cp-0000

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-1 Sheet 1 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray-brown, dry, loose.
			24	SM	100.5	3.8	Silty Fine Sand, red-brown, damp, loose to moderately dense.
5			48	SM	116.3	2.7	Silty Fine Sand, red-brown, damp to moist, moderately dense, gravelly in layers.
							Gravelly Silty Sand, red-brown, damp, moderately dense, interlayered with slightly Silty Fine Sand, gray.
10			40	SM & SP SM	104.6	2.1	
							Slightly Silty Sand, gray brown, dry to damp, loose to moderately dense, gravelly in layers.
15			33	SP/ SM	116.8	1.9	
							Gravelly Slightly Silty Sand, gray-brown, dry to damp, moderately dense, gravel to 3/4" size.
20			51	SP/ SM	105.6	1.2	
25			41	SM	99.6	3.1	Silty Very Fine Sand, gray-brown, damp, moderately dense.
30			50 2"	SM	No Good		Silty Very Fine Sand, gray-brown, damp, moderately dense.

cel:cp-0001

PLATE A-1

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-1 Sheet 2 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							Slightly Silty Fine to Medium Sand, gray-brown, dry to damp, moderately dense.
		■	53	SP/ SM	109.0	0.9	
35							Silty Very Fine Sand, gray red-brown, damp, moderately dense to dense.
		■	70	SM	104.1	4.5	
40							End at 40 ft., no water. Installed 3" dia. perforated pipe with gravel pack in 8" diameter hole.
45							

cel:cp-0001

PLATE A-2

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-2 Sheet 1 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0							Silty Fine Sand, gray-brown, dry, loose.
							Gravelly Silty Medium to Coarse Sand, red-brown, dry to damp, loose to moderately dense.
			30	SM	116.4	2.0	
			21	SM	113.5	2.5	Silty Coarse Sand, red-brown, damp, loose to moderately dense.
5							
			20	SP/SM	Hit Rock No Sample		Slightly Silty Sand, red-brown, damp, moderately dense, gravelly in layers, gravel to 3" size.
10							
			30	SM	90.5	6.5	Silty Very Fine Sand, rusty brown, moist, moderately dense.
15							
				SM	Fell Out No Sample		Silty Very Fine Sand, rusty brown, moist, moderately dense.
			40	SP/SM			Slightly Silty Medium to Coarse Sand, rusty brown, damp, moderately dense.
20							
			44	SP/SM & Occ ML	105.2	2.1	Slightly Silty Medium to Coarse Sand, brown, damp, moderately dense, occasional thin Silt lense.
25							
			56	SP/SM	107.4	2.2	Gravelly Slightly Silty Sand, red-brown, damp, moderately dense to dense.
30							

cel:cp-0001

PLATE A-3

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-2 Sheet 2 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
35		■	55	SP/ SM	Fell Out No Sample		
							Gravelly Clean Coarse Sand, gray, dry, moderately dense to dense, occasional thin lens of Silty Sand, red-brown.
40		■	45	SP Occ. SM	115.4	1.5	
							End at 40, no water. Installed 3" perforated pipe with gravel pack in 8" diameter hole.
45							
50							

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PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-3 Sheet 1 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray brown, dry, loose.
			30	SM	109.9	1.5	Silty Fine Sand, light rusty brown, dry to damp, loose to moderately dense.
5			21	SM SP/SM	109.9	1.7	Slightly Silty Coarse Sand, gray-brown, dry to damp, loose to moderately dense.
			33	SP/SM	110.6	3.3	Slightly Silty Coarse Sand, gray-brown, damp, moderately dense, some gravel size.
10							
			30	SP/SM and SM	104.1	6.3	Slightly Silty Coarse Sand, red-brown moist, moderately dense, gravelly in layers, thin interlayers of Silty Sand.
15							
			40	SP/SM	105.9	3.1	Gravelly Slightly Silty Coarse Sand, red-brown, moist, moderately dense.
20							
			50/6"	SP/SM	102.1	3.0	Gravelly Slightly Silty Coarse Sand, brown, moist, dense, gravel to 2" size.
25							
			40	SM to ML	112.9	10.0	Silty Very Fine Sand to Very Fine Sandy Silt, red-brown, moist, moderately dense.
30							

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PLATE A-5

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE W.O. 101849

Boring B-3 Sheet 2 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
							Clean Coarse Sand, brown, damp to moist, moderately dense to dense, some gravel size.
35		■	50	SP	111.9	2.1	
							Clean Medium to Coarse Sand, brown, damp to moist, moderately dense to dense.
40		■	55	SP	107.0	2.2	
							End at 40 ft., no water.
							Installed 3" perforated pipe with gravel pack in 8" diameter hole.
45							

Blcel:cp-0001

PLATE A-6

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-4 Sheet 1 OF 3

Date 9-18-92 By: CEL

18-inch diameter bucket

Sample Method: 2150# to 25 ft. 1350# to 45 ft.

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0							Silty Fine Sand, rusty brown, dry to 2 ft., then damp, loose to moderately dense.
5		■	2	SM	102.5	3.4	
							Gravelly at 9 ft.
10		■	1	SP/SM	Hit Rock No Sample		Gravelly Slightly Silty Sand, red-brown, moist, moderately dense, cobbles to 18-inch size, caving.
				SM			Silty Very Fine Sand, red-brown, moist, moderately dense.
15		■	6		97.0	9.3	
							End at 16 ft., large rock (18 inch) fell in from above, cannot get out - abandoned boring.
							No water, caving from 10 ft. - 12 ft. Moved 10 ft. Southerly to Boring B-4a.
20							
25							
30							

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-4a Sheet 2 OF 3

Date 9-18-92 By: CEL

Sample Method: 2150# to 25 ft.
1350# to 45 ft.

18-inch diameter boring

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0							For log to 16 feet, see Boring 4.
5							
10							
15							
				SM Occ. ML			Silty Fine Sand, red-brown, moist, moderately dense, interlayers of Medium to Coarse Sand (SM), occasional interlayer of Silt (ML).
20		■	4		114.7	7.0	
25		■	20	SM Occ. SP/ SM	114.4	4.7	At 25 ft., 4-inch thick layer of Gravelly Slightly Silty Medium to Coarse Sand, gravel to 1" size.
							Cleaner and coarser with depth.
30							

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-4a Sheet 3 OF 3

Date 9-18-92 By: CEL

Sample Method: 2150# to 25 ft.
1350# to 45 ft.

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30			17	SP/ SM	110.8	3.1	Gravelly Slightly Silty Sand, red-brown, moist, dense. Cleaner and coarser with /depth.
35			20	SP	101.6	3.5	Gravelly Clean Coarse Sand, gray-brown, damp to moist, dense, minor ravelling.
40			20		107.5	4.2	End at 40 ft., sampled to 41 ft., no water, caving from 10 ft. - 12 ft. minor ravelling from 34 ft. - 40 ft.
45							Installed 3 inch diameter slotted pipe with gravel pack in 18 inch diameter hole.
50							

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-5 Sheet 1 OF 2

Date 9-23-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray-brown, dry, loose (blow sand).
			32	SM	105.7	1.6	Silty Fine Sand, red-brown, dry to damp, moderately dense.
5			33	SM	110.1	1.7	
							Gravelly Slightly Silty Sand, red-brown, dry to damp, loose to moderately dense.
10			25	SP/SP	107.8	2.9	
15			60	SP/SM	108.1	1.9	Gravelly Slightly Silty Sand, red-brown, dry to damp, moderately dense, gravel to 1 inch size.
20			59	SP/SM	110.2	1.3	Gravelly Slightly Silty Sand, gray-red-brown, dry, moderately dense, gravel to ½ inch size.
25			66	SM/ML	109.1	5.1	Silty Very Fine Sand to Very fine Sandy Silt, red-brown, damp, moderately dense, porous layers.
30			55	SP/SM	110.2	1.3	Gravelly Slightly Silty Sand, red-brown, dry, moderately dense.

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PLATE A-10

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-5 Sheet 2 OF 2

Date 9-23-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30				SP/ SM			
35			40	SM	112.5	1.5	Silty Very Fine Sand, red-brown, damp, moderately dense.
40			52	SM	104.9	4.0	Silty Very Fine Sand, red-brown, damp, moderately dense.
45							End at 40 ft., no water. Installed 3 inch diameter perforated pipe with gravel pack in 8 inch diameter hole.
50							

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PLATE A-11

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-6 Sheet 1 OF 2

Date 9-23-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray-brown, dry, loose.
			34	SM	107.4	2.6	Silty Fine Sand, red-brown, damp, loose to moderately dense.
5			17	SM	104.0	2.1	
10			40	SM/ ML	94.7	7.4	Silty Very Fine Sand to Very Fine Sandy Silt, gray-red-brown, dry to damp moderately dense.
15			70	SM/ ML	105.1	4.2	Silty Very Fine Sand to Very Fine Sandy Silt, gray-red-brown, dry to damp, dense.
				SM			Slightly Silty Sand, red-brown, dry, moderately dense.
20			44	SM/ ML	112.1	1.1	Very Fine Sandy Silt to Silty Very Fine Sand, red-brown, damp, moderately dense.
25			50	SM	98.5	3.9	Silty Very Fine Sand, gray, dry, moderately dense.
							Interlayered Very Fine Sands, red-brown and gray, and Silt, red-brown, damp, moderately dense.
30			45	SM to ML	106.6	3.7	

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-6 Sheet 2 OF 2

Date 9-23-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30				SM			Silty Very Fine Sand, red-brown, damp, moderately dense.
35		■	45	SP/SM	107.9	7.0	Slightly Silty Fine to Medium Sand, red-brown, dry to damp, moderately dense.
40		■	40	SP/SM	104.3	3.2	Slightly Silty Fine to Medium Sand, red-brown, damp, moderately dense.
							End at 40 ft., no water.
							Installed 3 inch diameter perforated pipe with gravel pack in 8 inch diameter hole.
45							
50							

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

18-inch diameter boring

Boring B-7 Sheet 1 OF 2

Date 9-18-92 By: CEL

Sample Method: 2150# to 24 ft. 1350# > 25 ft.

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0							
			1	SM	105.8	2.1	Silty Fine Sand, light gray brown, dry, loose. Damp at 2 ft., red-brown, denser at 3½ ft.
5			4		116.5	4.2	
				SP/SM			Gravelly Slightly Silty Sand, gray-brown, damp, moderately dense.
10			2	SM	107.9	8.9	Silty Fine to Very Fine Sand, red-brown, moist, moderately dense.
15			4	SM	104.5	6.5	
20			2	SM	119.3	4.4	
				SM			Silty Sand, red-brown, damp to moist, moderately dense, 10±% gravel size.
25			25	SP/SM & SM	112.1	2.3	Gravelly Slightly Silty Sand, gray-red-brown, damp, dense, some interlayers of Silty Sand.
30							

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PLATE A-14

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-7 Sheet 2 OF 2

Date 9-18-92 By: CEL

Sample Method: 2150# to 24 ft.
1350# > 25 ft.

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30		■	12	SP/SM	111.9	2.8	Below 30 ft., more gravel size to 1½ inch, cleaner and coarser sand size, still interlayers of Silty Sand.
35		■	15		Fell Out No Sample		
40		■	13		111.4	3.7	End at 40 ft., sampled to 41 ft., no water, minor ravelling in cleaner strata but no severe caving. Perforated pipe and gravel from 10 ft. to 40 ft., solid pipe 0-10 ft. Hole diameter = 18 inches.
45							
50							

Blcel:cp-0001

PLATE A-15

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-8 Sheet 1 OF 2

Date 9-21-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, light gray-brown, dry loose.
							At 2 ft., red-brown, damp.
5			19	SM	105.0	2.7	Silty Fine Sand, red-brown, damp, moderately dense.
							At 7 ft., some gravel size.
10			22	SM/ ML	101.3	8.3	Silty Very Fine Sand to Very Fine Sandy Silt, red-brown, moist, moderately dense.
15			60	SM	102.7	3.5	Silty Fine Sand, light red-brown, damp, moderately dense to dense.
							At 16 ft., thin lense of gravel.
20			50/ 7"	SM	Fell Out No Sample		Silty Fine Sand, light gray-red-brown, damp, moderately dense to dense.
25			60	SP	107.8	1.6	Clean Medium Sand, gray-red-brown, damp, moderately dense to dense.
30			64	SP/ SM	108.3	2.4	Slightly Silty Medium to Coarse Sand, red-brown, damp, moderately dense to dense, 10±% gravel size.

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PLATE A-16

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-8 Sheet 2 OF 2

Date 9-21-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
35		■	55	SP/SM	108.1	3.5	Gravelly Slightly Silty Sand, red-brown, damp, moderately dense to dense.
40		■	52	SP/SM	101.0	1.8	Slightly Silty Fine to Medium Sand, gray-brown, damp, moderately dense to dense.
							End at 40 ft., no water.
							Installed 3" perforated pipe with gravel pack in 8" diameter hole.

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE W.O. 101849

Boring B-9 Sheet 1 OF 2

Date 9-21-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray-brown, dry, loose.
5		■	35	SM	115.2	8.8	Silty Fine Sand, red-brown, moist, moderately dense.
10		■	33	SP/SM	106.7	3.0	Slightly Silty Sand, red-brown, damp, moderately dense.
15		■	38	SM/ML	114.3	14.3	Silty Very Fine Sand to Very Fine Sandy Silt, red-brown, moist to very moist, moderately dense.
20		■	60	SP	103.6	2.0	Gravelly Clean Medium to Coarse Sand, gray-red-brown, damp, moderately dense, gravel to 1" size.
25		■	50	SP	110.5	2.1	Clean Fine to Medium Sand, gray-brown, damp, moderately dense.
30		■	54	SP	102.2	3.4	Gravelly Clean Medium Sand, gray-red-brown, damp, moderately dense.

Blank

cel:cp-0001

PLATE A-18

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-9 Sheet 2 OF 2

Date 9-21-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
35		■	70	SP	104.4	3.6	Gravelly Clean Medium to Coarse Sand, gray-red-brown, damp, moderately dense.
							Silty Fine Sandy, gray-red-brown, damp to moist, moderately dense.
40		■	44	SM	105.8	8.2	
							End at 40 ft., no water.
							Installed 3" perforated pipe with gravel pack in 8" diameter hole.

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-10 Sheet 1 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray-brown, dry, loose.
			8	SM	108.4	4.1	Silty Fine Sand, red-brown, damp to moist, loose.
5			16	SM	112.0	5.3	Silty Fine Sand, red-brown, damp to moist, loose, gravelly in layers, occasional thin caliche "webbing".
10			18	SM	Fell Out No Sample		Gravelly Silty Sand, red-brown, damp, loose.
15			50/	SM	No Sample		Gravelly Silty Sand, red-brown, dry to damp, dense.
20			47	SM	Fell Out No Sample		Gravelly Silty Sand, red-brown, dry to damp, moderately dense.
25			32	SM Occ. ML	91.3	4.1	Silty Very Fine Sand, light gray-red-brown, dry to damp, moderately dense, interlayers of Silt and Gravelly Silty Sand.
30			50/ 2"	SM	No Sample		Silty Very Fine Sand, gray-brown, dry to damp, moderately dense.

Bl:1
cel:cp-0001

PLATE - 20

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-10 Sheet 2 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
35		■	50/1"	SM	No Sample		Silty Very Fine Sand, light gray-brown, dry to damp, dense.
40		■	50	SM	Fell Out No Sample		Silty Very Fine Sand, light gray-brown, dry to damp, moderately dense.
							End at 40 ft., no water, hole fairly dry throughout. Installed 3" perforated pipe with gravel pack in 8" diameter hole.

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-11 Sheet 1 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray-brown, dry, loose.
							Silty Fine Sand, red-brown, damp, loose.
			18	SM	109.3	1.9	
5			22	SM	116.0	1.6	Silty Sand, red-brown, damp, loose to moderately dense, gravelly in layers, gravel to 1" size.
10			70/8"	SM	111.6	2.2	Silty Sand, red-brown, damp, dense, some gravel size.
15			44	SM	Fell Out No Sample		Gravelly Silty Sand, red-brown, dry to damp, moderately dense.
20			48	SM	99.3	3.5	Silty Very Fine Sand, red-brown, damp, moderately dense.
25			80/6"	SM	Fell Out No Sample		
30			42	SM	105.4	1.7	Silty Very Fine Sand, gray-brown, dry to damp, moderately dense.

Blk

cel:cp-0001

PLATE A-22

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-11 Sheet 2 OF 2

Date 9-22-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
35		■	50	SM	105.8	1.4	Silty Very Fine Sand, gray-brown, dry to damp, moderately dense.
40		■	75	SM	Fell Out No Sample		
							End at 40 ft., no water, hole relatively dry throughout. Installed 3" diameter perforated pipe with gravel in 8" diameter hole.

Blcel:cp-0001

PLATE A-23

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE W.O. 101849

Boring B-12 Sheet 1 OF 2

Date 9-21-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0							Silty Fine Sand, gray-brown, dry, loose. At 1-1/2 ft., red-brown, damp, moderately dense.
			23	SM	108.7	2.5	
			22	SM	112.9	2.8	Silty Fine Sand, rusty brown, damp, moderately dense.
5							
			30		Fell Out No Sample		Silty Fine Sand, rusty brown, damp, moderately dense, some gravel size.
10							
			55	SM	106.7	4.5	Silty Very Fine Sand, red-brown, damp, moderately dense, minor caliche seams.
15							
			40/ 2"		No Sample		
20							
			64	SM	102.7	2.3	Silty Fine Sand, red-brown, damp, moderately dense.
25							
				Occ. SP			From 28-1/2 to 29-1/2 ft., layer of Gravelly Clean Sand, gray, dry, loose.
			55	SM/ ML	108.0	2.0	Silty Very Fine Sand to Very Fine Sandy Silt, red-brown, damp, moderately dense.
30							

cei:cp-0001

PLATE A-24

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-12 Sheet 2 OF 2

Date 9-21-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
		■	54	SM/ ML & SM	99.8	2.8	Silty Very Fine Sand to Very Fine Sandy Silt, rusty brown, damp, moderately dense; 6-inch interlayer of Silty Sand, gray-red-brown, dry, loose to moderately dense.
35							
40		■	90/ 8"	SM/ ML	104.7	3.4	Silty Very Fine Sand to Very Fine Sandy Silt, rusty brown, damp, dense.
							End at 40 ft., no water.
							Installed 3" perforated pipe with gravel pack in 8" diameter hole.

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE W.O. 101849

Boring B-13 Sheet 1 OF 2

Date 9-21-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray-brown, dry, loose.
			22	SM	109.8	3.4	Silty Fine Sand, red-brown, damp, loose to moderately dense.
5			18	SM	111.4	3.1	Silty Sand, red-brown, damp, loose to moderately dense, some gravel size.
10			28	SP/SM	104.9	2.9	Gravelly Slightly Silty Sand, red-brown, damp, moderately dense.
15			41	SP/SM	103.4	5.9	Slightly Silty Sand, red-brown, damp, moderately dense, 10±% gravel size.
20			63	SP	105.1	2.0	Gravelly Slightly Silty Sand, gray-brown, dry to damp, moderately dense to dense, gravel to 3/4" size.
25			62	SP	Fell Out No Sample		Gravelly (30+%), Slightly Silty Sand, gray-brown, damp, moderately dense to dense, gravel to 1" size.
30			70	SP	109.1	2.4	Gravelly Slightly Silty Sand, red-brown, damp, dense.

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-13 Sheet 2 OF 2

Date 9-21-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
		■	75	SP and SM	106.7	2.3	Gravelly Slightly Silty Sand, red-brown, damp, dense with interlayers of Silty Sand, red-brown, damp, moderately dense to dense.
35							
		■	75	SM	103.8	3.9	Silty Fine Sand, red-brown, damp, dense.
40							End at 40 ft., no water. Set 3" perforated pipe with gravel pack in 8" diameter hole.

Blcl:cel:cp-0001

PLATE A-27

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-14 Sheet 1 OF 2

Date 9-23-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray-brown, dry, loose.
			44	SM	103.3	1.9	Silty Fine Sand, red-brown, dry to damp, moderately dense.
5			88	SM	103.3	2.0	
				SM			Drilling "rough" 7 ft. - 13 ft., too rocky to sample. Gravelly in layers.
10							Silty Sand, red-brown, damp, moderately dense to dense, gravelly in layers.
15			60/2"	SM	Hit Rock No Sample		
20			68	SM to ML	106.2	3.6	Silty Very Fine Sand to Very Fine Sandy Silt, red-brown, damp, moderately dense to dense.
25			70/3"	SM to ML	No Sample		Silty Very Fine Sand to Very Fine Sandy Silt, red-brown, damp, dense.
							Interlayers Silt, red-brown, with caliche seams and Silty Very Fine Sand, red-brown, damp, dense.
30			70/7"	ML and SM	100.5	6.3	

BL-1

cel:cp-0001

PLATE A-28

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-14 Sheet 2 OF 2

Date 9-23-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
		■	70/ 8"	SM and ML	109.5	7.0	Interlayered Silt, red-brown with caliche webbing and Silty Sand, red-brown, damp, dense.
35							
		■	80	SM and ML	Fell Out No Sample		Interlayered Silt, red-brown with caliche webbing and Silty Very Fine Sand, red-brown, damp, dense.
40							End at 40 ft., no water.
							Installed 3" diameter perforated pipe with gravel in 8" diameter hole.

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

W.O. 101849

Boring B-15 Sheet 1 OF 2

Date 9-23-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
0				SM			Silty Fine Sand, gray-brown, dry, loose.
			16	SM	100.4	3.3	Silty Fine Sand, red-brown, damp, loose.
5			38	SM	109.5	3.2	Silty Fine Sand, red-brown, damp to moist, moderately dense.
10			42	SM	114.1	3.2	Silty Fine Sand, red-brown, damp to moist, moderately dense.
15			46	SP/SM	Fell Out No Sample		Slightly Silty Fine to Medium Sand, red-brown, dry to damp, moderately dense.
20			43	SP/SM	Fell Out No Sample		Slightly Silty Fine to Medium Sand, red-brown, dry to damp, moderately dense.
25			40	SP/SM	Fell Out No Sample		
30			55	SP/SM and SP	108.1	1.3	Slightly Silty Sand, red-brown, dry to damp, moderately dense, interlayers of Gravelly Clean Sand, gray, dry dense.

PACIFIC SOILS ENGINEERING, INC.

Boring Log

PROJECT: LOCKHEED - 613 ACRE - PALMDALE

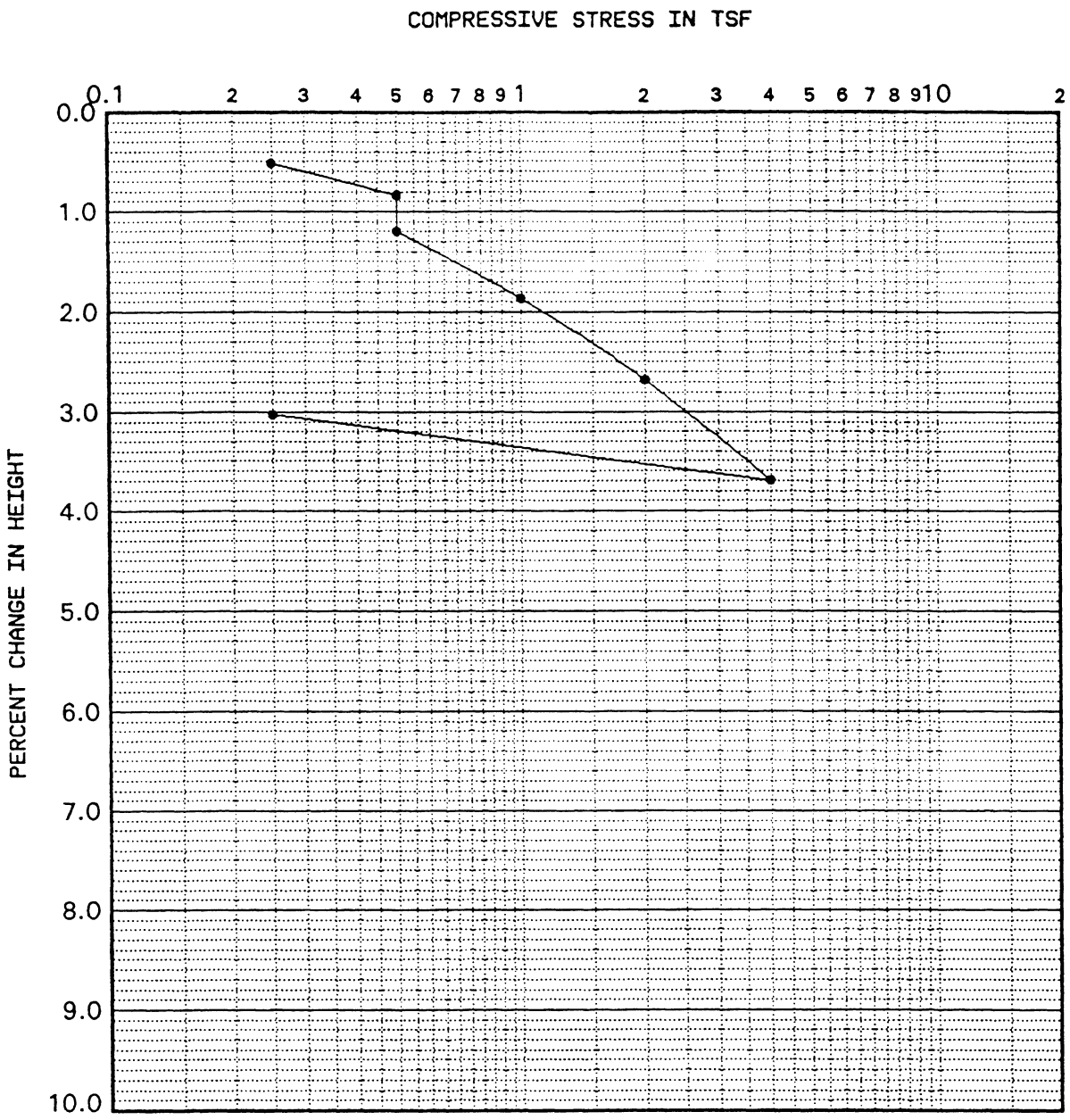
W.O. 101849

Boring B-15 Sheet 2 OF 2

Date 9-23-92 By: CEL

Sample Method: 140# - 30" FALL

Depth (ft.)	Bulk	Undisturbed	Blows/ft.	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description
30							
		■	67	SP/SM	108.8	1.7	Slightly Silty Sand, red-brown, dry to damp, moderately dense to dense, 10±% gravel size.
35							
							Silty Very Fine Sand, red-brown, damp, dense.
		■	70/6"	SM	104.1	2.6	
40							End at 40 ft., no water.
							Installed 3" diameter perforated pipe with gravel in 8" diameter hole.



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-2	4.00					

REMARKS:

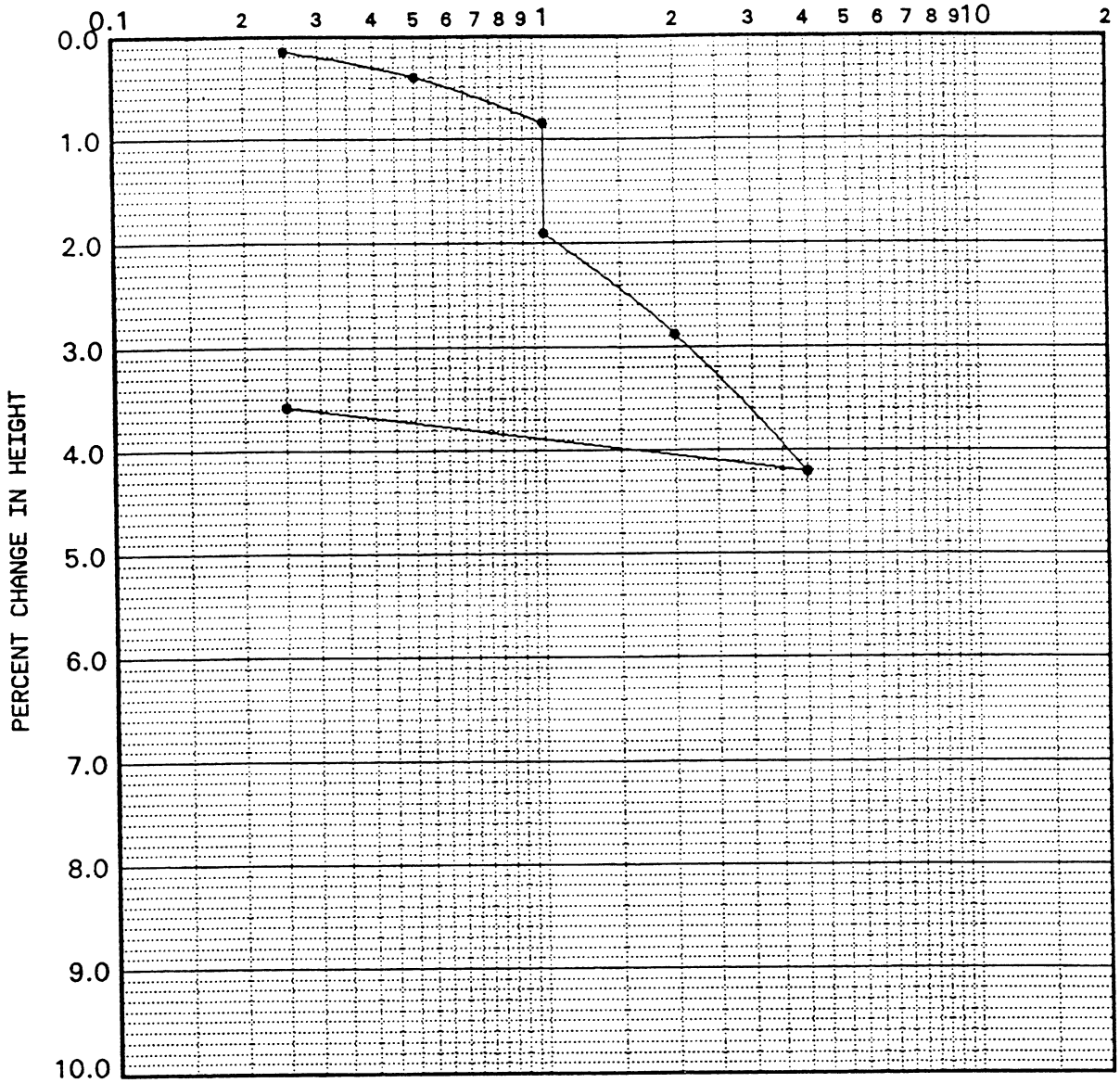
CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-1

COMPRESSIVE STRESS IN TSF



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-2	14.00					

REMARKS:

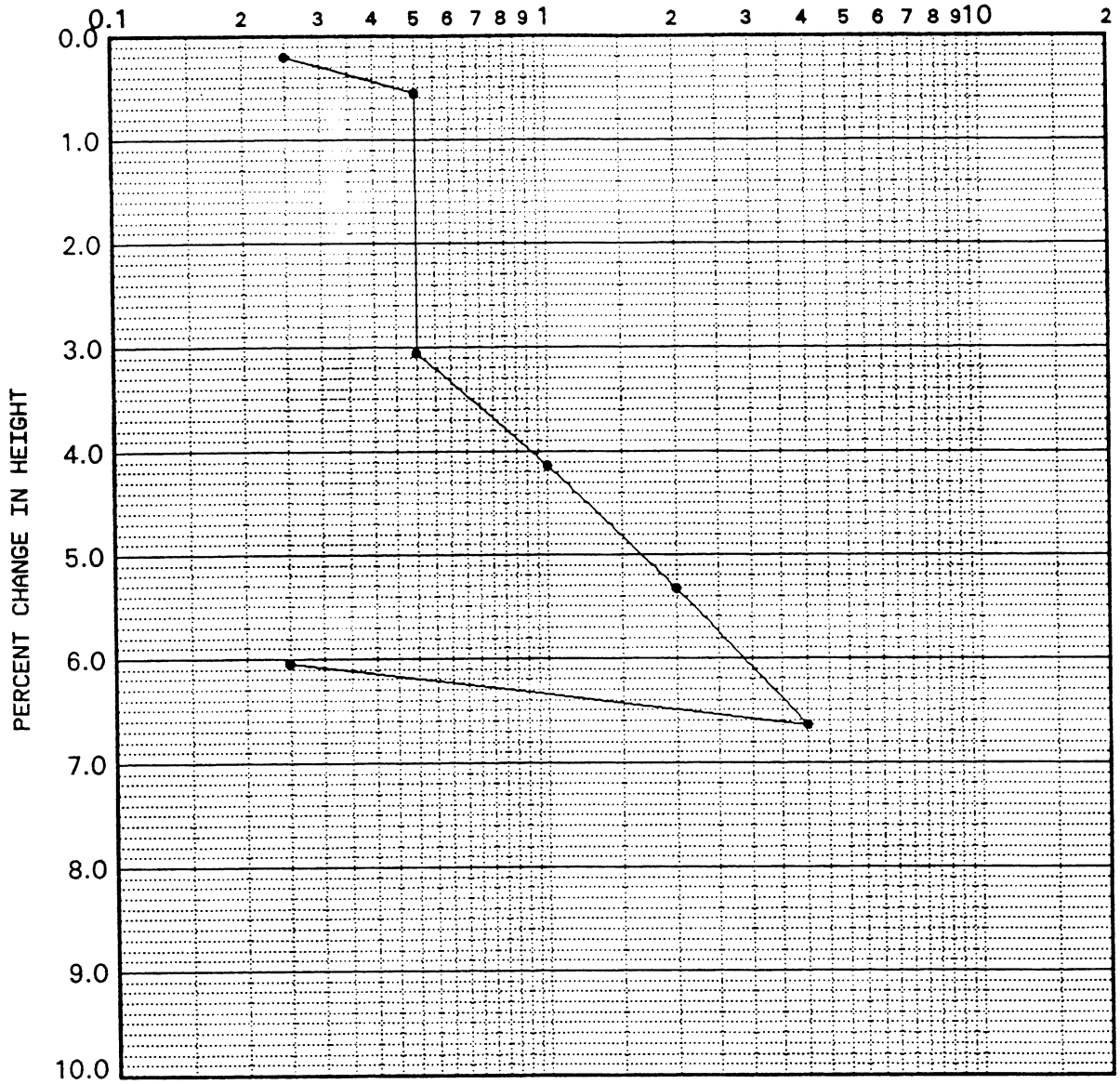
CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-2

COMPRESSIVE STRESS IN TSF



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-5	4.00					

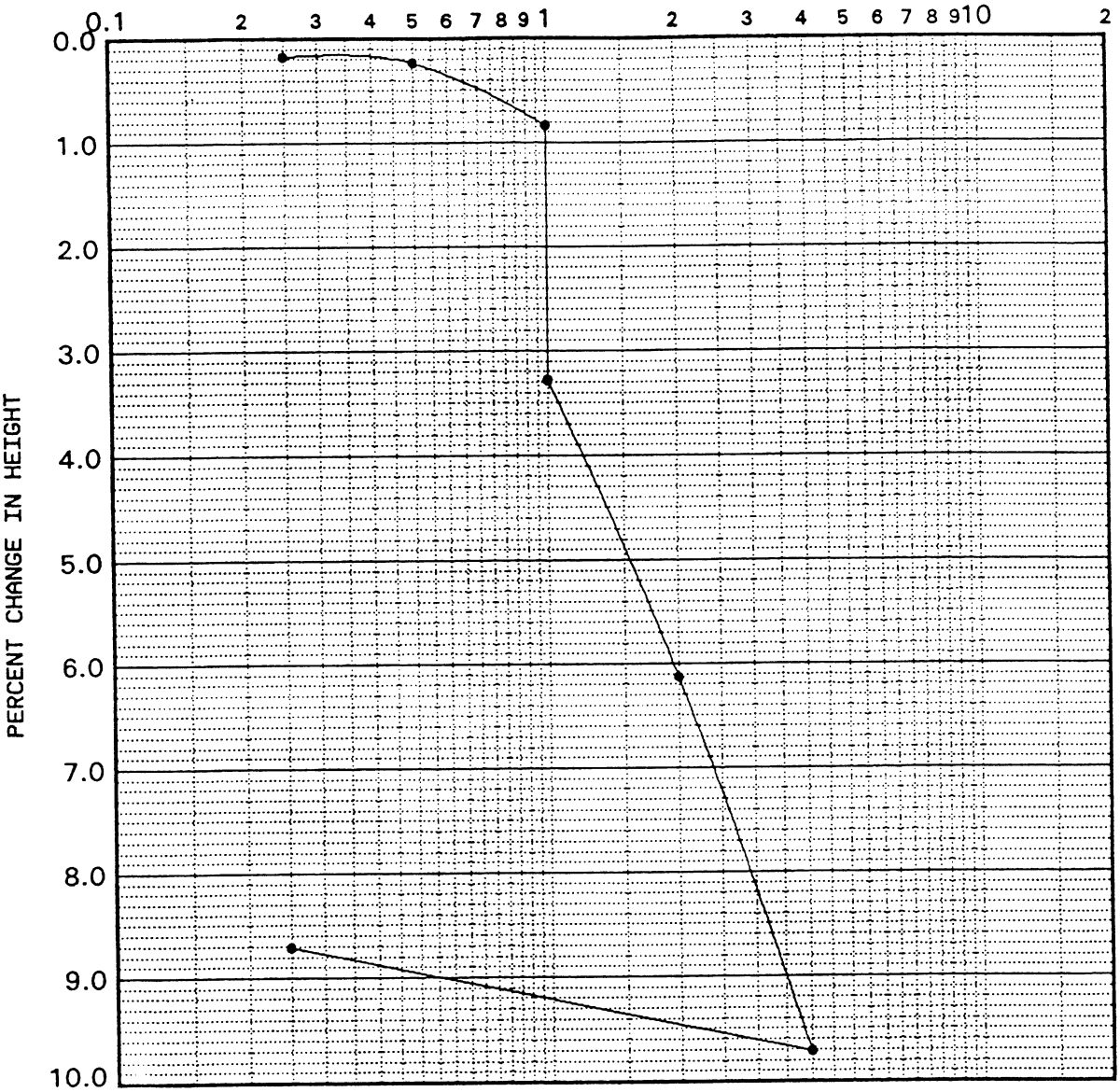
REMARKS:

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-3



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-5	24.00					

REMARKS:

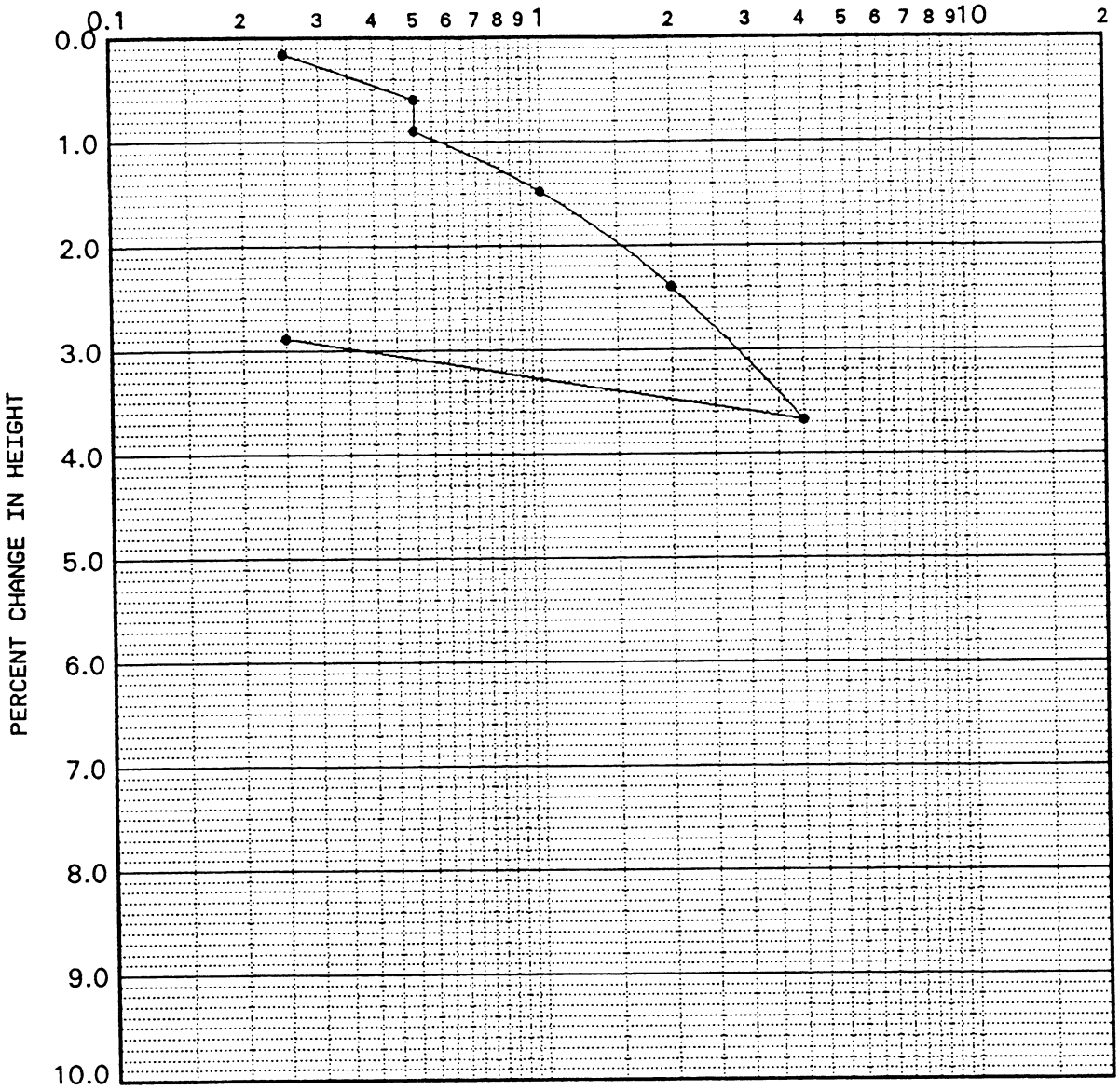
CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-4

COMPRESSIVE STRESS IN TSF



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-6	9.00					

REMARKS:

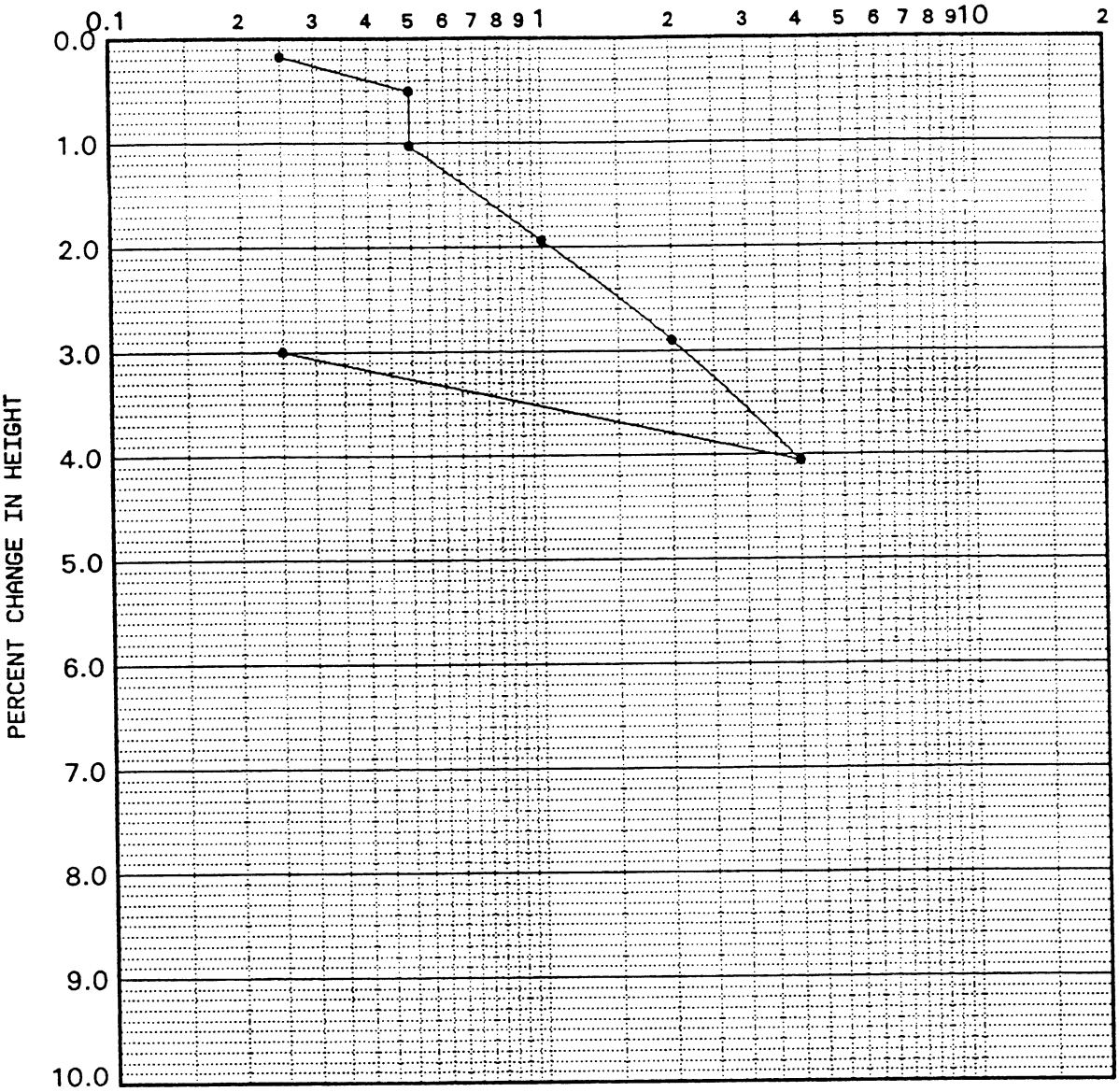
CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-5

COMPRESSIVE STRESS IN TSF



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-7	10.00					

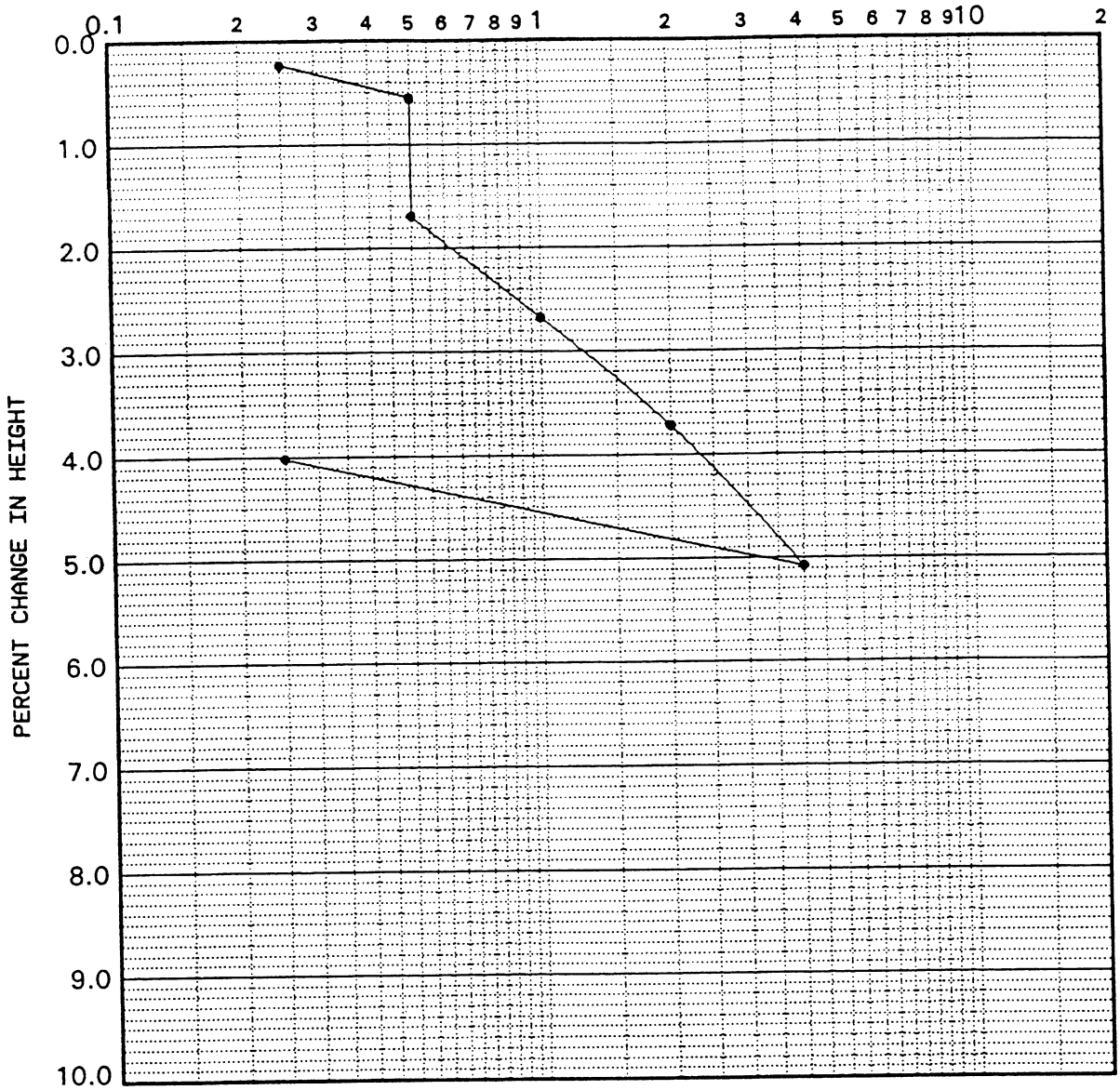
REMARKS:

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-6



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-8	9.00					

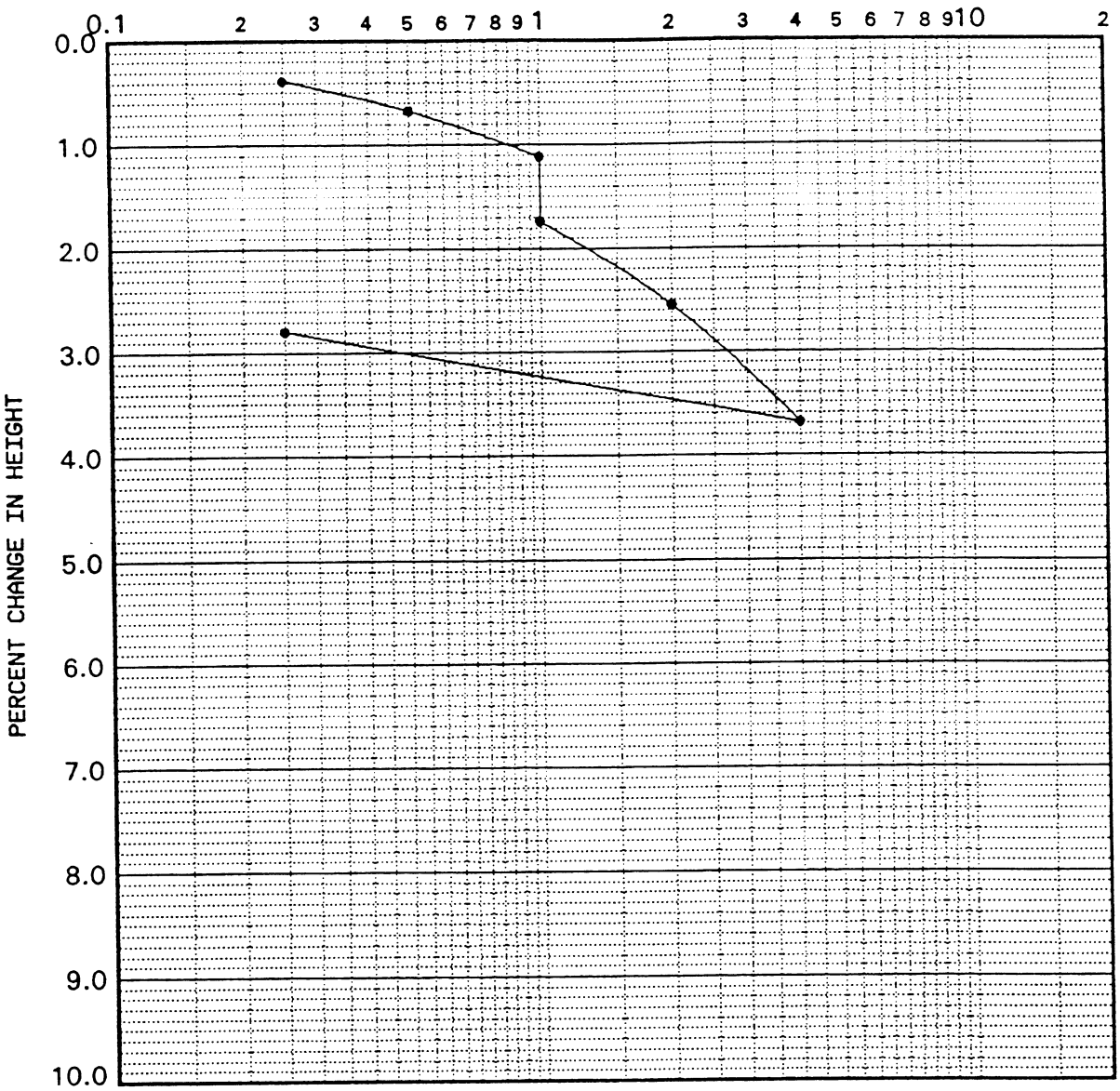
REMARKS:

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-7



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-11	29.00					

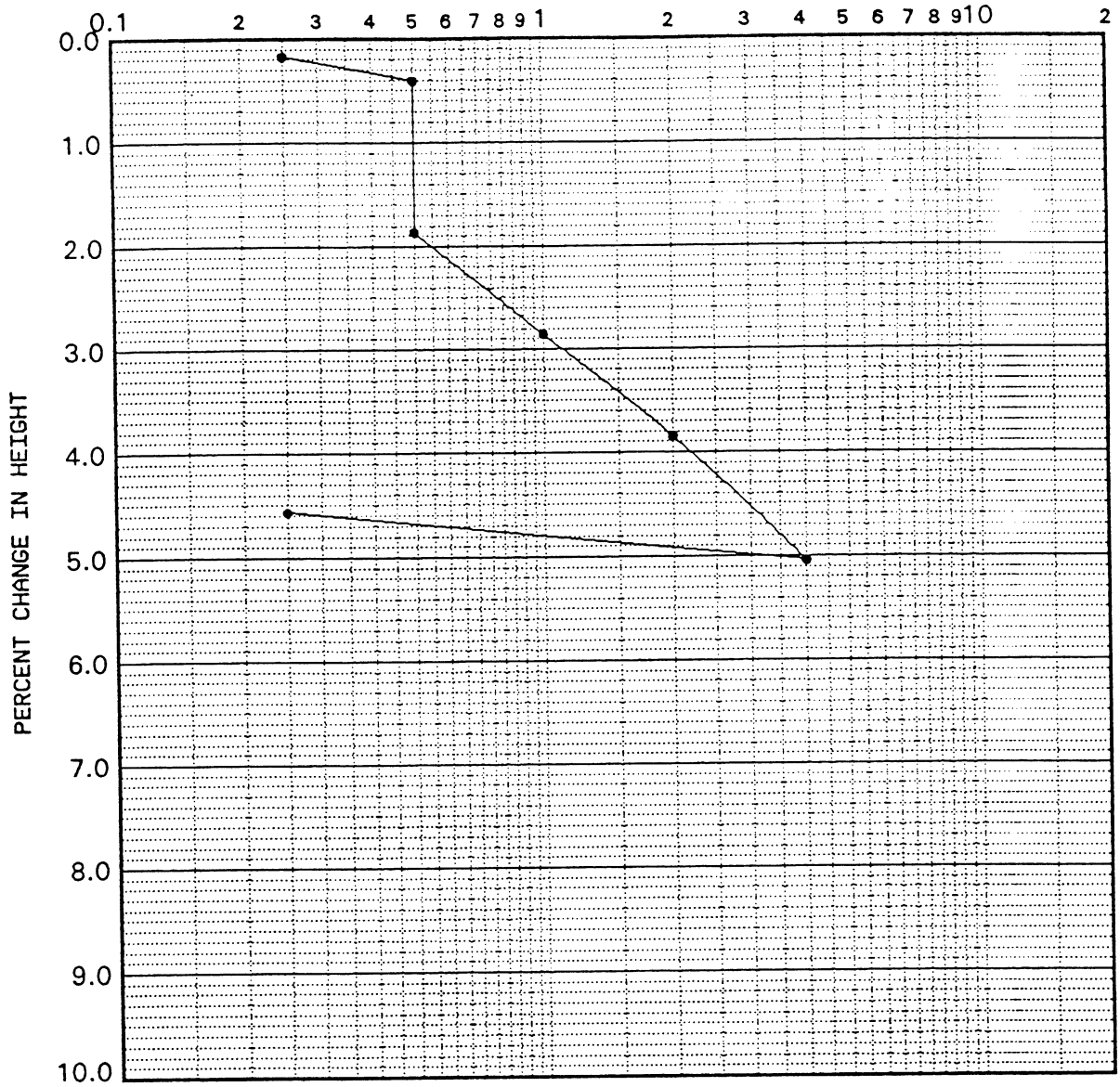
REMARKS:

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-8



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-12	4.00					

REMARKS:

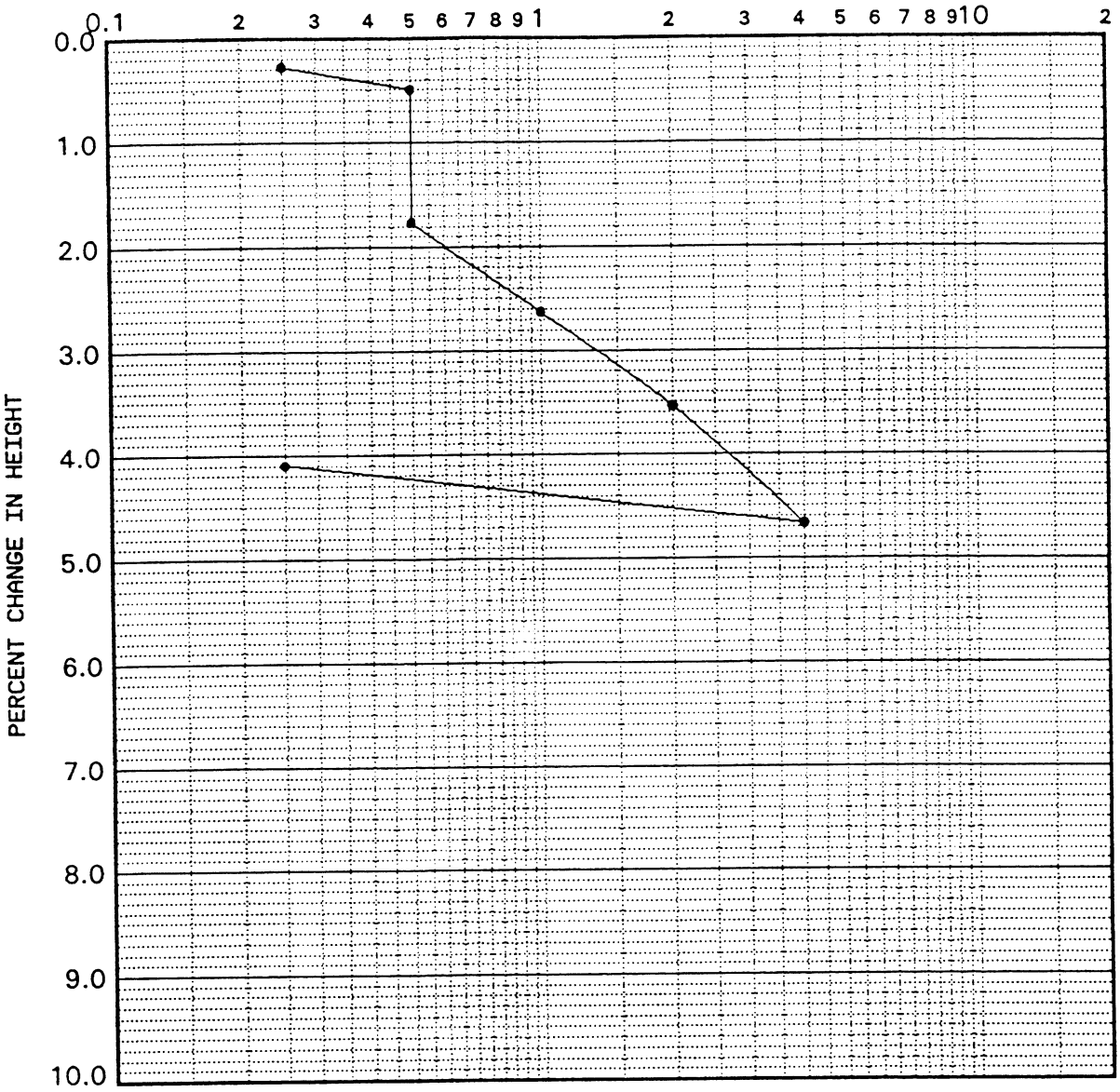
CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-9

COMPRESSIVE STRESS IN TSF



boring	depth(ft.)	LL(%)	PL(%)	PI(%)	group symbol	typical names
B-13	4.00					

REMARKS:

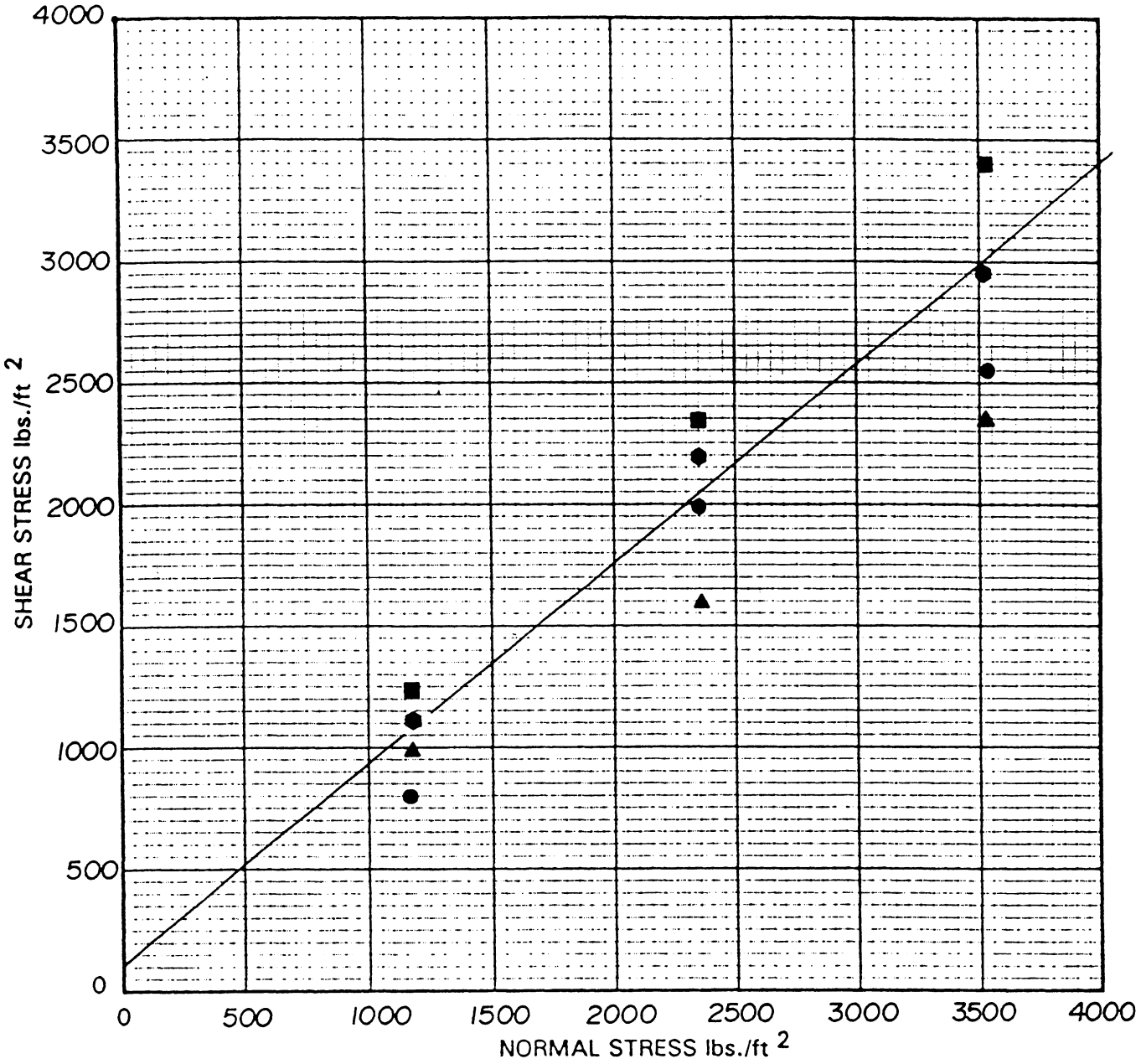
CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE B-10

DIRECT SHEAR TESTS



FOR REMOLDED MATERIALS

	COHESION 100 psf.
	FRICTION ANGLE 39 degrees

symbol	boring	depth (ft.)	symbol	boring	depth (ft.)
●	TP-18	1'			
▲	TP-20	3'			
■	TP-26	11'			
⬢	TP-35	1'			

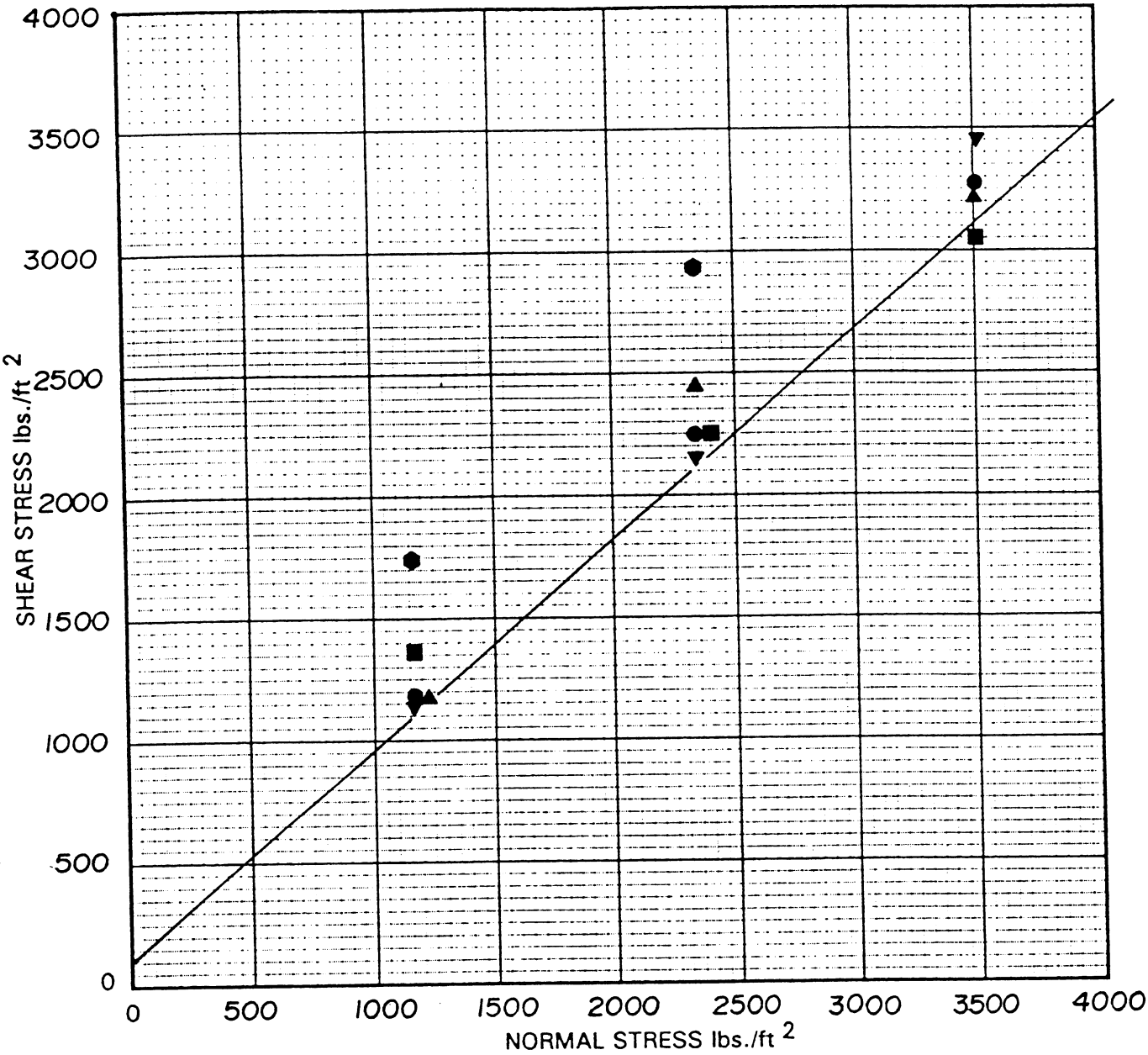
DIRECT SHEAR TEST

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE C-1

DIRECT SHEAR TESTS



FOR UNDISTURBED MATERIALS

	COHESION 100 psf.
	FRICTION ANGLE 40 degrees

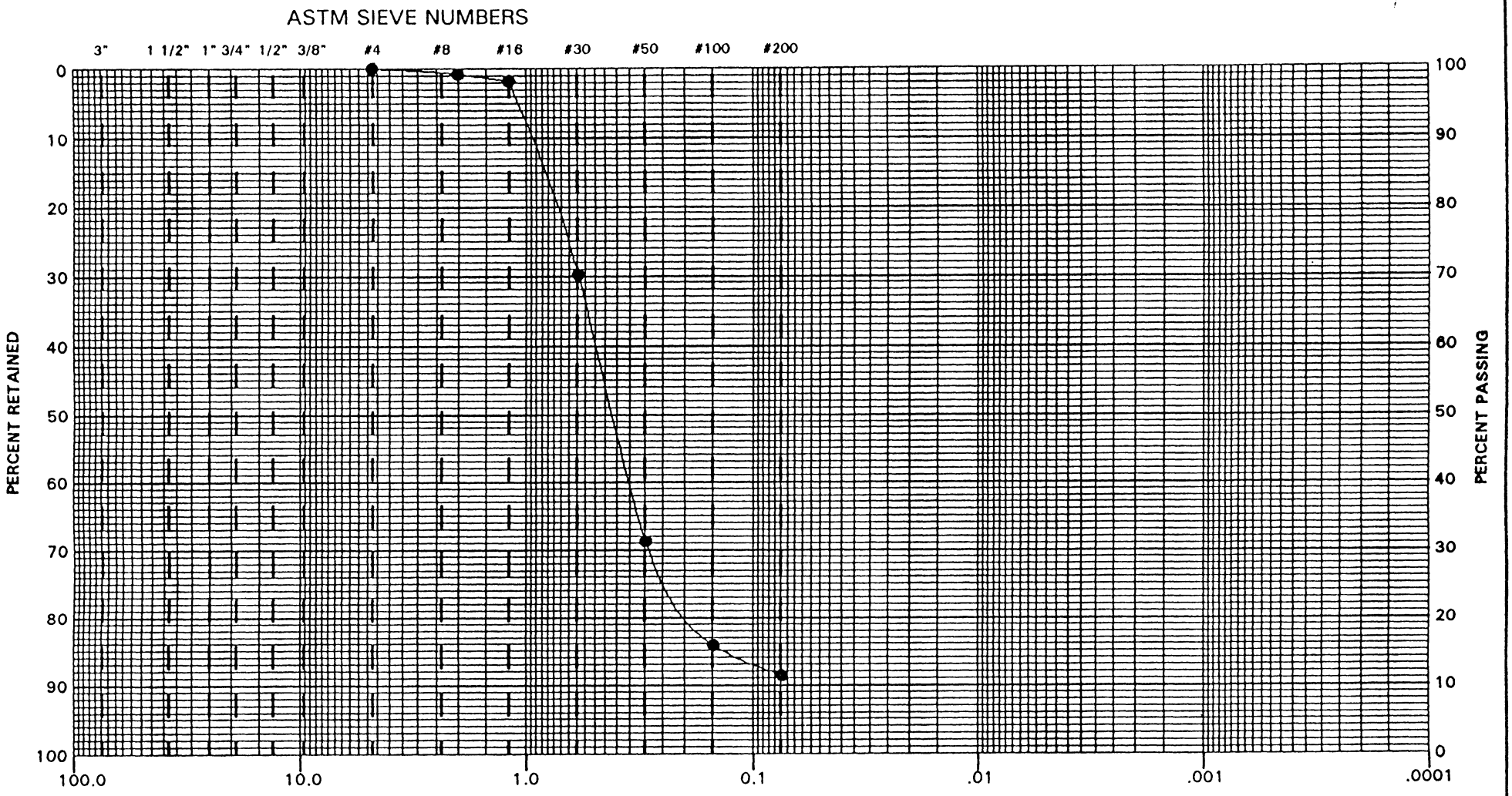
symbol	boring	depth (ft.)	symbol	boring	depth (ft.)
●	B-2	5'			
▲	B-2	14'			
■	B-6	4'			
⬢	B-9	9'			
▼	B-15	4'			

DIRECT SHEAR TEST

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE 10-30-92

PLATE C-2



	GRAVEL	SAND			SILT	CLAY	COLLOIDS
		COARSE	MEDIUM	FINE			

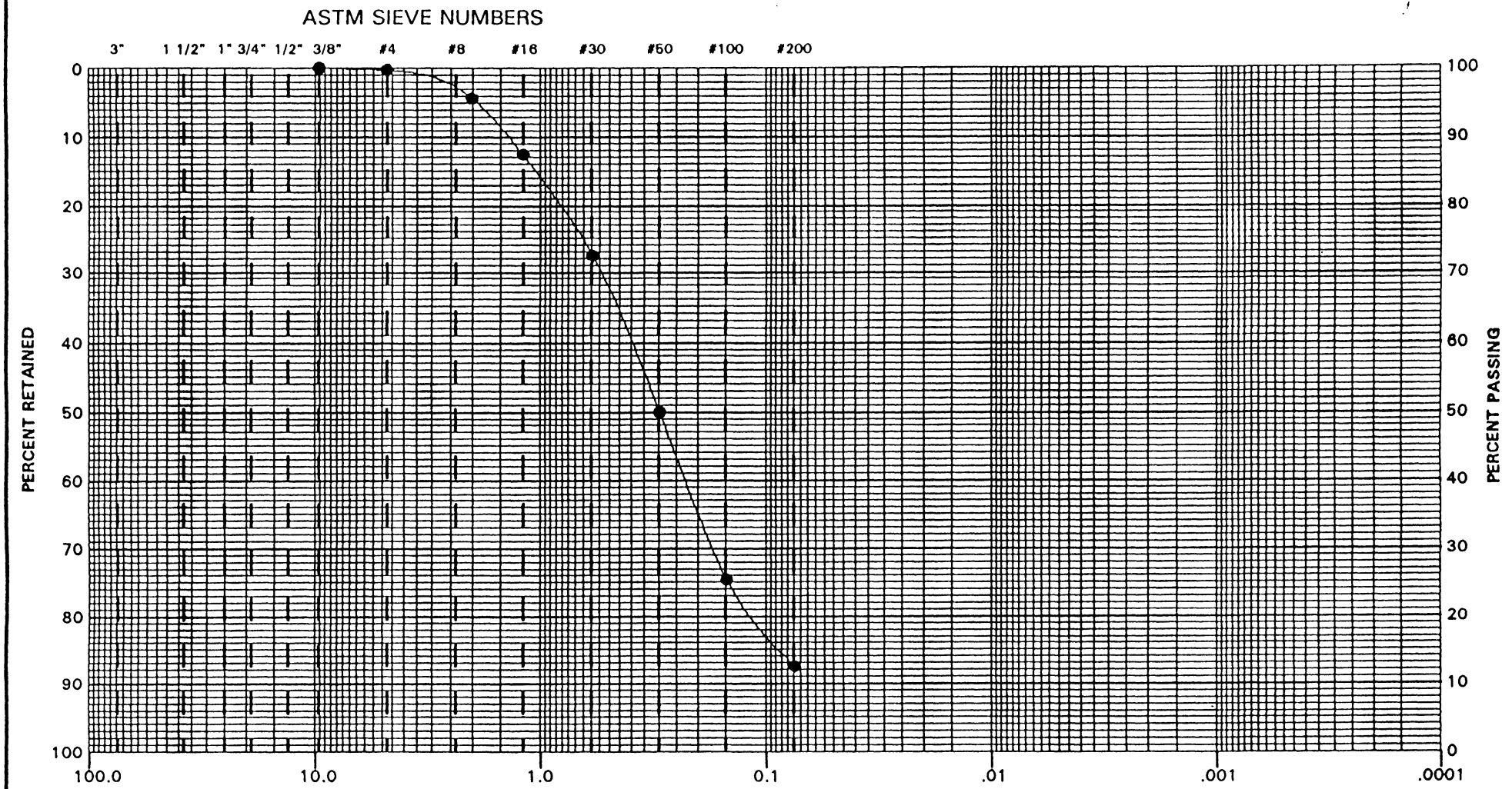
symbol	boring or trench	depth(ft.)	L.L.	P.L.	P.I.	% passing #200 sieve	group symbol	typical names
●	TP-18	1.00				11.4		SLIGHTLY SILTY FINE TO MEDIUM SAND

GRAIN SIZE DISTRIBUTION

PACIFIC SOILS ENGINEERING, INC.
10653 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE

PLATE D-1



	GRAVEL	SAND			SILT	CLAY	COLLOIDS
		COARSE	MEDIUM	FINE			

symbol	boring or trench	depth(ft.)	L.L.	P.L.	P.I.	% passing #200 sieve	group symbol	typical names
●	TP-26	1.00				12.5		SILTY SAND

GRAIN SIZE DISTRIBUTION

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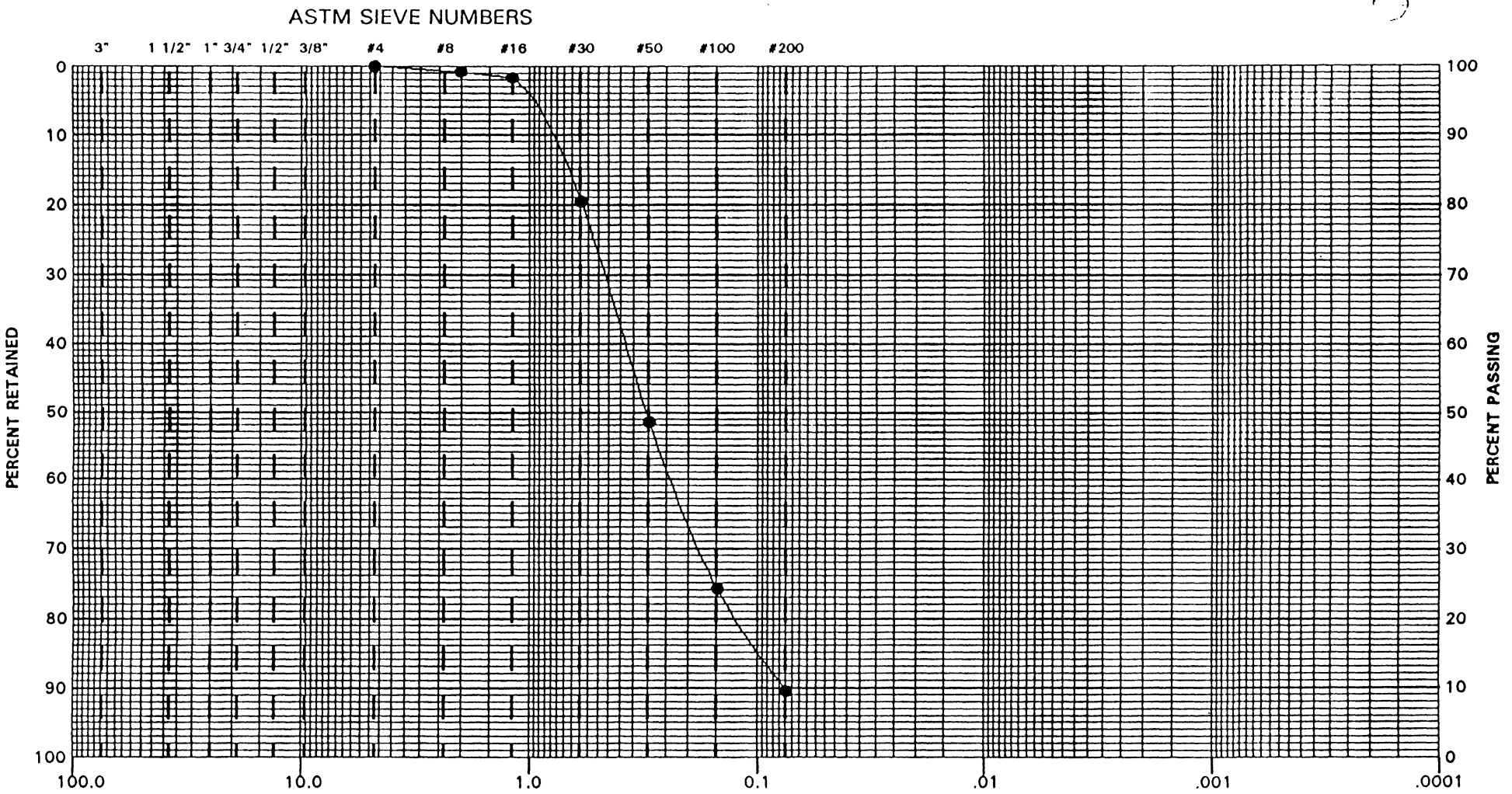
W.O. 101849 DATE

PLATE D-3



	GRAVEL	SAND			SILT	CLAY	COLLOIDS
		COARSE	MEDIUM	FINE			

symbol	boring or trench	depth(ft.)	L.L.	P.L.	P.I.	% passing #200 sieve	group symbol	typical names
●	TP-35	1.00				9.5		SLIGHTLY SILTY FINE TO MEDIUM SAND

GRAIN SIZE DISTRIBUTION

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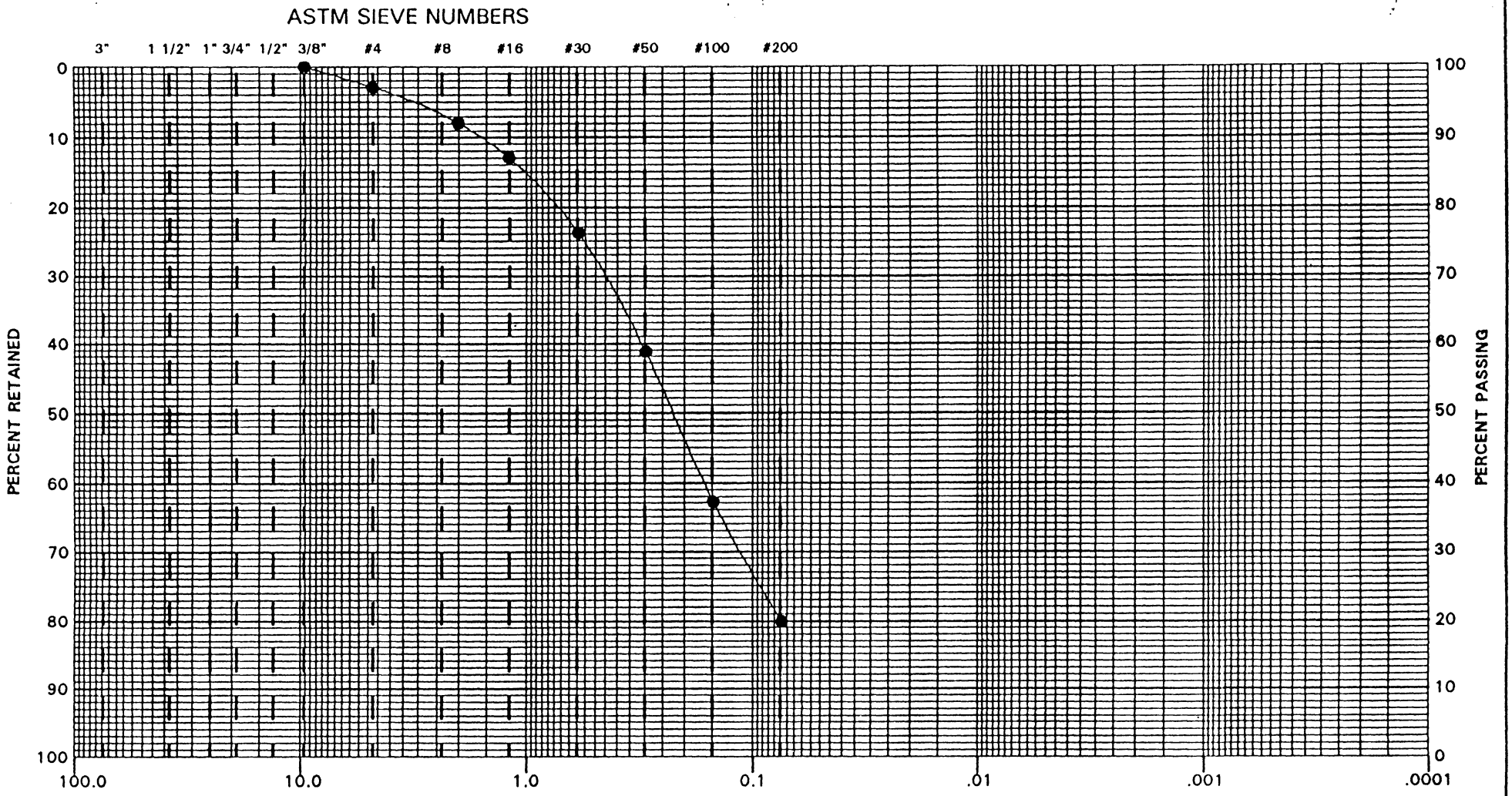
W.O. 101849 DATE

PLATE D-4



	GRAVEL	SAND			SILT	CLAY	COLLOIDS
		COARSE	MEDIUM	FINE			

symbol	boring or trench	depth(ft.)	L.L.	P.L.	P.I.	% passing #200 sieve	group symbol	typical names
●	B-12	3.00				19.9		SILTY SAND

GRAIN SIZE DISTRIBUTION

PACIFIC SOILS ENGINEERING, INC.
10853 PROGRESS WY. CYPRESS, CA 90630 714-220-0770

W.O. 101849 DATE

A P P E N D I X I

REFERENCES

October 30, 1992
Work Order 101849

GEOLOGIC REFERENCES

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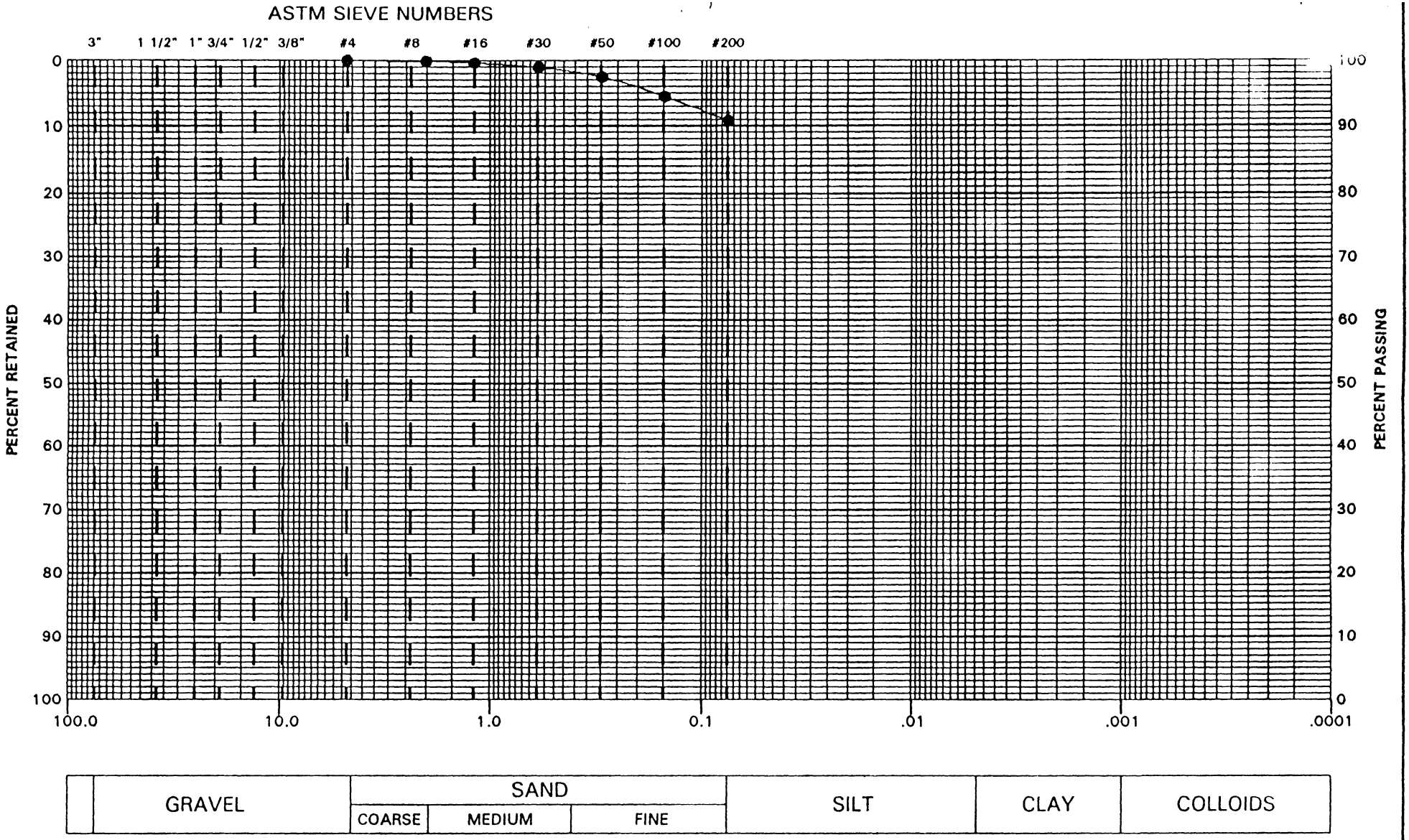
AERIAL PHOTOGRAPHS

U.S.D.A., 1959, A x J - 3W - 125 - 127
- 170 - 173

I.K. Curtis, 1988, LA - 171-B-5
D-5
F-5
J-5



	GRAVEL	SAND			SILT	CLAY	COLLOIDS
		COARSE	MEDIUM	FINE			

symbol	boring or trench	depth(ft.)	L.L.	P.L.	P.I.	% passing #200 sieve	group symbol	typical names
●	TP-20	3.00				90.7		CLAY SILT

GRAIN SIZE DISTRIBUTION

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W.O. 101849 DATE

PLATE D-2

October 30, 1992
Work Order 101849

A P P E N D I X II

LABORATORY ANALYSES

October 30, 1992
Work Order 101849

A P P E N D I X II

LABORATORY TESTING

Laboratory tests were performed on the samples to determine the soil properties for engineering analysis and to determine compaction characteristics. A brief description of the laboratory testing is presented below.

Moisture-Density Determinations

The unit dry weight and natural moisture content were determined for each of the undisturbed samples. The results of these tests are included in the boring logs, Plates A-1 through A-31. The laboratory maximum density and optimum moisture content were determined in accordance with ASTM Method of Test D-1557-78. Results of these tests are presented in Table A (following).

Consolidation Determinations

Consolidation tests were performed on undisturbed ring samples. At their natural moisture contents, the samples were loaded in 24-hour increments to their approximate overburden pressure (0.5 tsf or 1.0 tsf). At this load, water was introduced and the samples were allowed to saturate for a 24-hour period. Incremental loading, at 24-hour intervals, was continued to a maximum of four (4) tons per square foot after which rebound characteristics were determined. The results of these tests are presented on Plates B-1 through B-10.

October 30, 1992
Work Order 101849

A P P E N D I X II

Shear Strength Determinations

Shear tests were performed on both remolded samples and undisturbed specimens of the predominant soil types. These tests was performed using a direct shear machine of the strain control type in which the rate of strain is 0.05 inches per minutes. Specimens were inundated for approximately 24 hours, in confined conditions, and then subjected to shear under various normal loads. Results of tests on remolded specimens are plotted on Plate C-1. Results of tests on undisturbed specimens are plotted on Plate C-2.

Grain Size Determinations

Grain size analyses were performed on the minus No. 10 sieve portion of the representative bulk samples utilizing hydrometer test methods. The results of these tests were used as an aid in soil classification and are presented in Table A.

Additionally, sieve analyses were performed on representative portions of selected bulk samples. The grain size distribution for these samples are shown on Plates D-1 through D-5.

Expansion Characteristics

The expansive properties of the finer grained soils encountered were determined in accordance with the Expansion Index Test (UBC Standard 29-2). These results are presented in Table A.

October 30, 1992
Work Order 101849

A P P E N D I X II

Resistance Value Determinations

R-Value determinations of selected samples of on-site soils which could become street subgrade were determined in accordance with ASTM Test Method D2844-89. These results are presented in Table A.

Sand Equivalent Value Determinations

Sand Equivalent values of selected, typical soils were determined in accordance with State of California Test Method 217. These results are presented in Table A.

Chemical Analyses (by others)

Chemical analyses and resistivity measurements were performed by outside laboratories. These results are presented in Appendices IIa and IIb, following.

TABLE A

PARTIAL SUMMARY OF LABORATORY TEST DATA

TEST PIT OR BORING NO.	DEPTH (feet)	LABORATORY SOIL CLASSIFICATION	MAX. DRY DENSITY (lbs/cu.ft.)	OPT. MOIST. (%)	% Sand	% Silt	% Clay	EXP. INDEX	R-VALUE	SAND EQUIVALENT
TP-18	1.0-2.0	Silty Sand	113.5	10.5	87	8	5	-	66	55
TP-20	3.0-4.0	Clayey Silt	116.0	13.5	17	60	23	96	-	-
TP-26	1.0-2.0	Slightly Silty Sand	123.5	10.0	90	9	1	-	-	-
TP-35	1.0-3.0	Slightly Silty Sand	115.5	11.5	92	5	3	-	69	56
B-5	1.0-3.0	Silty Sand	117.0	10.5	80	12	8	-	-	33
B-7	5.0-6.0	Silty Sand	123.5	10.0	67	25	8	0	-	-
B-10	0.0-3.0	Silty Sand	131.0	8.0	70	20	10	0	-	-
B-12	3.0-5.0	Silty Sand	125.5	9.5	78	14	8	0	-	-

PACIFIC SOILS ENGINEERING, INC.

W.O. 101849 DATED: 10-30-92

Applied P & Ch Laboratory
4066 E. Mission Blvd., Pomona CA 91766
Tel: (714) 622-5148 Fax: (714) 622-3199

APCL Analytical Report

Submitted to:
Pacific Soils Engineering, Inc.
Attention: Keeney Van Horn
10653 Progress Way
Cypress, CA 90630
Tel: (714)220-0770 Fax: (714)220-9589

Service ID #: 801-923243 Received : 09/23/92
Collected by: Tested : 09/25-30/92
Collected on: 09/21/92 Reported : 10/01/92
Sample description:
Soil Samples, Boring#: TP 18,20,26,35
Work Order No. 101849

Analysis of Soil

801-923243 Page 1 of 1

Component Analyzed	Method	Unit	MDL	Concentration TP 18 92-3243-1	TP 20 92-3243-2	TP 26 92-3243-3	TP 35 92-3243-4
pH	9045	pH unit	±0.01	7.68	8.74	7.72	7.37
Sulfate (SO_4^{--})	375.4	mg/kg	1	4	42	4	N.D.
Chloride Cl^-	325.3	mg/kg	1	12	92	5	3
Alkaliuity	310.1	mg/kg	1	57	294	57	62
Resistivity	120.1	Ω-cm	±0.1	5,047	820	11,330	37,460

MDL : Method Detection Limit
N.D. : Not Detected in this analysis, or less than the method detection limit.

Respectfully submitted,

Jack Y. Zhang, Ph. D.,
Director
Applied P & Ch Laboratory

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Twining Laboratories of Southern California, Inc.

3310 Airport Way
Long Beach, CA 90806
Mail: P.O. Box 47, 90801

(310) 426-3355
(714) 828-6432
FAX (310) 426-6424

October 2, 1992 Exam No. CH92-536

Pacific Soils Engineering
1402 West 240th Street
Harbor City, CA 90710

Attention: Keeney Van Horn

Subject: Two soil samples submitted on September 23, 1992.

Identification: W.O.: 101849

Results:

A. Chemical Analysis:

Sample	5/1 water/soil extract pH	sulfate ppm	chloride ppm	alk* ppm	dry soil sulfate %
TP-18	7.2	0	3	9	0.000
TP-26	7.2	2	3	7	0.001

B. Resistivity:

Sample	Resistivity
TP-18	42,700 ohm.cm
TP-26	49,000 ohm.cm

TWINING LABORATORIES OF SOUTHERN CALIFORNIA, INC.

H.R. Landwehr
Chief Chemist

Richard Haug
Chemist

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October 30, 1992
Work Order 101849

A P P E N D I X III

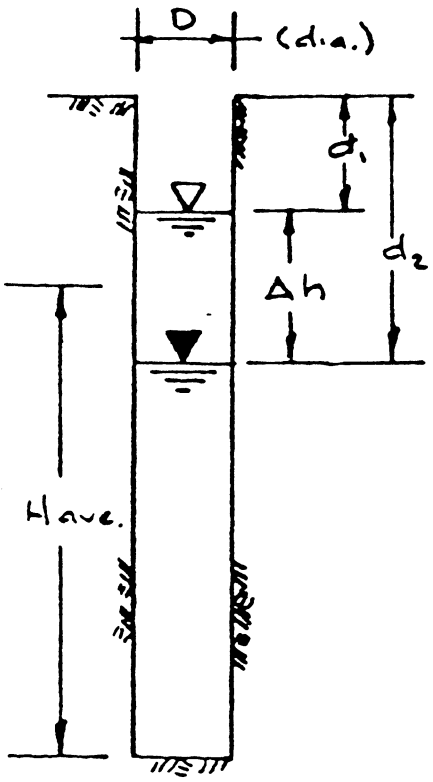
DOWNHOLE PERCOLATION TESTS

DATE _____ BY _____

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849
SHEET NO. 1 OF 17

SUBJECT Down hole percolation tests
TEST WELLS NOS. 1, 2, 3, 5, 6, 8, 9, 10, 11, 12, 13, 14 & 15
(8" ϕ WELLS)



d = depth to water at end of each time period (ft.)

Δh = water drop occurring between each time period (ft.)

Have. = average head of water in hole during time period (ft.)

D = diameter of test hole (ft.)

Δt = time interval between water level readings (minutes).

7.48 = gals. / cu. ft.

1440 = minutes in 24 hours.

A = Absorption Rate

$$= \frac{\text{Vol. of water absorbed (gals)}}{\text{Absorption Area (ft}^2\text{)} \quad \text{(day)}}$$

$$A = \left[\frac{\pi D^2}{4} \times \Delta h \times 7.48 \div \left(\pi D H_{ave.} + \frac{\pi D^2}{4}\right) \Delta t\right] \times 1440$$

$$= \frac{10771.2\,(D)(\Delta h)}{(D + 4\,H_{ave.})\,\Delta t} \text{ (gals/sq. ft./day)}$$

NOTE: The subject wells are 8-inch diameter, cased with 3-inch diameter slotted pipe and the annular spaced filled with No. 4 rock (n = 0.5). To account for the volume of gravel & the pipe wall thickness use 56% of the calculated value.

DATE _____ BY ℄

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849
SHEET NO. 2 OF 17

SUBJECT Down hole percolation test
Lockheed - 613Ac - Palmdale, Test Well No. 1

Drilled Depth = 40.0 feet Measured Depth = 37.2

Time, min.	Depth, ft.	Δh, ft.	ΔT, min.
0	5.0		
2	16.5		
4	23.0		
6	27.5		
8	30.0		
10	32.0		
12	33.5		
14	34.4	9.1	16
16	35.2		
18	35.8		
20	36.3		
22	36.6		

Effective Depth, Deff. = 40 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = $40 - (36.6 - \frac{9.1}{2}) = 7.95$ ft

$$A = \frac{10771.2\,(0.67)\,(9.1)}{(0.67 + 4 \times 7.95)\,(16)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \left(\frac{65,672.0}{519.52}\right)(0.56) = 70.8 \text{ gals/day/ft}^2$$

Use 65 gals/day/ft²

DATE _____ BY 4

PACIFIC SOILS ENGINEERING, INC.
1902 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849
SHEET NO. 9 OF 17

SUBJECT Down hole percolation test
Lockheed - 613 Ac. - Palmdale, Test well No. 2

Drilled Depth = 40.0 feet Measured Depth = 35.3 feet

Time, min.	Depth, ft.	Δh, ft.	ΔT, min.
0	5.0		
2	15.0		
4	21.0		
6	25.0		
8	27.5		
10	29.3		
14	31.6		
18	32.8	9.8	25
22	33.5		
26	34.1		
31	34.8		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = $40.0 - (34.8 - \frac{9.8}{2}) = 10.1$ ft

$$A = \frac{10771.2\,(0.67)\,(9.8)}{(0.67 + 4 \times 10.1)\,(25)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{70,723.7}{1026.75}\,(0.56) = 38.6 \text{ gals/day/ft}^2$$

use 35 gals/day/ft²

DATE 9-29-92 | PACIFIC SOILS ENGINEERING, INC. | WORK ORDER 101849

BY [illegible] | 1402 WEST 240TH STREET, HARBOR CITY, CALIFORNIA 90710 | SHEET NO. 4 OF 17

SUBJECT Down hole percolation test

Lockheed - 613 Ac. - Palmdale, Test Well No. 3

Drilled Depth = 40 feet ; Measured Depth = 34.1 feet

Time, min.	Depth, ft.	Δh, ft.	ΔTime, min.
0	5.0		
2	11.5		
4	15.5		
6	18.5		
8	20.5		
10	22.0		
14	24.0		
18	25.5		
22	26.8		
26	27.8		
30	28.5	7.3	42
40	30.5		
50	31.8		
60	32.8		

Effective Depth, Deff. = 40 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = $40.0 - (32.8 - \frac{7.3}{2}) = 10.85$ ft

$$A = \frac{10771.2\,(0.667)\,(7.3)}{(0.667 + 4 \times 10.85)\,(42)} \times (0.56) \text{ gals/ft}^2\text{/day}$$

$$= \frac{53,446.0}{1850.8} \times (0.56) = 15.4 \text{ gals/day/ft}^2$$

Use 15 gals/day/ft²

DATE _____ BY _____

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849

SHEET NO. 5 OF 17

SUBJECT Down hole percolation test
Lockheed - 6134 - Palmdale, Test Well No. 5

Drilled Depth = 40 feet Measured Depth = 36.8 ft.

ΔTime, min.	Depth, ft.	Δh, ft.	
0	5.0		
2	11.8		
4	16.4		
6	19.2		
8	22.0		
10	24.0		
14	27.0		
18	29.1		
22	30.7		
26	31.6		
30	32.5		
35	33.4	8.1	41
40	34.0		
45	34.5		
50	34.8		
55	35.1		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. − $(d_{last} - \frac{\Delta h}{2})$ = $40.0 - (35.1 - \frac{8.1}{2})$ = 8.95 ft

$$A = \frac{10771.2\,(0.67)\,(8.1)}{(0.67 + 4 \times 8.95)\,(41)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{58,455.3}{1,495.27}(0.56) = 21.9 \text{ gals/day/ft}^2$$

Use 20 gals/day/ft²

DATE _____ BY 4

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 10/849
SHEET NO. 6 OF 17

SUBJECT Down hole percolation test
Lockheed - 613 Ac. - Palmdale, Test Well No. 6

Time, min.	Depth, ft.	Δh, ft.	Δt, min.
0	5.0		
2	9.2		
4	12.5		
6	15.0		
8	17.5		
10	18.8		
14	21.6		
18	24.0		
22	26.0		
26	27.8		
30	29.4		
35	31.0		
40	32.4		
45	33.5	10.2	43
50	34.6		
55	35.4		
60	35.8		
65	36.2		

Effective Depth, Deff. = 40 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = $40.0 - (36.2 - \frac{10.2}{2})$ = 8.9 ft

$$A = \frac{10771.2\,(0.67)\,(10.2)}{(0.67 + 4 \times 8.9)\,(43)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{73,610.38}{1,559.61}\,(0.56) = 26.4 \text{ gals/day/ft}^2$$

Use 25 gals/day/ft²

DATE _____ BY C

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849

SHEET NO. 7 OF 17

SUBJECT Down hole percolation test
Lockheed - 613 A. - Palmdale, Test well No. 8

Drilled Depth = 40 feet Measured Depth = 37.5 ft.

Time, min.	Depth, ft.	Δh, ft.	Δt, min.
0	5		
2	16.6		
4	21.3		
6	25.0		
8	27.6		
10	29.8		
14	32.5		
18	34.2	— 12.3	— 29
22	35.3		
26	36.2		
30	36.8		
35	37.3		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. − $(d_{last} - \frac{\Delta h}{2})$ = $40.0 - (37.3 - \frac{12.3}{2}) = 8.95$ ft

$$A = \frac{10771.2\,(0.67)\,(12.3)}{(0.67 + 4 \times 8.95)\,(29)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{88{,}765.5}{1057.63}(0.56) = 47 \text{ gals/day/ft}^2$$

Use 45 gals/day/ft²

DATE _____ BY 4

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101869

SHEET NO. 3 OF 17

SUBJECT Down hole percolation test
Lockheed - 613 Ft. - Palmdale, Test Well No. 9

Drilled Depth = 40 feet Measured Depth = 38.0 feet

ΔTime, min.	Depth, ft.	Δh, ft.	
0	5		
2	13.0		
4	18.0		
6	21.1		
8	23.4		
10	25.2		
14	28.0		
18	30.4		
22	31.8		
26	33.0		
30	33.9	10.9	45
35	34.7		
40	35.2		
45	35.6		
50	35.9		
55	36.1		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = $40.0 - (36.1 - \frac{10.9}{2}) = 9.35$ ft

$$A = \frac{10771.2\,(0.67)\,(10.9)}{(0.67 + 4 \times 9.35)\,(45)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{78,662.1}{1,713.15}\,(0.56) = 25.7 \text{ gals/day/ft}^2$$

use 25 gals/day/ft²

DATE _____ BY CL

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849

SHEET NO. 9 OF 17

SUBJECT Down hole percolation test
Lockheed – 613Ac - Palmdale, Test well No. 10

Drilled Depth = 40 feet Measured Depth = 37.5 ft.

Time, min.	Depth, ft.	Δh, ft.	Δt, min.
0	5.0		
2	15.3		
4	22.0		
6	26.8		
8	29.4		
10	31.6		
12	33.2		
14	34.1		
16	35.0	10.4	18
18	35.8		
20	36.4		
22	36.8		
24	37.2		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. − $(d_{last} - \frac{\Delta h}{2})$ = $40.0 - (37.2 - \frac{10.4}{2})$ = 8.0 ft

$$A = \frac{10771.2\,(0.67)\,(10.4)}{(0.67 + 4 \times 8.0)\,(18)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{75,053.7}{568.06}(0.56) = 74.5 \text{ gals/day/ft}^2$$

Use 70 gals/day/ft²

DATE _____ BY 4

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101869

SHEET NO. 10 OF 17

SUBJECT Down hole percolation test
Lockheed - 613 Ac. - Palmdale, Test Well No. 11

Drilled Depth = 40.0 ft. Measured Depth = 37.0'

Time, min.	Depth, ft.	Δh, ft.	Δt, min.
0	5.0		
2	13.6		
4	17.5		
6	21.4		
8	25.0		
10	27.9		
12	30.0		
14	31.3		
16	32.6		
18	33.0		
20	33.2	10.2	37
25	33.8		
30	34.3		
35	34.7		
40	35.0		
45	35.2		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = 40.0 - $(35.2 - \frac{10.2}{2})$ = 9.9 ft

$$A = \frac{10771.2\,(0.67)\,(10.2)}{(0.67 + 4 \times 9.9)\,(37)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{73,610.4}{1489.99}(0.56) = 27.7 \text{ gals/day/ft}^2$$

use 25 gals/day/ft²

DATE _____ BY CL

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849

SHEET NO. 11 OF 17

SUBJECT Down hole percolation test
Lockheed - 613Ac - Palmdale, Test well No. 12

Drilled Depth = 40.0 feet Measured Depth = 36.0

Time, min.	Depth, ft.	Δh, ft.	Δt, min.
0	5.0		
2	12.0		
4	17.5		
6	21.5		
8	24.0		
10	26.0		
12	27.5		
14	29.0		
16	30.0		
18	30.9	9.3	23
20	31.7		
25	33.3		
30	34.5		
33	35.3		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = 40.0 - $(35.3 - \frac{9.3}{2})$ = 9.35 ft

$$A = \frac{10771.2\,(9.67)\,(9.3)}{(0.67 + 4 \times 9.35)\,(23)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{67,115.3}{875.61}(0.56) = 42.9 \text{ gals/day/ft}^2$$

Use 40 gals/day/ft²

DATE _____ BY 4

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849

SHEET NO. 12 OF 17

SUBJECT Down hole percolation test
Lockheed - 613A. - Palmdale, Test Well No. 13

Drilled Depth = 40.0 feet Measured Depth = 36.0 ft.

Time, min.	Depth, ft.	Δh, ft.	Δt, min
0	5.0		
2	14.6		
4	20.0		
6	23.1		
8	25.0		
10	26.4		
14	28.3		
18	30.0		
22	31.4		
26	32.4	9.8	42
30	33.3		
35	33.9		
40	34.3		
45	34.6		
50	34.8		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = 40.0 - $(34.8 - \frac{9.8}{2})$ = 10.1 ft

$$A = \frac{10771.2\,(0.67)\,(9.8)}{(0.67 + 4 \times 10.1)\,(42)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{10,723.7}{1,724.94}(0.56) = 23.0 \text{ gals/day/ft}^2$$

Use 20 gals/day/ft²

DATE _____ BY ℄

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 1018 69

SHEET NO. 13 OF 17

SUBJECT Down hole percolation test
Lockheed - 613Ac - Palmdale, Test Well No. 1C

Drilled Depth = 40.0 feet Measured Depth = 36.5 feet

Time, min.	Depth, ft.	Δh, ft.	Δt, min.
0	5.0		
2	9.9		
4	12.7		
6	15.6		
8	18.2		
10	20.4		
12	23.5		
18	26.0		
22	28.1		
26	29.8		
30	31.0		
35	32.1		
40	33.0	8.7	42
45	33.6		
50	34.0		
55	34.4		
60	34.7		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. − $(d_{last} - \frac{\Delta h}{2})$ = 40.0 − $(34.7 - \frac{8.7}{2})$ = 9.65 ft

$$A = \frac{10771.2\,(0.67)\,(8.7)}{(0.67 + 4 \times 9.65)\,(42)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{62,785.3}{1649.34}(0.56) = 21.3 \text{ gals/day/ft}^2$$

use 20 gals/day/ft²

DATE _____ BY CL

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849

SHEET NO. 14 OF 17

SUBJECT Down hole percolation test
Lockheed - 613 Ac. - Palmdale, Test well No. 15

Drilled Depth = 40.0 feet Measured Depth = 38.0 feet

Time, min.	Depth, ft.	Δh, ft.	Δt, min.
0	10.0		
2	16.7		
4	24.0		
6	28.0		
8	30.0		
10	31.5		
14	33.1		
18	34.3		
22	34.8	8.2	39
26	35.2		
30	35.6		
35	35.8		
40	36.0		
45	36.2		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = $40.0 - (36.2 - \frac{8.2}{2})$ = 7.9 ft

$$A = \frac{10771.2\,(0.67)\,(8.2)}{(0.67 + 4 \times 7.9)\,(39)} \times 0.56 \text{ gals/ft}^2\text{/day}$$

$$= \frac{59,176.97}{1758.53}(0.56) = 26.33 \text{ gals/day/ft}^2$$

Use 25 gals/day/ft²

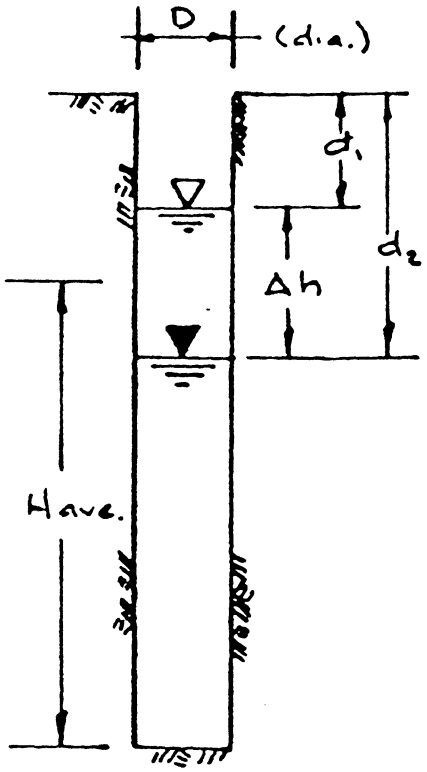
DATE _____ BY C

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849

SHEET NO. 15 OF 17

SUBJECT Down hole percolation tests
TEST WELLS NOS. 4 & 7
(19" ϕ WELLS)



d = depth to water at end of each time period (ft.)

Δh = water drop occurring between each time period (ft.)

Have. = average head of water in hole during time period (ft.)

D = diameter of test hole (ft.)

Δt = time interval between water level readings (minutes).

7.48 = gals. / cu. ft.

1440 = minutes in 24 hours.

A = Absorption Rate

$$= \frac{\text{Vol. of water absorbed (gals)}}{\text{Absorption Area (ft}^2\text{)} \quad \text{(day}}$$

$$A = \left[\frac{\pi D^2}{4} \times \Delta h \times 7.48 \div \left(\pi D H_{ave.} + \frac{\pi D^2}{4}\right) \Delta t\right] \times 1440$$

$$= \frac{10771.2\,(D)(\Delta h)}{(D + 4 H_{ave.})\,\Delta t} \text{ (gals/sq. ft./day)}$$

NOTE: The subject wells are 19-inch diameter, cased with 3-inch diameter slotted pipe and the annular spaced filled with No. 4 rock (n = 0.5). To account for the volume of gravel & the pipe wall thickness use 52 % of the calculated value.

DATE _____ BY 4

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849
SHEET NO. 16 OF 17

SUBJECT Down hole percolation test
Lockheed - 613A - Palmdale, Test well No. 4

Drilled Depth = 40.0 feet Measured Depth = 39.0 feet

Time, min.	Depth, ft.	Δh, ft.	Δt, min.
0	7		
2	14.5		
4	19.0		
6	22.5		
8	25.6		
10	27.9		
14	30.8		
18	32.8		
22	36.2	12.0	32
26	35.3		
30	36.2		
35	37.0		
40	37.6		

Effective Depth, Deff. = 40.0 ft.

$H_{ave} = D_{eff.} - (d_{last} - \frac{\Delta h}{2}) = 40.0 - (37.6 - \frac{12.0}{2}) = 8.4$ ft

$A = \frac{10771.2\,(1.58)\,(12.0)}{(1.58 + 4 \times 8.4)\,(32)} \times 0.52$ gals/ft²/day

$= \frac{204,221.95}{1,125.76}(0.52) = 94.3$ gals/day/ft²

Use 85 gals/day/ft²

DATE _____ BY ℄

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 101849

SHEET NO. 17 OF 17

SUBJECT Down hole percolation test
Lockheed - 613Ac. - Palmdale, Test Well No. 7

Drilled Depth = 40 feet Measured Depth = 39 fee

Time, min.	Depth, ft.	Δh, ft.	Δt, min.
0	10.0		
2	16.5		
4	21.5		
6	25.0		
8	27.1		
10	28.7		
14	30.8		
18	32.5		
22	33.7	12.2	34
26	34.8		
30	35.6		
35	36.5		
40	37.2		

Effective Depth, Deff. = 40.0 ft.

H_{ave} = Deff. - $(d_{last} - \frac{\Delta h}{2})$ = $40.0 - (37.2 - \frac{12.2}{2})$ = 8.9 ft

$$A = \frac{10771.2\,(1.58)\,(12.2)}{(1.58 + 4 \times 8.9)\,(34)} \times 0.52 \text{ gals/ft}^2\text{/day}$$

$$= \frac{207,625.7}{1,264.12}(0.52) = 85.4 \text{ gals/day/ft}^2$$

Use 75 gals/day/ft²

APPENDIX I

HYDROGEOLOGIC ASSESSMENT

RICHARD C. SLADE & ASSOCIATES
CONSULTING GROUNDWATER GEOLOGISTS

HYDROGEOLOGIC ASSESSMENT OF PALMDALE BUSINESS PARK CENTER ANTELOPE VALLEY LOS ANGELES COUNTY, CALIFORNIA

For
LOCKHEED CORPORATION

August 8, 1994

By
Richard C. Slade & Associates
Consulting Groundwater Geologists

Our Job No. S9417

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EXECUTIVE SUMMARY

Study Area and Purpose of Report

The 632-acre subject property lies within the City of Palmdale immediately south of the City of Lancaster and immediately east of the Southern Pacific Railroad; U. S. Air Force Plant 42 forms the eastern and southern boundaries. The property is undeveloped and no water wells have ever been drilled onsite.

Our report has assessed the hydrogeologic feasibility of developing an onsite groundwater supply to meet only the irrigation needs of the proposed 18-hole and 9-hole golf courses that are to be built in the southern portion of the subject property.

The purposes of this assessment were to: evaluate the areal extent and thickness of water-bearing sediments; determine the characteristics of the local aquifer systems; assess the feasibility of developing an adequate groundwater supply for golf course irrigation; provide optimum location(s), drill depth(s), and anticipated production rates for future well(s); provide general guidelines for construction and testing of the well(s); and provide a sufficiently detailed and well-documented report that the results can be used as part of environmental assessment(s) by others.

Regional and Local Water Purveyors

Within the Lancaster Subbasin of the Antelope Valley Groundwater Basin in which the subject property is located, there are several water purveyors. Large, municipal-supply pumpers include: the Los Angeles County Waterworks District No. 40 (LACWWD), which utilizes approximately 20 to 25 wells located west and north of the property; and Palmdale Water District (PWD) which utilizes approximately 20 wells to the south.

Seven small, privately-owned mutual water companies and/or water districts occur in the areas north, west, and southwest of the property. With the exception of the Quartz Hill Water District which has four active wells, these other

privately-owned companies generally utilize only one or two wells for domestic supply. The nearest of these water company wells to the subject property lies one-half mile to the north and is owned by Landale Farms Mutual Water Company.

Other nearby wells occur on USAF Plant 42 to the east and south, and are operated by various military contractors; these wells are used for domestic, industrial and/or fire suppression purposes. The nearest of these wells lies on Site 1 approximately one-fourth mile from the subject property.

LACWWD occupies a small "out-parcel" on the north side of the subject property; three large steel reservoirs have been constructed, nine more are planned, and one or two new wells may be drilled there in the future.

Hydrogeology

Older alluvium comprises the groundwater reservoir of the Lancaster Subbasin. Onsite, these deposits contain a lower (deep) aquifer system and an upper (shallow) aquifer system; the aquifers are separated by a thick, areally extensive aquitard known as the "blue clay."

Excluding several of the deeper LACWWD and PWD municipal-supply wells, virtually all remaining wells in the region produce only from the upper aquifer system (i.e., they are less than about 500 to 600 ft in depth).

Underlying the lower aquifer system are a group of geologically old, consolidated, cemented and/or crystalline rocks that are considered to be nonwater-bearing bedrock.

Current Groundwater Levels

April 1994 non-pumping water level data from the U.S. Geological Survey, from LACWWD, from AVEK, and from PWD were collected and evaluated to provide a regional assessment of current groundwater conditions. Groundwater currently moves toward two pumping centers in the Lancaster Subbasin, one near Lancaster and one near Palmdale. Both pumping centers contain several, closely-spaced, active, municipal-supply wells with high pumping capabilities. The subject property lies just on the southern edge of the Lancaster pumping center. A third

pumping center exists in the Pearland Subbasin, southeast of the Lancaster Subbasin and results from the same pumping conditions.

Hydrographs

A large number of water level hydrographs, based on groundwater monitoring by the USGS, were collected from AVEK. These graphs show the historic trend of non-pumping water levels at each respective well site. Analysis has been made of long-term and continuous water level data for 18 wells that have data beginning between the early-1950s and 1967. Seventeen of these wells have data continuing to at least 1993.

For these 17 wells, two specific trends are noticeable: 1) an overall water level decline in the 17 wells from the inception of the particular record until about 1977; 2) from 1977 to 1993, a rising water level trend is seen in nine of the wells, while in the eight remaining wells, the original declining trend had slowed significantly so that the 1977 to 1993 trend is now at a much lower annual rate of decline.

Rainfall and General Recharge Conditions

Long-term average rainfall in the area is 7.79 inches per year. Periods of excess rainfall (and, hence, more available recharge) have occurred from 1935 to 1946 and from 1977 to 1983 based on cumulative departure analysis. Periods of deficient rainfall (reduced recharge) include 1946 to 1977 and 1983 to 1990.

The long-term period of deficient rainfall between 1946 and 1977 has had a major role in affecting basin-wide water levels. Water wells showing an overall rise in water levels since 1977 tend to be located nearer recharge areas like Big Rock Creek and farther from pumping centers in Lancaster and Palmdale. The opposite tends to be true for wells showing the declining trend since 1977.

Aquifer Characteristics

Pumping rates in upper aquifer zone wells (i.e., wells less than about 600 ft deep) can be as high as 4000 gpm, but most wells in this aquifer have

maximum operational production rates in the range of 500 to 1500 gpm. Well depths, well age, well condition, well use, and well location are some of the factors which affect production rates.

There are no known wells in the region that produce solely from the lower aquifer system. Hence, the production capability, specific capacity, and other aquifer characteristics for this aquifer system are not known.

Well Site Selection

We have recommended and located two new wells for golf course irrigation. One well is on the golf course in the southern portion of the property while the other is in the eastern portion of the site.

These two locations were selected to maximize distance from neighboring wells, to minimize potential drawdown interference, and to obtain the groundwater at points of need. Two wells will permit greater flexibility in water system design, will allow for operation and maintenance in one well while keeping the other well productive, and will allow for emergency/stand-by use.

Both wells will be constructed to produce from both the shallow and the deep aquifer system. Anticipated pumping rates in each well will be more than capable of meeting the annual irrigation demands of the golf courses. Well depths will be approximately 1150 feet.

Project Development and Water Demand

The two golf courses will have a total area to be irrigated of 150 acres. Groundwater requirements for irrigation, to be met by new onsite water wells, will begin during the initial Phase I development of the property and will total: 780 acre-feet per year (AF/yr) based on conventional irrigation practices; or 611 AF/yr based on new state-of-the-art irrigation practices. Our report evaluates the worst case condition by assuming conventional irrigation practices will be used.

All other water requirements for onsite domestic and common-area landscape irrigation for the business park are to be met by LA County Waterworks District No. 40 (LACWWD).

Detailed calculations of irrigation water demand for the golf courses for each month of the year have been provided to us. These monthly groundwater production rates have been used in our assessment to identify the potential amount of water level drawdown that might occur in the region from new onsite wells.

Distance-Drawdown Interference

Monthly pumping rates, assuming conservative conventional irrigation practices for the golf courses, were determined by others to range between 154 gpm in January to 855 gpm in July. As expected, the five-month period of May through September requires the highest pumping rates.

Using the specific monthly pumping rate requirement, and representative aquifer characteristics of transmissivity and storativity, we calculated the theoretical amounts of water level drawdown that might be created for in the region by onsite pumping. For each of the months in the five-month period above, we assumed the two new wells would each be pumping at equal rates for each monthly period. For the remaining seven months of each year, the southernmost, primary well would pump; the secondary well in the east would be on standby only.

Resulting theoretical drawdowns on specific publicly- and privately-owned wells in the region are provided in the report. These data are based on the AQModel computer model. The largest theoretical water level drawdowns identified would be those induced following July extractions (855 gpm continued pumpage, 24 hours per day, for 31 consecutive days from the two new onsite wells) in the nearest offsite wells: Site 1, Well 1 on USAF Plant 42 one-fourth mile east of the property (maximum of 2.03 ft drawdown); and LFM Well No. 1 (one-half mile north of the property) where a maximum theoretical drawdown of 1.11 ft could occur. All other theoretical drawdowns, in all other wells in the region, for the remaining 11 months of the year would be less.

Drawdown values so calculated are not cumulative throughout the year. Moreover, all such water level drawdowns induced by golf course wells in these offsite wells are much less than the amount of actual water level drawdown induced in each of these other wells by its own pumpage.

Pumping Rights

Pumping rights in the Lancaster Subbasin are not adjudicated at present. Groundwater extractions for onsite beneficial usage are permissible.

There are no sources of reclaimed water or other non-potable waters available in the area for golf course use.

Golf Course Lakes

Storage of groundwater in several proposed lakes on the golf courses will be important for irrigation purposes. Off-peak pumpage to refill the lakes can be done to minimize energy costs.

INTRODUCTION

GENERAL STATEMENT

Presented in this report are the findings, conclusions and recommendations of our hydrogeologic assessment of the feasibility of developing onsite groundwater supplies for a 27-hole golf course complex at the proposed Palmdale Business Park Center in the City of Palmdale, California. The golf complex is the focal point of a 632-acre master planned commercial and industrial project. As seen on Figure 1 - Location Map and Service Area Boundaries - the property lies immediately south of the City of Lancaster and east of the Southern Pacific railroad. U. S. Air Force Plant 42 forms the eastern and southern boundaries of the site.

The overall purposes of this hydrogeologic assessment are to: assess the areal extent and thickness of water-bearing sediments; determine the characteristics of the local aquifer systems; assess the feasibility of developing an adequate groundwater supply for golf course irrigation; provide optimum location(s), drill depth(s), and anticipated production rates for future well(s); provide general guidelines for construction and testing of the well(s); and provide a sufficiently detailed and documented report that the results can be used as part of environmental assessments by others.

SCOPE OF WORK

As developed in our proposal dated April 4, 1994, the scope of work has included:

- Collection and review of published and private geologic and hydrogeologic reports and maps for the region.

- Plotting water well locations for historically drilled wells in the study area based on maps prepared by the State Department of Water Resources and the Los Angeles County Department of Public Works.

- Development of detailed correlations of drillers' logs and electric logs from water wells in the area. In addition, the locations of several wells proximal to the subject property were plotted during two separate reconnaissance visits in May 1994.

- Preparation of a geologic map from published literature.

- Preparation of two hydrogeologic cross-sections to illustrate the relationship between depth to bedrock and depositional changes in sediment patterns.

- Assessment of potential pumping rates and specific capacity in water wells in the region.

- Evaluation of historic and current water levels and groundwater flow directions for wells in the region, using existing data.

- Assessment of water quality in local aquifers.

- Evaluation of the general construction guidelines for new onsite water well(s); these data are provided under separate cover.-

- Preparation of a report with conclusions and recommendations regarding the feasibility of groundwater development from new onsite water wells.

This report has been prepared solely for the exclusive use of Lockheed Corporation, with specific application to the proposed construction of one or more new water wells for golf course irrigation at the subject property as shown herein. This report has been written in accordance with the care and skill generally exercised by reputable professionals working under similar circumstances in this or similar localities. No other warranty, either express or implied, is made as to the professional advice or opinions presented herein.

Specifically excluded from our work effort has been any analysis or evaluation of faults, seismicity, soils conditions, foundation design, earthwork and grading or geotechnical engineering. No drilling exploration, soils sampling, or groundwater monitoring has been performed during the course of this hydrogeologic assessment.

References that were specifically reviewed for this project are listed at the end of this report, and a glossary of technical terms is provided in Appendix C together with a table showing the geologic time scale. Per the specific request of the client, the professional qualifications of Richard C. Slade & Associates, Consulting Groundwater Geologists, are provided in Appendix D.

PROPOSED DEVELOPMENT

The 632-acre undeveloped parcel is being designed and planned as a phased development to include a high quality commercial and industrial complex, using a 27-hole golf course and ancillary facilities as a central focus. The present Land Use Plan, as provided in the Specific Plan (David A. Price Associates, 1994), proposes a mixture of commercial, business park, light industrial, airport related, golf course, and required open space usage at full project buildout.

The largest portion of the development, 227 acres (or about 36 percent of the total land area), is for the golf courses. Specific golf course facilities include:

a full 18-hole golf course, comprising 171 acres, along the southern and westerly boundaries of the property; and a 9-hole, 56-acre executive course situated along the proposed business park area within an unlined flood control channel that traverses the parcel. When not functioning as a flood control channel (and possible zone in which artificial recharge can occur via infiltration of surface water runoff into the unlined channel bottom), this structure will be a dry stream bed with some zones of riparian plantings. Total irrigable land within the golf courses is 150 acres.

Storage lakes are proposed because golf course water demands in this arid environment fluctuate over a wide range, depending on such factors as season of the year, time of day, type of grass being watered, and the specific part of the course being watered (greens vs. rough). These planned lakes are to have adequate storage "to cover demand surges during peak irrigation cycles, thus allowing well pumps to operate efficiently" (David A. Price Associates, April 1994, p. III-27).

Onsite-generated sewage wastewater disposal will occur principally via newly proposed onsite sewer lines with eventual transmission to trunklines utilized by L. A. County Sanitation District No. 14; treatment will be at the existing Lancaster Water Reclamation Plan located approximately 12 miles northwest of the subject property. Until the onsite sewer system is constructed, the City of Palmdale will allow the temporary use of a septic tank system for the Phase I golf clubhouse and remote restroom facilities to be designed and installed in accordance with Los Angeles County Health Department requirements.

GOLF COURSE WATER DEMANDS

According to data prepared by the project's civil engineers, PBS&J, Inc. (April 1994), the estimated water demands for golf course irrigation are set forth

below. The referenced PBS&J report provides a complete breakdown of water demands for each phase of the eight-phased project building schedule.

As expected for irrigation in arid environments, the largest demands for golf course irrigation will occur during the hottest months of the year, namely, May, June July, August, and September. July represents the peak demand month. In contrast, during the cooler and potentially wetter months of the year, January, February, March, April, October, November, and December, the monthly irrigation requirements are smaller.

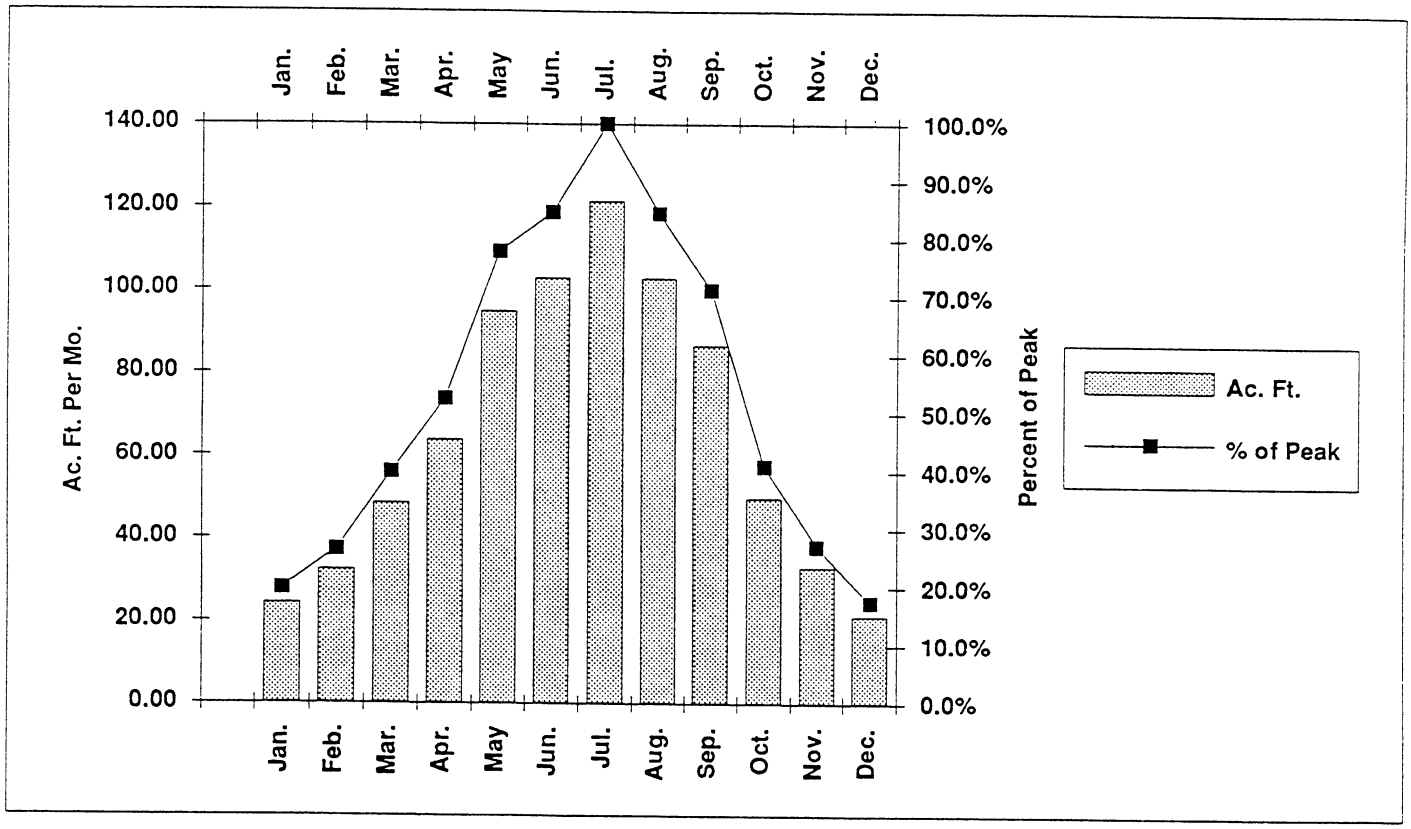
The annual variation in golf course water demand is clearly noted on Graph 1 - Golf Course Irrigation Demand, Conventional Irrigation. Graph 1 data have been adapted directly from the work done by the the Water Management Group (April 11, 1994). Graph 1 information identifies the 780.30 AF/yr water demand for golf course irrigation using conventional irrigation practices. Maximum or peak month is July at 121.29 AF, or about 885 gallons per minute (gpm), assuming a 24-hour-per-day pumping demand. Minimum month is December at 21.13 AF, or about 154 gpm assuming a 24-hour-per-day demand. For design purposes, our analyses in this report for theoretical water level drawdown interference which might occur in other offsite wells as a result of pumpage from new onsite wells utilizes the total 780.30 AF/yr water demand schedule set forth on Graph 1.

In contrast, the Water Management Group report also has provided the data shown on Graph 2 - Golf Course Irrigation Demand, State-of-the-Art Irrigation Practices. Those data, which show a total water demand of 611.39 AF/yr, were developed to illustrate the reduced water demand for each month of the year assuming the golf courses were irrigated by state-of-the-art methods. As shown, the state-of-the-art model requires 21.7 percent less water than the conventional irrigation model used for analytical purposes. A description of the landscape irrigation

GRAPH 1

Golf Course Demand - Conventional Irrigation Practices

PALMDALE BUSINESS PARK CENTER
GOLF COURSE WATER DEMAND
(Conventional Irrigation Practices - 780.30 Ac. Ft. Per Yr.)



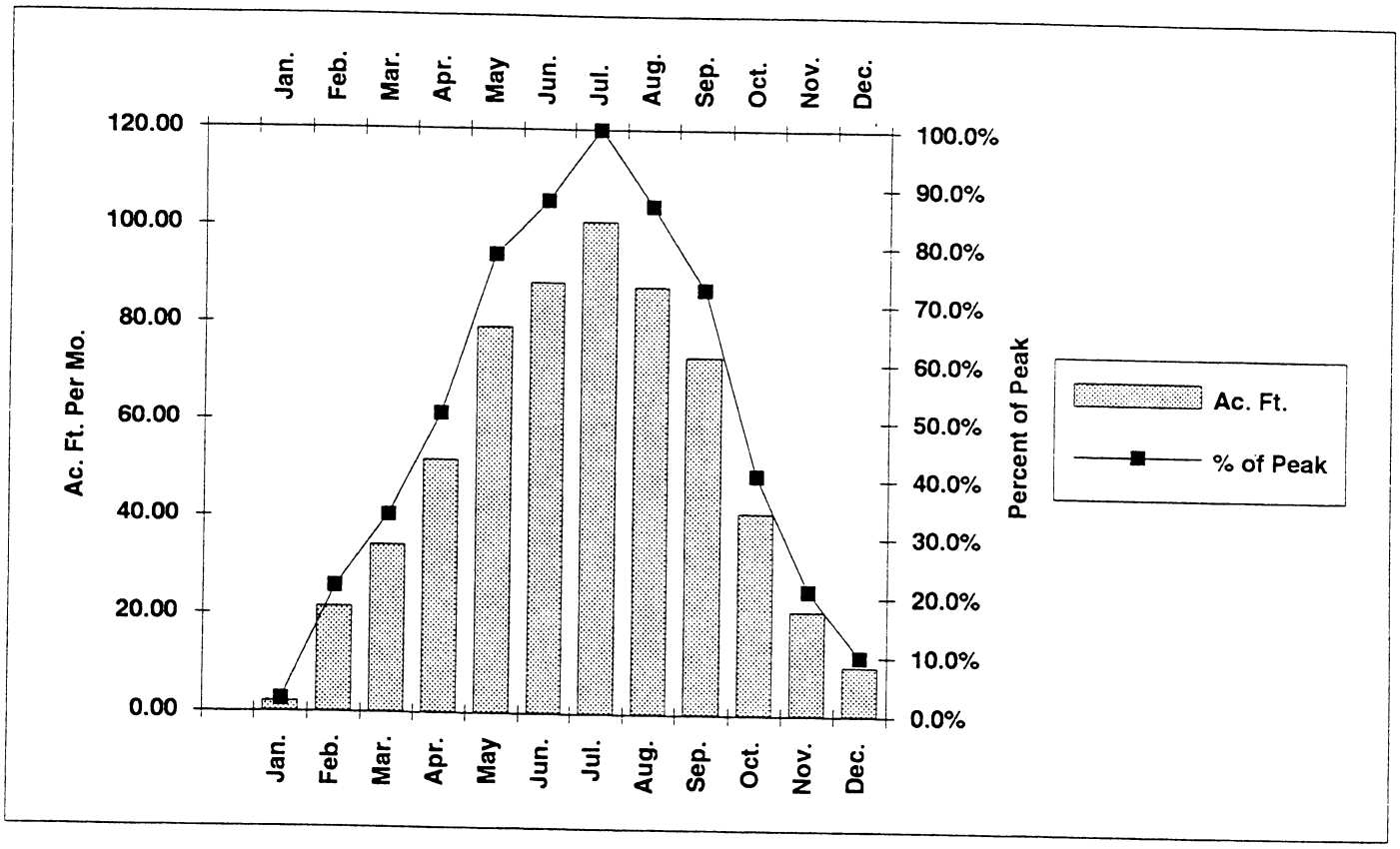
Month	Ac. Ft.	% of Peak	% of Year	Ac. Ft. / Day	24 Hr. GPM
Jan.	24.23	20.0%	3.1%	0.78	177
Feb.	32.31	26.6%	4.1%	1.15	261
Mar.	48.47	40.0%	6.2%	1.56	354
Apr.	63.75	52.6%	8.2%	2.13	481
May	94.69	78.1%	12.1%	3.05	691
Jun.	102.77	84.7%	13.2%	3.43	775
Jul.	121.29	100.0%	15.5%	3.91	885
Aug.	102.65	84.6%	13.2%	3.31	749
Sep.	86.37	71.2%	11.1%	2.88	651
Oct.	49.71	41.0%	6.4%	1.60	363
Nov.	32.93	27.1%	4.2%	1.10	248
Dec.	21.13	17.4%	2.7%	0.68	154
Total	780.30		100.0%		

SOURCE: Water Management Group.

GRAPH 2

Golf Course Demand - State-of-the-Art Irrigation Practices

PALMDALE BUSINESS PARK CENTER
GOLF COURSE WATER DEMAND
(State-of-the-Art Irrigation Practices - 611.39 Ac. Ft. Per Yr.)



Month	Ac. Ft.	% of Peak	% of Year	Ac. Ft. / Day	24 Hr. GPM
Jan.	2.05	2.0%	0.3%	0.07	15
Feb.	21.46	21.3%	3.5%	0.77	173
Mar.	34.04	33.7%	5.6%	1.10	248
Apr.	51.75	51.2%	8.5%	1.73	390
May	79.23	78.5%	13.0%	2.56	578
Jun.	88.49	87.6%	14.5%	2.95	667
Jul.	100.98	100.0%	16.5%	3.26	737
Aug.	87.73	86.9%	14.3%	2.83	640
Sep.	73.31	72.6%	12.0%	2.44	553
Oct.	41.16	40.8%	6.7%	1.33	300
Nov.	21.23	21.0%	3.5%	0.71	160
Dec.	9.96	9.9%	1.6%	0.32	73
Total	611.39		100.0%		

SOURCE: Water Management Group.

water management concept, as developed by the Water Management Group, is provided in Appendix A.

As seen on Graph 2, under this reduced-rate scenario, the maximum (peak) month of July would now require 100.98 AF, or about 737 gpm, assuming a 24-hour-per-day pumping demand. The minimum month is now January, and it would now require only 2.05 AF for golf course irrigation (15 gpm). As stated previously, our analyses for design purposes of theoretical water level drawdown interference uses the conventional irrigation practices water demand of 780.30 AF/yr and not this reduced water demand of 611.39 AF/yr which would result from using state-of-the-art irrigation practices.

It should be noted that, at the end of the 20- to 25-year project buildout cycle, maximum domestic water demand (exclusive of landscape irrigation) will total 1003 AF/yr. At project buildout, maximum onsite landscape irrigation (exclusive of golf course irrigation) may total an additional 270 AF/yr. Water for these two demands is to be provided by LACWWD-40. Distribution facilities for reclaimed water and the level of treatment from the local treatment plant are not currently appropriate for the project.

FINDINGS

SITE CONDITIONS

The regional study area lies primarily within Townships 6 and 7 North, Range 11 and 12 West, and the eastern portion of Range 13 West (SBBM), as shown on Figure 1 - Location Map and Service Area Boundaries. Approximate locations of water wells in the region, known to be in existence after 1963, are depicted on Figure 2 - Regional Water Well Location Map. The focus of our study is the Lancaster Subbasin which represents the largest groundwater subbasin within

the Antelope Valley Groundwater Basin. The 632-acre, roughly rectangular-shaped subject property lies wholly within the city limits of the City of Palmdale, within Sections 1 and 2 of T6N-R12W. Local boundaries between the Lancaster Subbasin and the Buttes and Pearland Subbasins on the southeast are also shown on Figure 2.

This undeveloped parcel of land is bounded on the north by Avenue M (which also forms the boundaries between the cities of Palmdale and Lancaster, to the north); on the east and south by U. S. Air Force Plant 42, and on the west by the Southern Pacific Railroad and Sierra Highway. Two small "out" parcels intrude into the subject property and have been excluded from the proposed development. These two parcels include:

- A 7-acre parcel, along Avenue M and between 5th and 6th Street West, is owned by L. A. County Waterworks District No. 40–Antelope Valley and presently contains three large water storage tanks, with a footing in place for a fourth. Future plans also call for one or two new water wells. The timing of well construction, the location and proposed depth of the new wells, and their design extraction rates are not known at this time.

- A 5-acre parcel along the south boundary, at approximately Avenue M-12 projected, that is in private ownership and is presently undeveloped.

Elevations in the regional study area range from about 4800 ft above sea level in the southwestern part of the area, to about 2300 ft along the northern boundary in the vicinity of Rosamond Dry Lake. Elevations on the subject property show a gentle slope to the northeast ranging from about 2550 ft above sea level in the southwest corner to about 2490 ft in the northeast corner of the property. Onsite drainage is via sheetflow in a northeasterly direction across the property.

There are no known historical seeps or springs on the site, and there are no records of any water wells ever having been drilled onsite either.

Figure 2 illustrates the approximate location of wells in the regional study area, specially annotated with the State designation and/or local or District designation for wells for which electric logs are available, or for which drillers' logs were used in cross-sections. The regional area is reported to have grown alfalfa as a major crop, and to have had significant cattle ranching west of Lancaster, so there was substantial groundwater production during the 1940s through the early 1960s. This history is reflected in the large number of wells shown on Figure 2, despite our in-house deletion of all wells reported in the literature as having been destroyed prior to 1963. As agricultural land has been taken out of production, residential developments have been built, and the local population has increased.

Regional Water Purveyors. Within the Lancaster Subbasin, as seen on Figure 1, there are approximately 7 small, privately-owned mutual water companies and/or water districts. As illustrated, mutual water companies to the north include Landale Farms Mutual Water Company (map symbol LFM); to the northwest and west lie White Fence Farms Mutual Water Company (symbol WFF) and the Quartz Hill Water District; to the southwest is White Fence Mutual Water Company (WFM), El Dorado Mutual Water Company (EDM), White Sands Mutual Water Company (WSP), and Shadow Acres Mutual Water Company (SAM). Each of these relatively small water purveyors owns and/or operates one or two water wells within their individual service area, except for the Quartz Hill Water District which utilizes four active well at this time.

Major regional water purveyors include:

- Palmdale Water District (map symbol, PW) which maintains on the order of 20 active wells, all of which lie south of the subject property.

- Los Angeles County Waterworks District No. 40–Antelope Valley. (According to Mr. Joe Aja of the County [personal communication, May 24, 1994] all water districts in the North-County area have been consolidated into the new WWD No. 40–Antelope Valley designation; although former zone districts and boundaries have remained the same, as have the original County well designations.) In the vicinity of the Lancaster Subbasin, former WWD Nos. 4 and 34 are now within WWD-40–Antelope Valley. For the purposes of this study, however, the original District well numbers are retained. Hence, Well No. 4-48, for example, is still Well No. 48 in District 4.

In the Lancaster Subbasin, the new LACWWD-40 owns and operates at least 20 to 25 wells for municipal-supply use; and all lie north of the subject property. As indicated previously, the County is considering constructing one or two new wells on its 7-acre "out" parcel along Avenue M at the north-central boundary of the subject property.

Selected District and Local Wells. All wells with electric logs in the study area were correlated into our large database in the vicinity of Lancaster. A lithologic "type log" from ground surface down to bedrock was developed with Lancaster area drillers' logs, using available electric logs for control. From that known database, working to the west, south and east, selected available drillers' logs for wells deeper than about 600 ft, and including the limited number of electric logs from water wells and wildcat oil wells in the area were correlated. Selected wells with available electric log data in the proximal Lancaster, Quartz Hill,

USAF/Rockwell and Palmdale areas are discussed below (refer to well locations on Figure 2).

Well No. 34-6. This well was drilled in December 1987 to a depth of 1150 ft by rotary methods, and was cased with 16-in casing from ground surface to a completed depth of 1060 ft. The casing was screened with louvers from 500 to 1060 ft; and with limited vertical slots from 780 to 860 ft. The well displays an overall coarser-grained section with only about 80 ft of "blue clay" on the drillers log. (The stratigraphic equivalent of the "blue clay" zone represents an area of transitional depositional conditions, as described below under "Aquifer Systems.") Well testing by the driller for a pumping rate of 1000 gpm created a water level drawdown of 68 ft and a calculated specific capacity of 15 gallons per minute per foot of drawdown (gpm/ft ddn). Here, specific capacity represents the ratio of the pumping rate in a well in gpm divided by the water level drawdown, in feet, created in that well while pumping at that rate.

Well No. 4-29. Direct rotary drilling methods were used to drill this 798-ft well in April 1967. The casing, which includes 14-in casing from the surface to a completed depth of 740 ft, contains perforations from 350 to 728 ft. "Blue clay" was encountered at 772 ft, below the completed (cased) depth of the well. Well testing by the driller for pumping rates of 600 to 2000 gpm revealed water level drawdown values ranging from 17 to 61 ft, which resulted in calculated specific capacity ranging from 35 to 33 gpm/ft ddn, respectively.

Well No. 4-44. This 1220-ft well was drilled by rotary methods in September 1988. Casing is 16 inches in diameter and extends down to a completed depth of 1202 ft. The electric log does not show the contact with the underlying

bedrock, but correlations suggest "granite" may be located at about 1275 ft. Casing perforations are from 400 to 740 ft and from 940 to 1202 ft; vertical Mill slot perforations were used from 740 to 940 ft through the fine-grained "blue clay" zone. Well testing by the driller for pumping rates from 1800 to 3000 gpm revealed water level drawdown values ranging from 25 to 48 ft, respectively. The resulting calculated specific capacity ranged from 72 to 63 gpm/ft ddn, respectively.

Well No. 4-45. Drilled in April 1989 by rotary methods, this 1220-foot deep well was cased with 16-in casing from the ground surface to a completed depth of 1200 ft. The electric log does not show the contact with the underlying bedrock, but proximal well No. 4-46 encountered "granite" at TD of 1140 ft. Thus, it is likely that "granite" lies just below TD for well No. 4-45. Casing contains perforations from 400 to 780 ft and from 900 to 1200 ft. Vertical Mill slot perforations were placed from 780 to 900 ft, approximately through the fine-grained "blue clay" zone. Well testing by the driller included pumping rates from 800 to 2000 gpm and revealed water level drawdowns ranging from 31 to 60 ft, respectively. The resulting calculated specific capacity ranged from 26 to 33 gpm/ft ddn, respectively.

Well No. 4-48. This 1135-ft well was drilled by direct rotary methods in March 1988; it has 16-in diameter casing from the surface to a completed depth of 1110 ft. The electric log for this well represents a good "type section" which includes the deeper stratigraphic zones for the Palmdale-Lancaster area.

The geologic contact between the overlying sedimentary materials and the underlying weathered bedrock occurs at about 1100 ft. Relatively fresh, hard "granite" is indicated at about 1120 ft on the electric log. There is good correlation

between the electric log and the driller's log, with the latter including the terms "decomposed granite" and "granite" at 1110 ft and 1120 ft, respectively. Casing perforations were placed from 320 to 560 ft and from 740 to 1100 ft. Louvers with limited slot openings were placed from 560 to 740 ft, within the fine-grained "blue clay" zone (refer to discussion titled "Aquifer Systems," below).

Well testing by the driller for pumping rates (Q) ranged from 1100 to 3000 gallons per minute (gpm) and revealed water level drawdowns ranging from 18 to 68 ft. The resulting calculated specific capacity (Q/s) for the well ranged from 61 to 43 gpm per ft ddn, respectively.

Well No. 4-49. This 1160-ft well was drilled by rotary methods in April 1988 and cased with 16-in casing from the ground surface to a completed depth of 1150 ft. The electric logs from this well and the proximal Well No. 4-48 are very similar and closely correlative. The electric log for Well 4-49 does not show the contact with bedrock, but the drillers' log describes "cemented sand or decomposed granite" at 1150 ft, and the correlations with the logs for Well No. 4-48 suggests that "granite" at No. 4-49 lies just below total depth (TD) of this well. Casing perforations were set from 320 to 500 ft and from 720 to 1140 ft. Louvers with limited slot openings were used from 500 to 720 ft, within the fine-grained "blue clay" zone.

Well testing by the driller revealed pumping rates from 1450 to 2950 gpm, and created water level drawdowns ranging from 31 to 69 ft, respectively. The resulting calculated specific capacity values ranged from 48 to 43 gpm/ft ddn, respectively.

Well No. 4-54. This well and proximal Well No. 4-55 are virtually identical. Well No. 4-54 was drilled to 1210 ft by rotary methods in August 1988. It

contains 16-in casing from the surface to a completed depth of 1200 ft. The contact with bedrock is at an unknown depth below TD of both wells. Casing in No. 4-54 contains perforations from 360 to 640 ft and from 880 to 1200 ft; Mill slot perforations were used from 640 to 880 ft, approximately through the fine-grained "blue clay" zone. Well testing by the driller for pumping rates from 1600 to 2400 gpm revealed water level drawdowns ranging from 37 to 65 ft, respectively. The resulting calculated specific capacity ranged from 43 to 37 gpm/ft ddn, respectively.

Rockwell Site 3, "North Well". This 810 ft well was drilled by rotary methods in November 1986 and fitted with 16-in cased from the surface to a completed depth of 800 ft. The casing was screened from 500 to 800 ft; "blue clay" was encountered at 775 ft, very near the bottom of the cased well. Well testing by the driller for pumping rates from 800 to 2000 gpm created water level drawdowns ranging from 73 to 118 ft, and resulted in calculated specific capacity values ranging from 11 to 17 gpm/ft ddn, respectively.

Quartz Hill/No. 9. Drilled to 622 ft in depth by rotary methods in January 1989, this well contains 16-in casing from the surface to a completed depth of 510 ft. Perforations are from 295 to 330 ft, 400 to 440 ft, and 470 to 500 ft. The electric log indicates the contact with the underlying "granitic" bedrock occurs at approximately 490 ft; this is corroborated by the driller's log, which describes weathered ("decomposed") "granite" commencing at 540 ft. The driller's well test recorded a pumping rate of 1250 gpm, but the reported drawdown is questionable, as the subsequent calculation of specific capacity is anomalous for the area.

Well No. 6A. This 1030-ft well was drilled by rotary methods in 1983 and cased with 16-in casing down to a completed depth of 1010 ft. The casing was perforated using vertical Mill-slot casing from 480 to 1010 ft. The drillers log describes "granite chips" near the bottom of the well; the electric log suggests weathered "granite" at approximately 1020 ft. The stratigraphic equivalent of the "blue clay" zone is present in this well, as described below under "Aquifer Systems." Well testing by the driller for a pumping rate of 800 gpm resulted in a water level drawdown of 140 ft and a calculated specific capacity of only 6 gpm/ft ddn.

Data for the above proximal wells are summarized later in this Report on Table 2 - Summary of Key Data, Proximal Water Wells. Of particular interest thereon are: the distances and directions of each of these wells to the nearest point of the subject property; specific information on the approximate depths to key hydrogeologic strata (the upper and lower aquifer systems, the blue clay, and granite); and information on specific capacity and yield factor.

NEARBY DEVELOPMENTS

U. S. Air Force Plant 42 is shown to the east and south of the subject property together with the generalized locations of each major Site on this government facility. Approximate locations of known wells on each Site are illustrated on Figure 3 - Map of Property, Nearby Development and Proximal Wells. These wells supply water for either domestic supply, industrial usage and/or fire suppression purposes. Not shown on the map are the locations of several cathodic protection wells on the Plant.

Shown also on Figure 3 are the large undeveloped parcels of land that lie in Sections 36 and 31 just north and northeast of the property and in Sections 3,

10, and 11 west and southwest of the parcel. A few remaining, active agricultural-supply wells are also noted in the region.

Municipal-supply wells shown on Figure 3 include those owned by L. A. County Waterworks District 40. These include Nos. 4-32, 4-34, 4-43, and 4-44 located 1 to 1½ miles to the northwest; and 4-29 and 4-30 located about 1 miles to the west. Just east of wells 4-43 and 4-44 is a large parcel owned by LA County Waterworks District No. 40 that contain a few active and inactive wells. This site also was the location of two recent U.S.G.S. recharge tests, via injection of AVEK water into LA County Wells 4-8 and 4-42.

Also significant to the proposed site development are the following:

1. There are two parcels within the general confines of the property, but which are not considered a part of the property: these include a site along Avenue M on the north which contains three new large steel water tanks, a foundation for a fourth tank, and one or two potential well sites for the County; and a parcel on the south near Avenue M-12 which is a privately-owned parcel (there are no wells on this parcel).

2. The nearest active offsite well is a domestic/industrial well on Site 1 of U. S. Air Force Plant 42. This well is ¼-mile east of the eastern property line of the subject property (see Figure 3).

3. The nearest active offsite domestic groundwater source is the well owned by Landale Farms Mutual Water Co. (LFM on Figure 1), located near L-8 and 5th Street East. This well is ½-mile north of the northern property line of the subject property.

4. Other active mutual water company wells in the area are: White Fence Farms Mutual Water Company well WFF-1 (1½ miles northwest of the subject property), WFF-2 located 1¼ miles to the west, WFF-3 and WFF-4 located about 2 miles to the west; White Farms Mutual Water Company well WFM-1 located 2¼ miles to the southwest; and well WSP-1 which lies about 2 miles south-

west of the site. Refer also to Figure 1 for the general service areas of these mutual water companies.

5. Beginning approximately two miles south of the property and extending to about three miles to the southeast of the subject parcel are a series of active Palmdale Water District wells (symbol PWD, on Figure 1).

LOCAL GEOLOGIC CONDITIONS

Lithology. Figure 4 - Regional Geology Map - has been adapted from work by Dibblee (1967, 1963, 1962, 1961) for the United States Geological Survey and from the State Department of Water Resources (DWR) maps (Bulletin 91-12) in order to illustrate geologic earth materials near the property. As seen thereon, local rocks consist of the following units from geologically oldest to youngest (refer to Appendix C for a table showing the geologic time scale):

Basement Complex consists of metamorphic rocks (map symbol scp) and plutonic igneous rocks (map symbol qmd) of pre-Tertiary geologic age; these rocks are exposed at ground surface in the Sierra Pelona Mountains which border the southern end of the Antelope Valley Groundwater Basin. Exposures of metamorphic schists and gneisses (scp) also occur as "window" outcrops at and near Quartz Hill as illustrated on Figure 4. Metamorphic rocks include gray to green Pelona muscovite schist, darker-colored Portal Ridge biotite schist and metamorphosed plutonic rocks (gneiss). Portal Ridge schist is reported by California Division of Mines and Geology (CDMG) staff to occur at Quartz Hill (pers. comm.) Plutonic rocks are generally of medium-grained granitoid texture, ranging in composition from gray-white granodiorite and quartz monzonite to dark gray to black hornblende diorite and gabbro. The predominant plutonic type in the area is light-colored massive homogeneous quartz monzonite.

All such crystalline basement complex rocks are referred to in this report as "granitic" or "granite." These rocks are considered to be wholly nonwater-bearing in terms of their overall ability to yield groundwater in acceptable quantity and quality to wells for domestic use as required for this project.

Vasquez Formation, of Oligocene to Miocene geologic age (map symbol Tv), is comprised by pink to dark reddish-brown andesitic volcanic rocks, greenish to cream-white tuffaceous rocks, and light-gray to buff or red, stream-deposited cobble-boulder conglomerate. The unit occurs southwest of the San Andreas fault zone, unconformable on an undulating "granitic" surface and in unconformable contact with the overlying Punchbowl Formation. Rocks of the Vasquez Formation are cemented and/or lithified, and are considered to be nonwater-bearing; they are locally exposed in the foothills of the Sierra Pelonas as seen in Figure 4.

Punchbowl Formation, of upper Miocene to lower Pliocene geologic age (map symbol Tpb), consists mostly of thick-bedded buff-white to locally pink arkosic sandstone, grading downward into gray to red cobble-boulder conglomerate at the base and grading upward into white sandstone interbedded with red to green siltstone. Due to their cemented and/or lithified character, these rocks are also considered to be nonwater-bearing. Exposures of these rocks occur within the foothills of the Sierra Pelona Mountains.

Anaverde Formation, of Pliocene (Tertiary) geologic age (map symbol Tav), is comprised of pink arkosic sandstone interbedded with conglomerate, grading upward to buff or nearly-white arkosic sandstone. This unit then grades upward through interbedded sandstone and shale into soft gray clay shale with some veinlets to thin lenses of white gypsum. The formation is severely deformed, and is

exposed along the San Andreas fault zone. Rocks of this formation are considered to be nonwater-bearing for this project. They, too, are exposed along the foothills of the Sierra Pelona at the southern end of the Antelope Valley Groundwater Basin (refer to Figure 4).

Older Alluvium, of Pleistocene (Quaternary) geologic age (map symbol Qoa), consists of poorly to moderately consolidated, alluvial fan and stream-channel deposits characterized by moderately- to poorly-sorted gravel, sand and silt. These sedimentary deposits are exposed in the southern portion of the Antelope Valley Groundwater Basin and in the area of Quartz Hill as seen on Figure 4.

The older alluvium is divisible into at least three units: an upper, coarse-grained alluvial-fan sand and gravel to boulder deposit; this upper unit grades downward into a greenish-gray lacustrine (lake-derived) sandy clay and silt with some gray-white to gray sand to gravel interbeds; and a lower gray-white massive to poorly-bedded medium- to coarse-grained sand unit.

Around the periphery of the basin outside the limit of the deposition of the lacustrine sediments, the clay/silt unit is reddish-gray where exposed at ground surface; the maximum exposed thickness is 300 ft. Where the alluvial fan unit is exposed, it is about 400 ft thick and displays a cobble gravel at the base. Older alluvium is reported to have a maximum thickness of about 1200 ft and lies unconformably upon all geologically older formations in the region. Due to the nature and character of these older alluvial sediments, they are considered to be potentially water-bearing in the region.

Younger Alluvium, of Holocene (Quaternary) geologic age (map symbol Qya), consists of several mappable facies which include alluvium, playa clay, windblown sand and bars of wave-deposited sand. Younger alluvium has a re-

ported maximum thickness of 150-200 ft. Depending on local groundwater levels and time of the year, portions of the younger alluvium may become saturated and may be considered to be potentially water-bearing. Younger alluvium mantles nearly all of the present-day ground surface of the Antelope Valley Groundwater Basin as shown on Figure 4.

Geologic Structure. The entire Antelope Valley comprises a groundwater basin of about 1615 square miles located in the southwesterly portion of the Lahontan Hydrologic Region.

Structurally, the valley is a graben (downthrown faulted block) bounded on the northwest by the Garlock fault and on the southwest by the San Andreas fault zone (see Figure 4). Granitic highlands (rock exposures) occur in numerous locations along the floor of the valley. The Antelope Valley Groundwater Basin is internally drained into three dry lakes (Rosamond, Rogers and Buckhorn lakes), which are located in the central part of the basin (Durbin, 1978). The study area is located in the southern part of the basin, and is separated from the westward extension of the main basin by the northeast-southwest-trending Neenach fault. The Neenach fault is truncated by the east-west-trending Rosamond fault, which fronts the Rosamond hills, immediately north of Rosamond dry lake. The Neenach and Rosamond faults are northwest and north, respectively, of the study area as mapped on Figure 4.

Geologic structure in the regional study area is dominated by the San Andreas fault system, located in the southern portion of the area. Structure is extremely complex throughout the region as evidenced by horizontal and vertical movement on the numerous faults, combined with folding in the sedimentary section overlying an irregular weathered crystalline bedrock surface. As a result, the available thickness of potentially water-bearing sediments varies substantially with

geographic location. Geologic complexity and the lack of a significant number of deeper wells with electric-log data cause predictions herein of depth to bedrock to be guidelines subject to revision as further data become available.

Depth to Bedrock. Lithologic information for wells deeper than about 800 ft is meager, particularly in the eastern portion of the regional study area. Some of the more experienced drillers in the Antelope Valley area will designate a zone called "decomposed granite," and/or "granite," on their drillers' logs, at which point generally the test hole is terminated. Comparison of drillers' logs to electric logs for these wells indicates that experienced drillers are reasonably accurate (within 50 ft to 100 ft or so) of their assessment of cuttings as representing "decomposed (*i.e.*, weathered) granite" or "hard (*i.e.*, fresh, unweathered) granite."

As a consequence, if a sufficient number of drillers' logs which penetrate "granite" are available in an area in which electric logs are lacking, a reasonable estimate (within 50-100 ft) of the sedimentary/bedrock contact can be made based on analogy with nearby geologically similar areas where more data are available. Drillers' logs which do not recognize this geologic contact, but which do show an overall lithologic change, can be interpreted into the known geologic framework.

Local outcrops ("windows") of crystalline rock exposures in the vicinity of the San Andreas fault system and at Quartz Hill, suggest that a limited thickness of sediments (less than 200 ft) will be available overlying crystalline bedrock in the immediate vicinity of these exposures. Depth to "decomposed granite" or "granite" increases in an irregular fashion in all directions away from such granitic outcrops on the valley floor. For example, depth to bedrock is estimated at about 600 ft for roughly a one-mile radius around the northern half of the community of Quartz Hill, for about a two-mile radius south and southeast of the community, and less in the central part of that area, based on drillers' logs and limited electric logs. Thus, the

area from Quartz Hill south to the crystalline outliers along the mountain front and east to the subsurface "escarpment" forming the boundary of the Lancaster subbasin with the Buttes and Pearland subbasins (refer to Figure 2 and to discussion of "Groundwater Conditions," below), essentially forms a semi-circular irregular bedrock shelf which deepens to the north/northwest, toward Rosamond dry lake.

Our interpretation of depth to weathered and/or unweathered crystalline bedrock in the vicinity of the property area is shown on Figures 5.1 and 5.2 - Hydrogeologic Cross-Sections A-A' and B-B', respectively. These illustrations indicate that approximately 1000 to 1200 ft of potentially water-bearing sediments can be expected in the study area, depending on the irregularity of the crystalline bedrock surface underlying the alluvial deposits and the thickness of weathered bedrock surface. This estimate is based on interpretation of drillers' logs in the study area integrated with data from electric logs in the Palmdale/Lancaster area (refer also to our interpretation of the depth to "granitic" bedrock in wells near the subject property as shown on Table 2 later in this report). Because groundwater has been shown to accumulate in a 0 to 150-foot thick, weathered crystalline bedrock layer (Babu, et al., 1991), the weathered layer is included in the thickness of potentially water-bearing sediments as estimated herein.

LOCAL GROUNDWATER CONDITIONS

Groundwater Basin Boundaries. The Lancaster/Palmdale area lies within the Antelope Valley Groundwater Basin, as defined by the Department of Water Resources (DWR, 1964). This large groundwater basin was subdivided into 8 subbasins (DWR 1964) and more recently into 13 subbasins (Pierotti, 1989) by the DWR based upon mapped surface geology and fault boundaries inferred from apparent barriers to groundwater flow. A few of the subbasin boundaries within the

Antelope Valley Groundwater Basin have been selected along non-geologic bases and include groundwater divides and political divisions, or even ones selected for purposes of convenience. The regional and project study areas, as defined by the maps for this report, are located in the Lancaster Subbasin of the Antelope Valley Groundwater Basin as shown on Figure 2.

Bulletin 106-1, the major reference for basin boundaries in the Lahontan region (DWR, 1964), and the one used for our investigation, defined the Lancaster subbasin as the largest of the subbasins in the Antelope Valley Groundwater Basin. This subbasin is bounded by the San Andreas fault system on the southwest, the Neenach fault on the northwest, the Rosamond fault on the north, a groundwater divide between Rosamond and Rogers dry lakes on the northeast, and crystalline basement outcrops with subsurface inferred faulting on the east/southeast.

Aquifer Systems. Two major aquifers have been identified within the Antelope Valley Groundwater Basin: the "principal" and the "deep" aquifer (Durbin, 1978; Pierotti, 1989). These two zones are separated by relatively thick beds of "blue clay" which were originally deposited in deep, ancient perennial lakes (lacustrine deposits). According to Durbin, 1978, this large ancient lake system occupied parts of the Lancaster and North Muroc subbasins (the North Muroc subbasin lies northeast of Rosamond dry lake, outside our area of study).

At intervals during Pleistocene geologic time, the lower part of the Antelope Valley appears to have been flooded by the lake system which included what are now Rosamond dry lake, Rogers dry lake and the intervening playas. This ancient lake was named Lake Thompson and has been reported to extend as far south as the 2330-ft topographic contour (Dibblee, 1963), in the vicinity of the City of Lancaster. A portion of the ancient shoreline is reportedly discernible on aerial photos to the 2330-ft contour, with a possible older shoreline noted along the 2400-ft

contour in the vicinity of Rosamond and Tropico Hill. In late Holocene geologic time, precipitation in this region diminished and Lake Thompson eventually evaporated (Dibblee, 1967, 1963).

For our evaluation of subsurface conditions, we relied heavily on drillers' logs for wells deeper than about 600 ft, and also on correlating available electric logs in the Lancaster/Palmdale area. Our evaluation reveals that the principal aquifer (herein called the upper aquifer), the underlying lacustrine clay/silt ("blue clay") unit, and the deep aquifer (herein called the lower aquifer) comprise the water-bearing section in the vicinity of the study area.

The overall configuration of the Lancaster subbasin, the location of the source for the sediments which occurs to the south/southwest for the regional study area, and the transport and deposition of these sediments via streams flowing from south/southwest to the north toward the low areas of the subbasin do not appear to have changed significantly throughout Pleistocene time. Hence, the Pleistocene depositional systems for the region are essentially similar to those in existence today (Dibblee, 1963). These systems consist of long-term alluvial fans which prograded (moved onward) toward the north and debouched into the ancient lake system during the time intervals when greater precipitation caused the lake to expand.

The clay/silt unit (the "blue clay" according to the local terminology) grades upward through overall increasingly coarser sediments into the relatively coarse-grained alluvial-fan deposit which comprises the upper aquifer system. In general, the clay/silt unit is thickest and has the highest clay content in the topographically lowest part of the Lancaster subbasin which lies to the north of the regional study area. Sand and gravel content in the clay/silt unit increases toward the periphery of the basin, in the vicinity of sediment sources (Ethridge and Flores, 1981). Where the lower aquifer system underlies the fine-grained facies of the

clay/silt unit, groundwater occurs under confined conditions (*i.e.,* under pressure conditions) . Toward the basin periphery, as the clay/silt unit grades into its coarse-grain facies, groundwater within the lower aquifer may be unconfined (*i.e.*. under water table conditions).

The fine-grained facies of the clay/silt unit consists of lake-deposited, lacustrine deposits, while the coarse-grained facies consists of lake-shore and lower alluvial-fan deposits (Reineck and Singh, 1980). In our report we have termed this coarse-grained, lake shore and/or lower alluvial fan deposits as the "blue clay" stratigraphic equivalent. The distinguishing characteristic is the lack of the use of the term "blue clay" on drillers' logs, although electric logs, proximal drillers' logs and relatively high clay content indicate that the zone is a shoreward continuation of the lacustrine clay/silt unit.

The "blue clay" stratigraphic equivalent becomes progressively thinner as it overlaps onto bedrock, and becomes so coarse-grained that it merges with the upper aquifer in the southern part of the regional study area. The apparent limit of "blue clay" stratigraphic equivalent forms a semi-circle extending from the vicinity of Quartz Hill south to the vicinity of Palmdale and then east through Sections 19, 20, 16, 10 and 2 of Township 6 North, Range 11 West. South of this semi-circular zone, all the units are merged into an overall coarse-grained section. The true "blue clay" lacustrine facies is found north of this stratigraphic equivalent zone.

From our detailed assessment there appears to be an embayment circumscribed by the more shallow areas of buried "granitic" basement rocks (approximately less than 600 ft below the surface) which opens north/northeast roughly across the subject property (as shown on Hydrogeologic Section B-B') and which deepens toward wells No. 4-58/4-59 and No. 4-54/4-55 (see Hydrogeologic Section A-A'). Limited data in this area suggests that "granitic" basement is greater than 1200 ft below the surface north of Well No. 4-46 and east of the City

of Lancaster. An extension of the shallow Quartz Hill "granitic" structure continues under the City of Lancaster and forms the western limit of this embayment. This extension deepens toward the north/northeast to merge into the deeper "granitic" floor of the Lancaster subbasin north of the study area.

The upper aquifer in the regional study area consists of a long-term alluvial-fan sequence (Heward, 1978) where most of the detritus was transported to the north/northeast from its source in the San Gabriel Mountains on the south side of Antelope Valley. The axis (and hence, the coarsest-grained portion) of the fan extends approximately along Hydrogeologic Section A-A' toward wells No. 4-54 and 4-55. Sediments along the upper and middle fan axis are coarser-grained closest to the axis (due to proximity to the principal trunk stream channel) and nearest the source areas, then become finer-grained in the direction of the lower fan and also toward the fan margins (Bull, 1972, 1977).

The finer-grained fan margins are associated with water wells having lower values of specific capacity. Limited specific capacity data suggests that the western fan margin overlaps onto the east side of the Quartz Hill subsurface extension (east side of the City of Lancaster), while the eastern fan margin overlaps onto the shallow basement to the southeast and east of Hydrogeologic Section A-A' (Figure 5.1), along the periphery of the Lancaster subbasin. Table 1 summarizes original well testing data and specific capacity data for the major municipal-supply water wells proximal to the subject property.

As shown on Hydrogeologic Section B-B' (Figure 5.2), the lower aquifer is limited by the confines of the embayment in the vicinity of the property, but spreads out and deepens to the north/northeast, as the depth to crystalline bedrock increases (Hydrogeologic Section A-A'). Dibblee (1967) presents a series of paleogeographic maps which indicate that this embayment area was surrounded by highlands and was thus a site of continuous deposition from late Miocene to early

Pleistocene time. The highland areas were more limited and deposition more widespread from Pleistocene time to the present.

The lower aquifer is essentially comprised by alluvial sediments older than the Pleistocene lacustrine clay/silt unit and is reported to be late Pliocene to earliest Pleistocene in geologic age. As a consequence, the basal portion of the sediments in the embayment area may be older than expected for the lower aquifer unit. They may possibly be as old as early Pliocene or even late Miocene. Due to the limited extent of the lower aquifer in the southern part of the project area and the small number of wells which penetrate to the underlying bedrock, we have not attempted a depositional systems analysis for this unit to predict the geographic location of coarser-grained portions of this aquifer system. Limited data on the west side of the City of Lancaster, in the Mira Loma area, and in the vicinity of wells No. 4-45 and 4-55 suggest that the lower aquifer does contribute to groundwater production where it contains a relatively coarser-grained section. There are no data or reports, to our knowledge, which provide results of any in-situ sampling or aquifer testing solely from the lower aquifer system.

Groundwater Flow Directions and Water Levels. Groundwater flow directions typically represent a subdued replica for surface topography, with groundwater draining from mountain highlands toward the internal drainage lowlands of the Antelope Valley. Recharge of groundwater in the Palmdale/Lancaster area occurs principally by means of infiltration of surface water runoff in the major creek channels (such as Amargosa Creek and Little Rock Creek) which drain northward from the mountains bordering the southerly end of the Antelope Valley Groundwater Basin. According to a 1955 report (Division of Water Resources), approximately one-half of the runoff into the Antelope Valley may originate from Big Rock

and Little Rock Creeks, while Armargosa and Cottonwood Creeks rank next in the amounts of runoff contributed to the valley from the mountains on the south.

Lesser amounts of groundwater recharge occur via deep percolation of direct rainfall on the valley floor and via deep percolation of excess irrigation. It is probable that rainfall contributes recharge only during particularly wet seasons or wet years because most rainfall is likely consumed through transpiration or direct evaporation from the ground surface. The relative magnitudes of aquifer recharge via stream infiltration, or deep percolation of rainfall or excessive irrigation have not been quantified for this project.

To illustrate the current status of groundwater levels in the Lancaster Subbasin, we obtained recent water level data from the USGS from their ongoing groundwater monitoring program for wells in the region. Also, we collected additional non-pumping (static) water level data for April 1994 from wells owned by LA County Waterworks, Palmdale Water District, and the Quartz Hill Water District. We then corrected these water level data using approximate ground surface elevation data to determine the approximate elevation of the non-pumping groundwater in each respective well for which data were available. The results are illustrated on Figure 6 - Groundwater Elevation Contours, April 1994. The locations of wells and their respective non-pumping (static) groundwater elevations during April 1994 are specially denoted on that figure. Wells that were pumping at the time of the April 1994 groundwater monitoring canvass are also specially marked with the letter "p" on Figure 6.

Review of the interpretive groundwater elevation contours on Figure 6 indicates that regional groundwater flow in the Lancaster Subbasin moves generally toward two pumping centers: one near Lancaster and one near Palmdale. Both pumping centers contain several, closely-spaced, active, municipal-supply water wells. The pumping center near Lancaster has been interpreted to be a single area

comprising several square miles, within which the non-pumping water level elevation for Spring 1994 was at or below an elevation of 2150 ft (the subject property lies at the southern edge of this pumping center). Two very small areas within this larger 2150-foot elevation contour have been interpreted to be encircled by a 2125-foot groundwater elevation contour (see Figure 6). The other pumping center in Lancaster Subbasin has a water level low elevation of 2025 feet. Broad arrows on Figure 6 illustrate the general directions of groundwater flow in the region during April 1994.

In the Pearland Subbasin, southeast of Lancaster Subbasin, data from several active municipal-supply wells also reveal the presence of another probable pumping center. The differences in the contour interval, together with the differences in shapes and orientation of the groundwater elevation contours between the Lancaster Subbasin and the Pearland Subbasin appear to corroborate the existence of a northeast-southwest trending groundwater barrier between these two subbasins (see Figures 2 and 6).

Water Well Hydrographs. To evaluate the history of groundwater levels in the region and to assess whether or not any water level trends have occurred in the record, we collected hydrographs from a large number of water wells that were on file at the AVEK office in Quartz Hill. These hydrographs have been prepared on an on-going basis by AVEK, using depth-to-water data monitored over the years in numerous water wells as part of the ongoing USGS groundwater monitoring program.

An example of one of these hydrographs (refer to Figure 7 - Hydrograph of Water Well 7N/11W-27Q1) has been included in our report to provide an example of the type of available hydrographic data prepared by AVEK for numerous wells in the region. Figure 8 shows water level data for this 650-foot deep well are

available for the period 1953 through 1993. For this particular well, the water level trend between 1953 and 1993 is shown to be an overall decline of approximately 83 feet. However, based on detailed evaluation of this graph and of the other AVEK-prepared hydrographs, we noted that other water level trends were detectable. Specifically for well 7N/11W-27Q1, the water level declined continuously between 1953 and about 1977, but between 1977 and 1993, that declining water level trend reversed and, indeed, revealed a rising water level trend of +59 ft between 1977 and 1993.

To assist our more detailed analysis of hydrographs, we prepared Figure 8 - Water Wells with Long-Term Hydrograph Data. This map illustrates the locations of 18 wells for which long-term and continuous water level hydrograph data are available. The 18 wells shown on Figure 8 have water level hydrographic data beginning between the late-1940s or early-1950s to 1967. Most important, however, is that each record is continuous into 1993 with the exception of the one well noted thereon.

Review of the long-term hydrographs indicates that, beginning in approximately 1977 and continuous through to at least 1993, water levels in numerous wells in the area began to recover (*i.e.*, began to rise). The hydrograph on Figure 7 is an example of this change in the water level trend after 1977. Special annotations are used on Figure 8 to illustrate the specific well number and well location for wells showing the following long-term water level trends:

A. A solid circle is used for wells showing a rising water level trend during the period 1977 to 1993. A total of nine of the 18 wells shown on Figure 8 display this rising trend since 1977. The amount of water level rise in these wells between 1977 and 1993 has ranged approximately between +8 ft (Well 7N/12W-12R1, located four miles north of the subject property) and +59 ft (Well 7N/11W-27Q1, located four miles northeast of the subject property). Most of the wells in the region

showing water level rising trends during this period appear to be located along or near Little Rock Wash (*i.e.*, near a major source of recharge).

B. An **X** is used for wells showing a declining water level trend during the period 1977 to 1993. A total of eight of the 18 wells shown on Figure 8 display a declining water level trend during the period 1977 to 1993. The amount of water level decline during this period in these wells has ranged approximately between –6 ft (Well 6N/12W-7A1, located three miles east of the subject property) and –23 ft (Well 7N/12W-19R1, about 3½ miles northwest of the property). Wells displaying the declining water level trends appear to occur randomly in the region, but include areas near the Lancaster pumping center and areas farther from sources of recharge.

C. An open circle is shown on Figure 8 to show the location of well 7N/12W-35M1. This well does not have data continuing into 1993; its period of available hydrographic data date between 1948 and 1987. Hence, it is not possible to determine the 1977 to 1993 water level trend as was evaluated for the other 17 wells on Figure 8. Unfortunately, this well is located very near the subject property.

Based on recent conversations with the USGS (personal communication, Mr. Chuck Lamb, July 12, 1994), this well was formerly owned by a "Sierra Mutual Water Company." It was drilled in 1950 and had perforations from 220 to 540 ft. The well was abandoned, and possibly destroyed (?), by 1987.

A definitive summary of the hydrograph data available for the 18 subject wells is provided on Table 1 - Summary of Hydrographic Data for Proximal Wells. Shown thereon for each well is its respective State well number; the approximate distance of this well to and its direction from the subject property; the initial year of water level monitoring and the depth to water in that year; the depth to water in 1977 and in 1993; the total amount of rise or decline in water levels between the initial year and 1977 and between 1977 and 1993; and the annual rates of water level rise or decline between the initial year and 1977 and between 1977 and 1993. It is the data from the eighth column on Table 1 (*i.e.*, total water level rise

TABLE 1 – SUMMARY OF HYDROGRAPHIC DATA FOR PROXIMAL WELLS

State Well No.	Approx. Distance and Direction From Site	Initial Year of Monitoring	Depth to Water (ft) Initial Year	Depth to Water (ft) 1977	Depth to Water (ft) 1993	Total (ft) Rise–Decline 1st Yr. to 1977	Total (ft) Rise–Decline 1977 to 1993	Annual Rate of Rise–Decline 1st Yr.to 1977 ft/yr	Annual Rate of Rise–Decline 1977 to 1993 ft/yr
7N/11W–1Q1	8½ mi, to the NE	1958	179	208	186	–29	22	–1.53	1.38
7N/11W–5L1	5½ mi, to the NE	1963	103	120	132	–17	–12	–1.21	–0.75
8N/12W–31Q2	7¼ mi, to the NW	1963	44	64	71	–20	–7	–1.43	–0.44
7N/12W–12R1	4¼ mi, to the N	1963	95	142	134	–47	8	–3.36	0.50
7N/11W–21E1	4 mi, to the NE	1963	104	121	154	–17	–33	–1.21	–2.06
7N/12W–22K1	2½ mi, to the N	1961	172	236	256	–64	–20	–4.00	–1.25
7N/12W–19R1	4 mi, to the NW	1951	97	205	228	–108	–23	–4.15	–1.44
7N/13W–26J2	5½ mi, to the NW	1957	216	271	248	–55	23	–2.75	1.44
7N/11W–27Q1	4½ mi, to the NE	1953	201	343	284	–142	59	–5.92	3.69
7N/11W–29H1	3 mi, to the NE	1959	284	308	268	–24	40	–1.33	2.50
7N/12W–27H1	1½ mi, to the NW	1949	114	251	273	–137	–22	–4.89	–1.38
7N/11W–33N1	2½ mi to the E	1951	217	323	289	–106	34	–4.08	2.13
7N/12W–35M*	½ mi, to the N	1948	212	344	–	–132	–	–4.55	–
6N/11W–3E2	3½ mi, to the E	1960	304	345	298	–41	47	–2.41	2.94
6N/11W–6G2	1¼ mi, to the E	1967	283	331	343	–48	–12	–4.80	–0.75
6N/11W–11M1	4½ mi, to the SE	1960	307	341	307	–34	34	–2.00	2.13
6N/11W–16J1	4 mi, to the SE	1964	320	346	320	–26	26	–2.00	1.63
6N/12W–7A1	3½ mi, to the W	1955	286	341	347	–55	–6	–2.50	–0.38

NOTES: * = Period of Record = 1948 to 1987
1) Hydrographs used for the analysis above were prepared by AVEK from USGS data.
2) See location of wells with hydrographs, on Figure 8.

or decline between 1977 and 1993) that are illustrated for each respective well on Figure 8.

Table 1 data clearly show the following historic water level trends in the region:

- A general water level decline trend which has occurred in nearly all wells over their entire data base record.

- The decline trend is most noticeable during the earlier part of the data record; that is, from the initial year of data to about 1977 (see column 7 on Table 1). In that column, total water level declines ranged from about 17 ft (in wells 7N/11W-5L1 and 7N/11W-21E1) to 142 ft (well 7N/11W-27Q1). The average amount of total water level decline for the 18 wells on Table 1 from the first year of data to about 1977 is approximately 61 ft.

- The annual rates of water level decline between the initial year of data to about 1977 are seen to range from one or two feet per year (ft/yr) to about 6 ft/yr (column 9, Table 1). These data translate to an average rate of annual water level decline in this period for the 18 wells of about 3 ft/yr.

- Superimposed on this long-term record are the water level data from about 1977 to at least 1993. During this period, Table 1 data reveal that both the total amount and rate of water level change has either slowed dramatically or has even been reversed so that water levels have been rising instead of continuing to decline in this more recent time period.

- Hence, during the 1977 to 1993 period, column 8 on Table 1, shows that 9 of the 17 wells having requisite data (7N/12W-35M1 data end in 1987) display a rising water level trend while the remaining 8 wells with requisite data to 1993 show a continuing water level declining trend.

- However, the final column in Table 1 clearly notes that of the 17 wells with requisite data, only one (7N/11W-21E1) displays a greater annual water level decline rate in the 1977 to 1993 period (2.06 ft/yr; column 10) than it did for the period of its initial data to

1977 (1.21 ft/yr of decline; column 9). The remaining 16 wells all displayed reduced rates of annual decline in the latter period or completely reversed trends.

- The factors creating the observed change or reversal in the water level history since approximately 1977 in the region would include: the change from agricultural land use to residential; the import of AVEK water to the area; and the change in annual precipitation, and hence recharge, over the years. The relative degree of impact of each of these factors is not known.

To further document the aforedescribed rises in groundwater levels in wells in the Antelope Valley in recent years, discussions were held with Mr. Larry Rottman of Rottman Drilling Company of Lancaster (this company has been constructing water wells in the region since 1928). Mr. Rottman, through Harrison Price Company provided us with water level data for 28 wells drilled in various locations in the greater Palmdale-Lancaster area.

Those data, which are provided on Table B-1 in Appendix B - Additional Water Level Data - provide the approximate location of the specific well, the data and water level measurement from the earliest monitoring of the well, and the date and water level measurement from the most recently available monitoring of the well. Computation by others using those data are provided in the final three columns of Table B1 and include the total period over which the data were monitored, the amount of rise or decline in the water level over that period, and the annual rate of water level rise or decline during that period of measurement.

Of the 28 wells on Table B-1, only 7 display a water level decline during their particular period of data record, while the remaining 21 wells show a water level rise. Annual rates of water level decline are seen to range from about 10 ft/yr to about 0.1 ft/yr for the data record of these wells. Annual rates of water level

rises range from 0.3 ft/yr to 22.5 ft/yr for the specific years of record of those wells (see final column on Table B-1).

Rainfall and General Recharge Conditions. We have reviewed annual rainfall records for the Palmdale area (gage No. 046624, as available from the Western Regional Climate Center in Reno, Nevada), in order to compare historic water levels with historic rainfall. Available data are shown on Figure 9.1 – Bar Chart of Annual Rainfall – and represent the period of record of calendar years of 1931 through 1993. Record rainfall low and high years are 1985 (1.35 inches) and 1943 (18.87 inches). The average calculated annual rainfall for this period of record is 7.79 inches.

Historic rainfall has also been evaluated using the accumulated departure method as seen on Figure 9.2 – Accumulated Departure Curve for Rainfall. This curve was developed by calculating the amount of departure that each year of rainfall has displayed, beginning in 1931, relative to the long-term average of 7.79 inches. The percentage of departure that each year's rainfall is to the long-term average is then algebraically added to the accumulated total from the successive prior year of rainfall to develop the accumulative departure from the long-term average graph seen on Figure 9.2

Periods of excess precipitation, that is, a series of years during which the accumulative rainfall was generally above the average, are represented on Figure 9.2 by those portions of the graph that slope upward to the right. Hence, the periods of 1935 to 1946 and 1977 to 1983 represent periods of excess rainfall (and related recharge) to the valley.

In contrast, periods of deficient rainfall (a series of successive years during which the accumulative rainfall was less than the long-term average) are marked by the years 1946 to 1977 and 1983 to 1990. It is noteworthy that the

Figure 9.1 - Bar Chart of Annual Rainfall

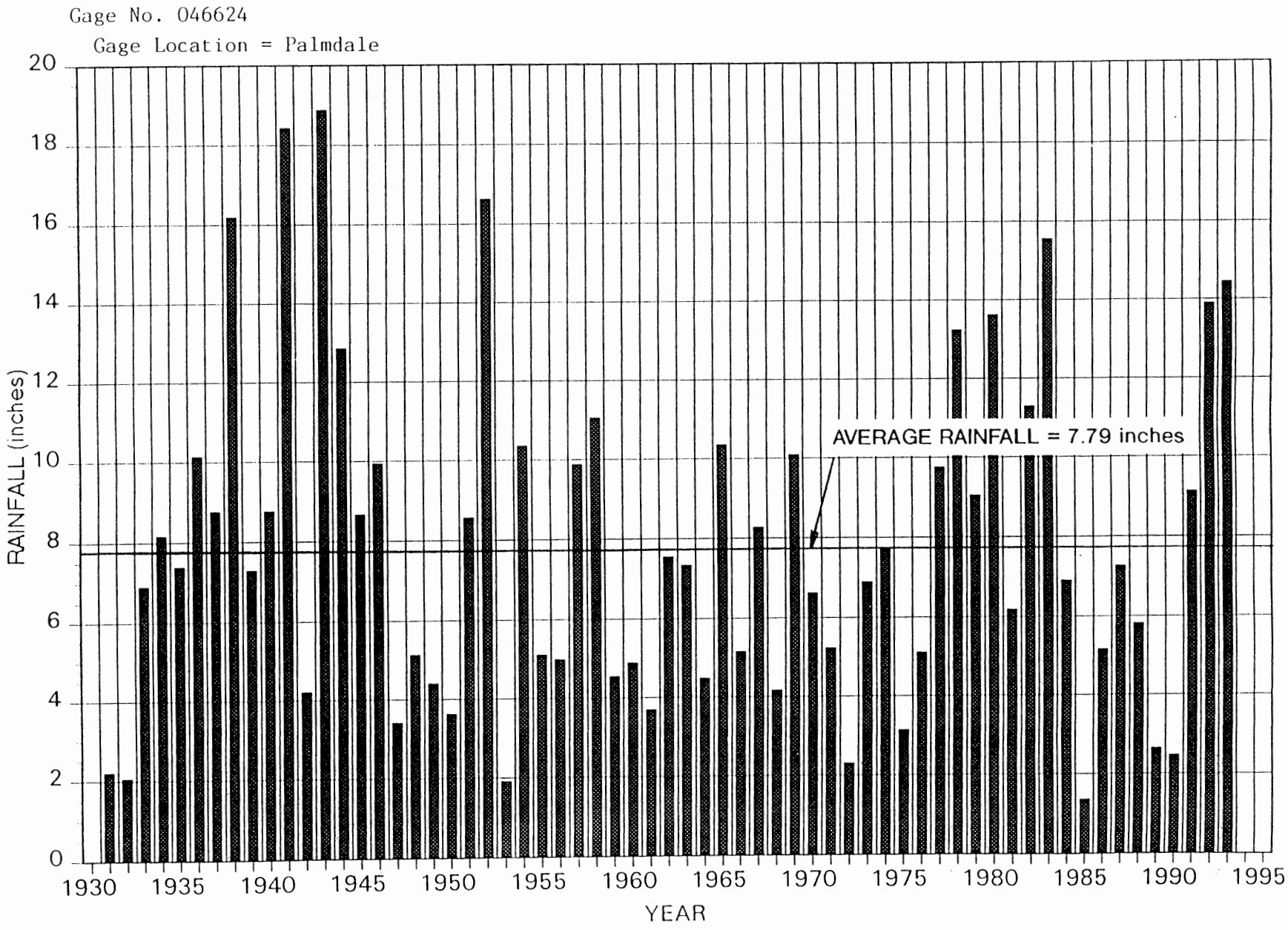
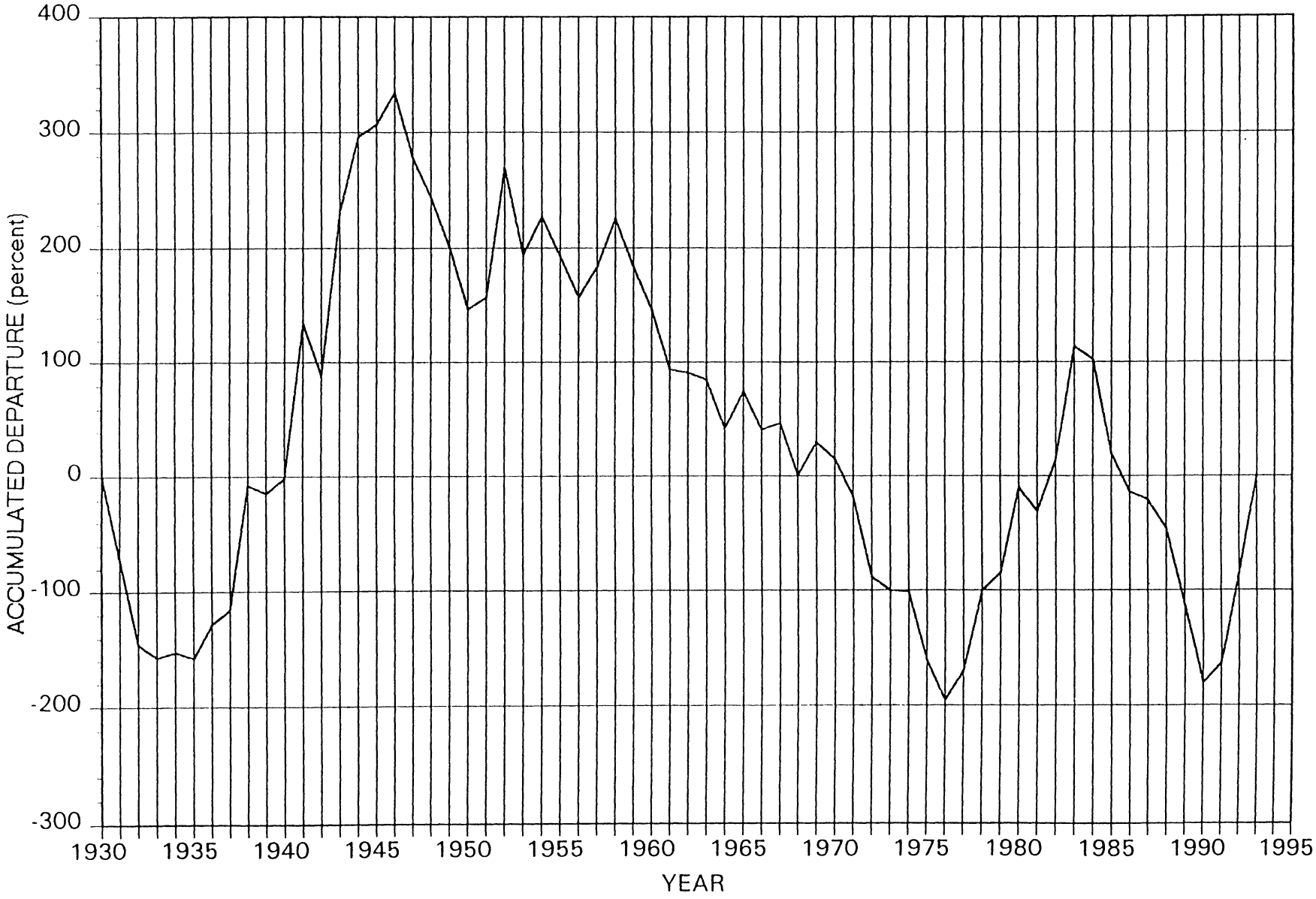


Figure 9.2 - Accumulated Departure Curve for Rainfall



Gage No. 046624, Pamdale

long-term water level decline trend in regional wells became reduced and/or was reversed in 1977. The long-term period of deficient precipitation between 1946 and 1977 has apparently had a major role in affecting basin-wide water levels.

Aquifer Characteristics. The yield of wells tapping the upper alluvial aquifer is reported to range from about 300 gpm (DWR, 1966) to as much as 4000 gpm (DWR, 1964), depending on the number and thickness of gravel and sand lenses penetrated in the borehole. For the most part, these data are for wells pumping only from the upper aquifer system. Table 2 – Summary of Key Data, Proximal Water Wells – summarizes the original specific capacity data for municipal-supply wells closest to the subject property.

In the vicinity of the upper aquifer system associated with the long-term alluvial fan within the project area, specific capacity tends to be relatively high (values from 30 to as high as 72 gpm/ft ddn) for wells located in the upper and middle fan, proximal to the fan axis. Specific capacity tends to be relatively low (less than 10 or 20 gpm/ft ddn) in marginal areas located in the lower fan.

Simplified calculations of aquifer transmissivity from specific capacity data suggest values of 52,500 to as much as 126,000 gallons per day per foot (gpd/ft) of aquifer for wells in the upper and middle fan proximal to the fan axis. Values of aquifer transmissivity for wells in the marginal lower fan areas may be in the range of less than 17,500 to as much as 35,000 gpd/ft. These data primarily apply to the upper aquifer, but there are a few wells where casing perforation data and lithology suggest that production does occur from the lower aquifer when the section is coarse-grained. Well Nos. 4-45 and 4-55 demonstrate pumping rates up to 2000 and 2400 gpm, respectively, with specific capacity value of 33 and 38 gpm/ft of drawdown, respectively, in lithologic sections where potential aquifer ma-

TABLE 2 – SUMMARY OF KEY DATA, PROXIMAL WATER WELLS

Well No.	Distance to Property (miles)	Direction from Property	Depth to Base of Upper AQ (ft)	Presence of Blue Clay	Depth to Top of Lower AQ (ft)	Approximate Depth to Granite (ft)	Perforation Interval (ft)	Total Length of Perfs. (ft)	"Actual" Length of Perfs. (ft)	From Test Pumping at Time Well Was Drilled					
										Static Level (ft)	Pumping Levels (ft)	Pumping Rates, Q, (gpm)	Specific Capacity (gpm/ft ddn)	Yield Factor (gpm/ft perfs)	Cascading Water
34–6	1½	SW	625	Yes	860	NDE	500–1060	560	480	461	529	1000	15	2	No
4–29	1	W	690	Some	NDE	NDE	350–728	378	378	299	316–360	600–2000	35 to 33	1.5 to 6	Yes
4–44	1½	NW	675	Yes	895	1275*	400–1202	802	552	310	335–358	1800–2000	72 to 63	3 to 6	No
4–45	2½	NE	650	Yes	884	1225*	400–1200	800	680	280	311–340	800–2000	26 to 33	1 to 3	No
4–48	4½	NW	500	Yes	732	1120*	320–1100	780	600	125	143–193	1100–3000	61 to 43	2 to 5	No
4–49	4½	NW	505	Yes	728	1150*	320–1140	820	600	124	155–193	1450–2950	48 to 49	2 to 5	No
4–54	3¼	NE	645	Yes	865	NDE	360–1200	840	600	303	342–368	1600–2400	43 to 37	2 to 4	Yes
Rockwell No.3–North	1¼	E	720	Some	NDE	NDE	500–800	300	300	332	405–450	800–2000	11 to 17	2 to 6	No
Qtz Hill No. 9	4½	NW	490	Not present	Not present	490	295–500 intersp.	105	105	247	263–307	500–1500	31 to 25	10 to 14	Yes
PWD–6A	1½	S	620	Yes	875	1020*	480–1010	530	530	460	600	800	6	1.5	Yes

NOTES:
1) NDE = not deep enough
2) Actual length of perforated interval equals total length of perforations minus footage of special perforations, if any, placed in blue clay unit.
3) Wells 4–29 and Rockwell well extract solely from upper aquifer.
4) * indicates depths are estimated based on electric log correlations with deeper wells.

terials also occur in the lower aquifer, at depths below surface of roughly 1050 to 1210 ft.

Summaries of key aquifer characteristics for wells near the property are provided on Table 2. Shown thereon are the casing perforation depth zones in these wells, the total length of perforations, and the "actual" length of perforations; key information generated on water levels, pumping rates, and calculated specific capacities at the time the particular well was drilled are also listed on Table 2.

"Actual" length of perforations represents the total length of perforations minus the total footage of special perforations (vertical, mill-slot perforations) that are often installed in the blue clay zone in the well bore to aid the contractor in placing and settling the gravel pack around the casing. Since the blue clay unit does not normally produce groundwater, the length of perforations in this zone is not counted for our subsequent calculations of yield factor (see next to last column in Table 2).

Using data from wells in the region, including information from Table 2 wells, we have calculated representative values of aquifer transmissivity (T) and have assigned a representative value for aquifer storativity (S); these two parameters represent the principal characteristics of aquifers. The representative T value for our report is 95,000 gpd/ft. An S value of 1×10^{-2} has been assigned for our subsequent calculations of mutual water level drawdown in nearby pumping wells.

Another aquifer characteristic calculated herein is yield factor. It represents a measure of the amount of groundwater pumped by a well per lineal foot of perforations in the well casing. Yield factor is calculated by dividing the pumping rate by the actual footage of perforations. In essence, the higher the yield factor, the more permeable are the sediments in the wellbore, and the more groundwater they will produce for each foot of perforations.

Yield factors, as seen on Table 2, range between 1.5 to 6 gallons per minute per foot of perforations (gpm/ft perfs). Most values, however, are in the range of 2 to 5 gpm/ft perfs. Such data are used as a tool to assess the total footage of perforations required in a new well in order to obtain the pumping rate desired from the well.

Theoretical Drawdown Interference. To assess the magnitude of the theoretical water level drawdown (*i.e.*, mutual well interference) induced in proximal wells by pumping from one or two future onsite wells, we prepared Figures 10.1 through 10.12 – Theoretical Cone of Depression. These figures illustrate the amount of theoretical water level drawdown induced on offsite wells by pumpage from one or both of the two new onsite wells. For design purposes, we utilized the conservative pumping rate data provided in the April 11, 1994 report by the Water Management Group which assumes that conventional irrigation practices would be used to irrigate the two onsite golf courses. This, then, would require 780.30 AF/yr of groundwater to meet the golf course irrigation demand. Our calculations which follow use this value and not the 611.39 AF/yr irrigation demand that would occur if state-of-the-art irrigation methods were used.

Figures 10.1 through 10.4, and 10.10 through 10.12 provide the size, water level interference values, and areal extent of the cone of depression resulting from one new onsite well (the primary well in the south-central portion of the subject property) that is pumping by itself to meet the irrigation water demands of the two golf courses for the months of January, February, March, April, October, November, and December, respectively. Pumping rates for this single well are those listed for each respective well in Graph 1 for conventional golf course irrigation practices.

To meet the irrigation water demand of the two golf courses during the summer months of May, June, July, August, and September, we have utilized a two-well scenario for the property: the primary well in the south-central area and a secondary or backup well on the east side of the property. Two wells simultaneously pumping to meet the summer demands (seen on Graph 1) will permit each well to pump at one-half the required rate, thus allowing the pumping to be spread out over the property instead of having a single, relatively large pumping center. Hence, Figures 10.5 through 10.9 were prepared to illustrate the size, water level interference values, and areal extent of the cone of depression resulting from two onsite wells, each pumping at one-half the required rate to meet the irrigation demand during the months of May, June, July, August, and September, respectively.

Review of the theoretical cone of depression data presented on Figures 10.1 through 10.12 reveals the following:

A. Low Water Use Months. During the months of January, February, March, April, October, November, and December (Figures 10.1 through 10.4 and 10.10 through 10.12, respectively), water demand to meet the conventional irrigation requirements for the onsite golf courses will require continuous pumping rates of 117 gpm, 261 gpm, 354 gpm, 481 gpm, 363 gpm, 248 gpm, and 154 gpm, respectively (refer also to Graph 1).

   To meet these relatively low pumping demand, only one onsite well will be needed; this well will be the primary well located in the south-central portion of the site (Figure 3 and Figures 10.1 through 10.4, and Figures 10.10 through 10.12 illustrate the location of this primary well). The curves shown on these seven figures for the months of lowest water demand illustrate the size and extent of the resulting cone of depression from this one well.

   The largest theoretical water level interference under "A" drawdown values determine by aquifer model in offsite wells by pumpage from this one onsite well during the months in question are:

- For January (Figure 10.1), 0.27 ft at Site 1-Well 1 and 0.23 ft at LFM-1 and at Site 8-Well 1. All other drawdown interference amounts, on all other offsite wells illustrated in these figures are less.

- For February (Figure 10.2), 0.37 ft at Site 1-Well 1 and 0.31 ft at LFM-1 and at Site 8-Well 1. All other drawdown interference amounts on all other offsite wells are less.

- For March (Figure 10.3), 0.53 ft at Site 1-Well, and 0.45 ft at LFM-1 and at Site 8-Well 1. All other drawdown interference amounts on all other offsite wells are less.

- For April (Figure 10.4), 0.71 ft at Site 1-Well, and 0.60 ft at LFM-1 and at Site 8-Well 1. All other drawdown interference amounts on all other offsite wells are less.

- For October (Figure 10.10), 0.55 ft at Site 1-Well, and 0.46 ft at LFM-1 and at Site 8-Well 1. All other drawdown interference amounts on all other offsite wells are less.

- For November (Figure 10.11), 0.37 ft at Site 1-Well, and 0.31 ft at LFM-1 and at Site 8-Well 1. All other drawdown interference amounts on all other offsite wells are less.

- For December (Figure 10.12), 0.23 ft at Site 1-Well, and 0.23 ft at LFM-1 and at Site 8-Well 1. All other drawdown interference amounts on all other offsite wells are less.

B. Moderate Water Use Months. During the months of May, June, July, August, and September (Figures 10.5 through 10.9, respectively), water demand to meet conventional irrigation requirements for the golf courses will require continuous pumping rates of 691 gpm, 775 gpm, 885 gpm, 749 gpm, and 651 gpm, respectively (refer also to Graph 1).

To meet these somewhat higher extraction rates, only one new onsite well would be needed. However, for reasons stated previously two new wells will be assumed: the primary wells and a secondary (backup) well located in the eastern portion of the site (see locations of these two wells on Figure 3 and on Figures 10.5 through 10.9) The curves shown on these five figures illustrate the size and extent of the resulting cones of depression from simultanous

pumpage from the two new wells. Each well is assumed to be producing at one-half of the total rate required for the summer month in question.

The largest theoretical water level interference drawdown values determined by aquifer model in offsite wells by simultaneous pumpage from these two onsite wells during the months in question are:

- For May (Figure 10.5), 1.5 ft at Site 1-Well 1, 0.90 ft at Site 2-Well 1, and 0.95 ft at LFM-1. All other drawdown interference amounts on all other offsite wells are less.

- For June (Figure 10.6), 1.75 ft at Site 1-Well 1, 0.99 ft at Site 2-Well 1, and 0.95 ft at LFM-1. All other drawdown interference amounts on all other offsite wells are less.

- For July (Figure 10.7), 2.03 ft at Site 1-Well 1, 1.16 ft at Site 2-Well 1, and 1.11 ft at LFM-1. All other drawdown interference amounts on all other offsite wells are less.

- For August (Figure 10.8), 1.72 ft at Site 1-Well 1, 0.98 ft at Site 2-Well 1, and 0.94 ft at LFM-1. All other drawdown interference amounts on all other offsite wells are less.

- For September (Figure 10.9), 1.47 ft at Site 1-Well 1, 0.83 ft at Site 2-Well 1, and 0.79 ft at LFM-1. All other drawdown interference amounts on all other offsite wells are less.

It is important to note that interference drawdown values discussed above and shown on Figures 10.1 through 10.12 are <u>not</u> additive throughout the year. For each month, the theoretical drawdown values are based on pumping rates and pumping durations. Because the pumping durations for each month vary so little (only from 28 days to 31 days for the various months), the biggest factor is the pumping rates for the various months. In low water use months, like January, there is little, if any, interference drawdown. But even in the largest water use month of July, interference drawdowns can be recognized as being substantially smaller than the amount of actual water level drawdown created in the respective

well by its own groundwater pumpage. Moreover, once the peak pumpage of July is completed, the amount of interference drawdown in offsite wells will be reduced because pumping for the remainder of the year are all lower than that in July.

Data presented on these figures were developed using our assigned values of: representative aquifer transmissivity, T, and of representative aquifer storativity, S (based on evaluation of the possible water table occurrence for groundwater in the upper aquifer system and of the known confined occurrence of groundwater in the lower aquifer system). The selected values for our calculations were T = 95,000 gpd/ft and S = 1×10^{-2}. These aquifer values, together with the assigned pumping rates and pumping durations, were then input into an analytical groundwater computer modeling program known as AqModel. This model then calculates, for the twelve monthly pumping scenarios, the theoretical resulting amount of water level drawdown (*i.e.*, the cone of water level depression) surrounding the one or two pumping wells that we are recommending to be constructed on the subject property. Locations and known ownerships for the proximal wells considered in our assessment are shown on Figure 3 and on Figures 10.1 through 10.12. These latter 12 figures show the location and extent of the theoretical cones of depression surrounding the one or two onsite pumping wells under the 12 separate monthly pumping scenarios (monthly pumping requirements were adapted directly from Graph 1 herein).

Key assumptions for AqModel and its theoretical formulae include: the aquifer is homogeneous, isotropic, and of infinite areal extent; there is no recharge to the aquifer during the pumping periods; and all wells being evaluated fully penetrate the aquifer systems present.

RECENT INJECTION TESTING

Near the intersection of Avenue K-8 and Division Street in Lancaster, LA County Waterworks operates a facility with a few reservoirs and several water wells, a few of which are still active. At the request of County Waterworks, the U. S. Geological Survey, conducted recharge tests in two wells there during April and May 1994. For these recent injection tests, the U.S.G.S. utilized wells 4-8 and 4-42 (see test location on Figure 3). The source of water for injection into the two wells was treated water from AVEK, via the State Water Project.

Based on a few field and office conversations with Mr. Devin Galloway, Hydrologist, with the Water Resources Division of the U.S.G.S., basic information on the injection testing includes:

Well 4-8: This test was begun in April 1994 and included an average injection rate of approximately 650 gpm over a continuous period of approximately 12 days. During this period, the water was only a small amount of backpressure on the pipeline system so that the injection did not occur strictly by the "free-fall" method. A relatively large recharge mound was created at Well 4-8; this mound may have risen to as high as only 50 ft below ground surface (the original, pre-test non-pumping water level at the well was at a depth of about 300 ft). At the end of the injection test, the radius of water level influence (the zone of recharge effects) may have extended to about 2000 ft from Well 4-8.

Apparently, during the injection at Well 4-8, two other County wells (possibly 4-32 and 4-34) were inadvertently pumped for a while; these wells lie about one-half mile west of Well 4-8. Reportedly, the 650 gpm injection rate may be the maximum for this well due to its age and to partial plugging of its casing perforations.

Well 4-42: This test was performed in May 1994 and included an average injection rate of approximately 1400 gpm over a continuous period of approximately 14 days. Injection was performed simply by the free-fall method. The resulting groundwater mound may have risen to as high as 70 to 90 ft below ground surface at this well (the pre-test static level was at a depth of about 300 ft). At the end of this injection test, the radius of recharge influence on local water levels may have extended outward a distance of about 2000 ft around Well 4-42.

No other County wells were known to be pumping in the region during this test. Reportedly, the 1400 gpm injection rate may not be the maximum capability of this well for injection.

WATER QUALITY

Groundwater quality for the vicinity of the subject property is considered to be acceptable for all beneficial uses, There are no known nearby sources of contamination by petroleum hydrocarbons or by volatile organic compounds which would otherwise be considered a potential problem to the development of onsite groundwater.

Typical values for total dissolved solids (TDS) are on the order of 200 to 250 milligrams per liter (mg/l; same as parts per million), while total hardness is on the order of 125 mg/l. The groundwater is considered to have a calcium bicarbonate character. This quality information is considered representative of the upper aquifer system. There are no independent quality data solely for the lower aquifer system since no wells are known to contain perforation only in this deeper zone.

Moreover, there are no known water quality problems in nearby wells associated with high levels of inorganic constituents like nitrate, iron or manganese,

which might otherwise require water treatment. Bicarbonate in the groundwater may, in time, induce precipitates or scale to form on the casing perforations; such scale may also occur in any irrigation drip systems (particularly on the emitters) that might be used for onsite irrigation in the future.

CONCLUSIONS AND RECOMMENDATIONS

Based on our review of limited data from unpublished and published literature and from available information regarding proximal wells, the following conclusions and recommendations are provided.

1. It is considered hydrogeologically feasible to drill new water wells and to develop an onsite groundwater supply to meet the annual irrigation requirements of the proposed golf courses on the subject property. Two new wells are recommended to meet this irrigation demand. Each well, pumping on its own, will be capable of meeting this demand, but two wells will provide more system reliability and flexibility and will allow for groundwater production at two sites during the five months of peak production. Hence, the use of two wells during these months will not concentrate onsite groundwater production at one location on the property.

2. Water-bearing units exposed at ground surface on the property consist of older and younger alluvium. The younger alluvium is above the water table, so that the older alluvium constitutes the principal aquifer. The older alluvium consists of a wide-spread coarse-grained upper unit ("upper aquifer"), a middle clay/silt unit ("blue clay"), and a lower sandy unit ("lower aquifer"). The depths to and thickness of these units have been defined at the subject property.

3. Two well sites are recommended, as shown on Figure 3. Both wells will produce from the upper and lower aquifer systems, with some small contribution possibly from potential coarse-grained zones in the underlying "blue clay." Because the wells will be deep, they can be expected to produce from the lower aquifer with some contribution from weathered bedrock. Sites have been selected to optimize local hydrogeologic conditions, to minimize the potential for drawdown interference with existing offsite wells, to provide for sites in areas where the groundwater is needed, and to not create a problem for future onsite construction development.

   There is no information available which identifies the groundwater production capability solely from the lower aquifer system. Most existing wells in the region produce from the upper aquifer system.

4. The first (principal) well site should be drilled, completed with casing, and tested for pumping capabilities and water quality before proceeding with pilot hole drilling at the secondary site. Data obtained from the first well site may be useful in modifying anticipated well parameters and/or casing design for the second site. The principal site lies in the southern portion of the property near the main golf course (see hachured area on Figure 3). The secondary well site was selected in the eastern portion of the property (as seen on Figure 3). Hydrogeologic Section A-A' shows the approximate location of these wells in cross section view and indicates the subsurface conditions anticipated at each drill site.

5. Parameters for the new test wells include:

   a. Pilot hole depths to test the lower aquifer are estimated at 1100 to 1200 ft; pilot hole depths for well(s) to test the upper aquifer are estimated at 650 to 750 ft.

   b. Estimated sustainable pumping rates for each of the new deep wells are on the order of 1000 to 1250 gpm, depending on the depth to weathered bedrock and the number, thickness and quality of porous and permeable sand units encountered, and on the eventual depth to nonwater-bearing crystalline bedrock.

   c. Specific capacities of about 30 to 45 gpm/ft of drawdown are estimated for the wells.

   d. A preliminary estimate at this time for the uppermost perforations is on the order of 425 ft below ground surface, to minimize the potential for future cascading water conditions.

   e. A yield factor of 4 gpm/ft of perforations is considered representative for the well design.

   f. The well in the southern portion of the property should serve as the principal water well for the golf course. We recommend that this well, by itself, be used to meet golf course irrigation requirements in January, February, March, April, October, November, and December of each year. The slightly higher water demand during the months of May through September can readily be met by simulta-

neously pumping both new wells, with production from each well being at one-half of the required demand rate.

g. The well in the eastern portion of the property will serve as the secondary or backup well, and can be available also for emergency and standby use during any down-time on the principal well.

h. Water quality from the new wells is likely to have a calcium bicarbonate character, and its individual constituents are expected to meet State standards for the intended use.

6. The subject property lies on the southerly edge of the Lancaster pumping center, one of two such pumping centers in the regional study area in the Lancaster Subbasin. By providing for two new wells on the property, groundwater production from the property will not be concentrated at a single location having a high pumping rate that is continued without interruption over a long period of time, Instead, two wells are to be used that will spread out the groundwater extractions farther across the property, with each well having a lower production rate.

7. Theoretical drawdown interference with known proximal offsite wells has been determined using the conservative (higher) value of 780.30 AF/yr for the annual groundwater demand for golf course irrigation (assume conventional irrigation practices) and not the lower 611.39 AF/yr value which assumes state-of-the-art irrigation practices will be used.

   Our calculations were performed for each of the twelve months per year and illustrate the amount of drawdown created in known offsite wells by pumpage from the new onsite well(s). Because irrigation demand is highest in the period of May through September, both wells are to be used. In the peak month of July (total of 855 gpm is required), maximum theoretical drawdowns in the nearest offsite wells are: 2.03 ft at Site 1-Well 1, 1.16 ft at Site 2-Well 1, and 1.11 ft at LFM-1. All other resulting drawdowns in all other offsite wells, regardless of the month of the year, are less. These theoretical drawdown values are not cumulative from one month to another. These theoretical drawdown interference values are recognized as being considerably less than the actual amount of drawdown created in each of the offsite wells by virtue of its own pumpage by each respective well owner.

Golf course irrigation will begin at the inception of the first phase of project development. There are no present sources for reclaimed water or other non-potable water in the valley.

8. Long-term, continuous water level hydrographs for 18 wells in the region were evaluated for this project. Since approximately 1977, the long-term water level declining trend observed on most of the hydrographs has either diminished or has been reversed completely. Since 1977, nine of the wells have shown a long-term water level rise, while eight have shown a continued decline. The wells displaying the reversed trend tend to be located near recharge areas like major creek channels.

   Wells displaying the continued water level decline trend are more randomly located but do include areas near pumping centers and areas farther from recharge zones. In these wells showing the continued water level decline, the annual rate of decline since 1977 has been significantly less than the annual rate of decline prior to 1977.

9. Between 1946 and 1977, the cumulative rainfall graph indicates a series of years of generally deficient rainfall (and, hence, deficient recharge) to the local groundwater basin. Since 1977, and continuing to 1993, this graph reveals a series of years of generally excess rainfall and recharge. Changes in recharge, coupled with the reduction in agricultural irrigation pumpage and with the import of AVEK water to the region have all combined to create this change in groundwater levels in the region.

10. At present, pumping rights in the Antelope Valley Groundwater Basin, including the Lancaster Subbasin in which the subject property is located, have not been adjudicated. Groundwater extractions for onsite beneficial usage are still permissible.

11. Reportedly, a few lakes will be constructed in and around the golf course. Storage of groundwater in these lakes for subsequent irrigation usage will be important. The larger the amount of storage provided for, the shorter will be the duration of pumping required to maintain lake levels, given a constant pumping rate from the two new wells. Off-peak pumpage at night to refill the lakes may be done to minimize energy costs.

12. Additional recommendations include:

a. For all new wells, ensure that accurate flow meters (both instantaneous rate and totalizer volume meters) are installed on each well.

b. Establish a permanent reference point on all new wells from which future depth-to-water measurements can be taken; use a surveyor to obtain accurate elevations for these reference points.

c. Monitor water levels on a regular basis (at least twice per month); ensure that these are true static levels, not partial recovery levels.

d. Conduct Edison-type efficiency tests on a regular basis in all wells (at least once or twice per year).

e. Plot water level hydrographs and graphs of specific capacity vs time for all wells; monitor water for inorganic and organic constituents on a regular basis.

f. Perform operation and maintenance (O & M) on the wells on a regular basis. Such O & M is essential to maintain well efficiency and to return declining specific capacities to their original values. The wells should be periodically surged in order to prevent clogging of the gravel pack by silt or clay.

13. Advanced Golf Course Irrigation. State-of-the-art, computer-regulated irrigation methods are being applied at various golf courses in southern California. An example of such a system currently being utilized is located at the Ojai Valley Country Club, located in Ojai, California. This system supplies water to vegetation at the golf course only on an as-needed basis. The advantage to using such a system is that the possibility of over watering the playing areas of the golf course is virtually eliminated.

Generally, the operation of such a system consists of the following. Information is obtained, electronically, from an onsite weather station and in-ground soil moisture sensors on the amount of rainfall, amount of evaporations, and the amount of air and soil moisture present at the time of data collection. The weather station continuously monitors local meteorologic conditions with regard to wind speed and direction, air temperature, relative humidity, solar ra-

diation, and rainfall. The in-ground soils moisture sensors monitor the root zone moisture conditions. These data are electronically assimilated and processed to ascertain daily evapotranspiration (ET) requirements of the irrigated vegetation. Based on the electronically calculated ET requirements and root zone moisture conditions, only that amount of water needed to supplement the current ET and root zone moisture requirements is applied to the golf course. In essence, ET values are used to govern the amount of water that is applied to the course.

As previously stated, use of such a system has the advantage of virtually eliminating overwatering vegetation at the golf course. The consequence of this is a drastic reduction in the amount of water used, compared with use by conventional irrigation systems, and therefore, this method will provide a significant savings in costs for water purchased and/or imported into the golf course. In addition, such a system will minimize the pumping demand on the underlying aquifer systems. It is recommended that such a system be utilized to more efficiently manage the local water resources.

Should such a system be incorporated into the design and construction of the new golf courses, then the future golf course irrigation demand for the project should be 611.39 AF/yr (see Graph 2) and not the higher and more conservative demand of 780.30 AF/yr (Graph 1) for conventional irrigation practices that was used herein for our design purposes.

The attachments which complete this report are listed in the Table of Contents.

Respectfully submitted,

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Registered Professional Hydrogeologist

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APPENDIX A

LANDSCAPE IRRIGATION WATER MANAGEMENT CONCEPT

WATER MANAGEMENT GROUP

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Irrigation Master Planning · Water Management · Water Audit · Irrigation Design

Landscape Irrigation Water Management concept description for the Lockheed Palmdale Business Park / Golf Course Project.

1. Water management goals

The goal of landscape irrigation water management is to control and optimize the volume of water consumed and replenished into the soil.

California Assembly Bill AB-325 requires cities and municipalities to adopt the state sample ordinance or develop a Water Efficient Landscape Ordinance in order to manage landscape irrigation water. The City of Palmdale has developed its own water-efficient landscape ordinance which incorporates some elements of the state sample ordinance as well as defined methods to address local water management issues.

Section 14.05.020 of Ordinance # U-992 of the City of Palmdale, Water Efficient Landscape Ordinance, which sets standards for landscape irrigation water management, describes as the intent of the ordinance:

1. to promote the values and benefits of landscaping while recognizing the need to utilize water and other resources as efficiently as possible;
2. to establish a structure for designing, installing, and maintaining water-efficient landscapes in new projects;
3. to establish provisions for water management practices and water-waste prevention for established landscapes; and
4. to implement water conservation policies contained in the City's General Plan.

The Palmdale Golf Course / Business Park Landscape Irrigation Water Management Plan was adopted and based on these principles and practices.

2. Water management practices and the water management process

2.1 General

The ordinance recognizes water management as a vertical process, from the very early planning stage through design, construction, and operation. At each step of the process, variables and factors of water management are identified, defined, and controlled.

By defining the upper and lower limits of the parameters, we are defining the scope of water management as well. The lower limit of the parameters indicates the limits of what water conservation can accomplish. The upper limit indicates the potential in comparison to a scientifically defined optimum.

The process follows the development of the water sources and the irrigation system. At each step of this process, there are opportunities to define and control water management parameters to ensure efficiency levels.

2.2 Planning phase and features

Since the accuracy of a water budget depends on the accuracy of operation, we have developed two different sets of water budgets.

One can be accomplished, but needs sophisticated management and careful maintenance of the irrigation system. The other set is a more conservative budget, which reflects an average consumption under similar climates, based on average water management practices.

Upon approval of the EIR document, as part of the planning phase, a Landscape Irrigation Master Plan and Landscape Irrigation Design Guidelines may be developed. The Irrigation Master Plan is the large-scale physical planning of the equipment and implementation of the water management concepts. The Irrigation Design Guideline establishes the technical design and operation standards for the project.

Planning features:

1. Evaluation of climatic and soil factors

The analysis of the local climatic and soil conditions drives the calculations of project water consumption, and will serve as the base for the planning and the design process. The various historical data bases, publications and the comparison of data from functioning weather stations in the vicinity of the project will be reviewed, in order to establish accurate calculations.

2. Appropriate plant palette selection; Hydrozoning

At the planning phase, a preliminary plant palette is developed. The plant palette takes into consideration both the project concept as well as water consumption goals of the project. It will reflect "Hydrozoning", parameters , required by the local ordinance. Hydrozoning is a term for designing landscape palette by grouping of plant material by water consumption.

3. Preliminary and final Water Budget development; demand and timing of demand.

The goal of establishing a water budget for the project is to project limits of water consumption for planning purposes. At the time of operation, the projected volume of water is expected to be used. The actual water consumption will deviate only by the differences between the historical, assumed values and the actual climatic values at given times.

4. Establishment of serving areas

As part of the irrigation master planning process, the hydrozoned plant material will be further grouped into larger consumption units called "serving areas". A "serving area" is an irrigated area served by one water meter. It serves the purpose of accurate and continuous monitoring of water consumption.

5. Establishment of the pressure conditions and schematic water distribution.

Another feature of the master planning process is establishment of the pressure conditions and the distribution system for the project. The early establishment of pressure conditions will benefit the overall efficiency of the irrigation system and direct the selection of the most efficient and appropriate equipment to match the circumstances.

6. System and equipment

The main feature of the equipment selection at the planning level is to control the the volume and the appropriate distribution of water at the schematic level. The irrigation master plan will incorporate equipment such as low precipitation rate heads, central control, sensors and back indication devices.

2.3 Design phase and features

General

At the design phase, we select and appropriately place both the water distribution and system control equipment. The equipment will be selected to insure performance, and to garantee that the parameters established in the planning process will be met. For example, layout of irrigation heads will met distribution efficiency requirements. When or if reclaimed water will be available, the system will be then able to accept it.

The Palmdale Golf course / Business Park has established a projected water budget based on the various factors described above.

Design features

The following features may be incorporated into the design:

1. Segregation of irrigation systems based on various conditions.

In addition to hydrozoning, there are a number of conditions that require distinguished irrigation treatment of a landscaped area, such as terrain, exposure, soil conditions, etc..

2. Efficient irrigation head layout will define the possible maximum efficiency of the system.

Our goal is to achieve at least 70% overall irrigation efficiency, depending on the type of equipment selected at the time of master planning of the system,

3. Circuiting by hydrozone

The irrigation system design will follow the established hydrozones, based on plant water consumption.

4. Operation sensitive design for actual operation

The type of equipment specified will reflect the actual operational conditions, such as planned water management and maintenance practices as well as personnel. This approach will ensure that equipment specified will be operated in the most efficient manner. As part of the design process we will define the level of sophistication of the operation.

5. Priority irrigation

The design will reflect an established priority of the various irrigated areas, for instance, tees and greens will have higher priority than the landing areas or roughs.

6. Control

The landscape irrigation system control is a critical element of the vertical water management process. A typical centrally controlled system can achieve a higher operation efficiency than individually controlled systems.

7. Irrigation system design for established water budget.

The goal of the design is to specify and locate the type of equipment which is capable of achieving the established water consumption goals.

8. Sensors equipment

The project may employ appropriate back-indication devices, sensors to operate the system as efficiently as possible. The application of sensors, back indication devices may include;

- moisture sensing devices with a combination of irrigation scheduling, optimizing the vole of water neccesary to keep plant material in healthy condition with minimal water use
- rain sensing, a device to turn all systems off in case of rain.
- a weather station which makes the programming of the central controller more accurate by utilizing local and current data instead of historical or regional data from a different location.
- safety features, such as flow sensors, break indicators in the pipe, can also be important parts of the water conservation effort. Maintenance and safety features such as leak detection aree also vital.
- horticultural aspects of design such as employing automated fertilizer injection by enhancing the overall health of the plant material and optimizing water use.
- safety shut of valves and break indicators
- manual, automatic resetting
- Pumping system selection (vartiable speed, energy saving, optimizing computer program)

2.4 Installation phase and features

During the construction phase, after installation, these variables are checked for compliance with the process. After installation and prior to planting, a water audit is performed to confirm the design and system efficiency parameters, and to establish base values for actual optimum operation.

It is critical to install irrigation equipment in accordance with design, to ensure that the design criteria is implemented. Accurate installation is the basis for accurate control of the system. in addition to general quality of the system. Accurate placement of irrigation heads is especially important.

2.5 Initial operation and maintenance phase and features

Finally, after the completion of the system, the parameters that guided the planning and design process will ensure that the system will perform as it was planned. A water management and maintenance manual which describes how to set up and run the irrigation system may be developed. Some of the important features of effcient operation may include:

1. Accurate programming of the controller and at least weekly, adjustment responding to changing climatic and soil conditions. Central controller features such as "cycle and soak" which, by incorporating pauses into the programming for the water to infiltrate into the soil, prevent run off.

2. Local data base development may enhance accurate scheduling since data based on local scheduling data makes the system more responsive.

3. A final and continuous water audit will keep the irrigation system highly efficient.

4. Horticultural manual

Since the plant material is a living entity, a horticultural manual will help to respond, or adjust to changes accuring in the plant's life cycle.

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1. Water management goals

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2.4 Installation phase and features

2.5 Initial operation and maintenance phase and features

APPENDIX B

ADDITIONAL WATER LEVEL DATA

Table B-1

Water Level in Twenty Eight Antelope Valley Wells

Approximate Location	Yr. First Measured	SWL (Ft.)	Yr. Last Measured	SWL (Ft.)	Period (Yrs.)	SWL +/-	SWL +/- Per Yr.
70th East & F	1982	155	1984	110	2	45	22.5
113th East & I	1981	415	1991	330	10	85	8.5
110th East & I	1981	419	1991	347	10	72	7.2
115th East & I-8	1981	411	1991	341	10	70	7.0
113th East &H-8	1981	406	1991	337	10	69	6.9
118th East & I-4	1981	409	1991	341	10	68	6.8
118th East & H-12	1981	395	1991	330	10	65	6.5
45th East & L-2	1981	360	1993	293	12	67	5.6
Division & G-6	1980	125	1991	65	11	60	5.5
70th West & H-8	1963	210	1984	100	21	110	5.2
45th East & L-8	1981	365	1993	307	12	58	4.8
45th East & M	1981	357	1993	304	12	53	4.4
93rd West & H/I-8	1973	255	1991	215	18	40	2.2
15th East & I	1968	115	1975	100	7	15	2.1
27th East & I-8/K	1963	278	1988	248	25	30	1.2
50th East & F	1962	145	1989	120	27	25	0.9
10th West & M	1983	375	1993	367	10	8	0.8
30th East & K	1961	270	1989	250	28	20	0.7
50th West & J-14 *	1973	241	1991	231	18	10	0.6
25th East & K-8	1969	290	1989	280	20	10	0.5
50th East & I	1953	195	1971	190	18	5	0.3
50th West & I *	1957	150	1991	153	34	-3	-0.1
Division & H-8 *	1958	160	1988	168	30	-8	-0.3
27th West & I/H-8	1959	107	1988	125	29	-18	-0.6
Division & K-8 *	1969	259	1988	300	19	-41	-2.2
17th West & K-8	1955	160	1992	270	37	-110	-3.0
10th East & P	1955	305	1991	500	36	-195	-5.4
10th West & P	1988	461	1991	491	3	-30	-10.0
Averages:							
Total Sample		289		267	18	21	2.9
1980's Only		358		305	9	53	5.9

Notes:

* Denotes Clustered Wells.

Median Value of Array Is Shaded.

SOURCE: Rottman Drilling Company, and Harrison Price Company

APPENDIX C

GLOSSARY OF GEOLOGIC AND HYDROGEOLOGIC TERMS

GLOSSARY OF GEOLOGIC AND HYDROGEOLOGIC TERMS

Acre-Foot: The volume of water required to cover one acre of land to a depth of one foot (43,560 cubic feet or approximately 325,850 gallons).

Adjudicate: To determine in a court of law.

Air Drilling: A relatively rapid method of rotary drilling, particularly in hard rocks, where high volumes of air are used as the circulating medium to remove cuttings from the borehole.

Airline Gage: A small diameter plastic or copper tubing installed below the water level in a well between the pump column and the well casing, for the purpose of measuring the approximate depth to either the static water level or the pumping water level in the well.

Alluvial fan: A sloping, spreading mass of gravel and sand deposited by a stream as it issues from a narrow mountain valley.

Alluvium: General term for clay, silt, sand, gravel, or similar unconsolidated detrital material deposited by running water in the streambed or floodplain; may contain groundwater in the void spaces between the sedimentary grains.

Andesite: A medium-colored volcanic rock containing a high proportion of feldspar; may contain groundwater in fractures and joints.

Annular Space: The space between the well casing and the rough well bore or the space between two casings of different diameters.

Anticline: A fold in rocks in which the strata dip in opposite directions from a common ridge or axis; a fold that is convex upward.

Applied Water: Water delivered to an individual's urban meter (does not include direct precipitation).

Aqueduct: An artificial channel for conducting water from one place to another.

Aquifer: A geologic formation or zone sufficiently permeable to transmit and yield an appreciable supply of water to wells; a water-bearing layer, generally of sand and gravel.

Aquifer Test (Pumping Test): A test generally involving the withdrawal of measured quantities of water from a well (*i*.e., a constant pumping test rate) while simultaneously monitoring the change in water levels in the well during both the drawdown (pumping) period and the subsequent recovery (non pumping) period.

Aquitard/Aquiclude: A geologic formation or zone which, although porous and capable of absorbing water slowly, will not transmit it rapidly enough to furnish an appreciable supply for wells; a zone with poor flow permeability, such as clay.

Area of Influence: The area beneath which groundwater or pressure surface contours are modified by pumping. The area influenced by the drawdown curve of a pumping well at a particular time; also known as the radius or zone of influence.

Attitude: Used to describe the oorientation of a directional planar feature in a rock relative to a horizontal plane. See dip and strike.

Basalt: A dark gray or black volcanic rock, very fine-grained and often with gas bubbles or vesicles; may contain groundwater in fractures and joints.

Base Flow: Stream discharge derived from effluent (rising) groundwater seepage.

Base Period: A time period chosen for detailed hydrologic analysis during which prevailing conditions of water supply and climate were approximately equal to mean conditions, and where adequate data were available.

Basement Complex: A series of undifferentiated rocks generally with complex structure beneath the dominantly sedimentary rocks in an area. Basement rocks generally are igneous or metamorphic in character; and typically are considered as nonwater-bearing, or nearly so.

Bed: The smallest division of a stratified series of geologic materials; a thin layer or stratum of sedimentary materials.

Breccia: Volcanic rock consisting of broken fragments ejected from a volcano, cemented together with lava or volcanic ash.

Cable Tool Drilling: The oldest method of drilling; also called percussion drilling. Equipment operates by repeatedly lifting and dropping a heavy string of drilling tools into the borehole; drill bit breaks/crushes the rocks and when water is present, a slurry forms in the bottom of the borehole. Slurry is removed by a bailer or sand pump, and additional casing is driven into the hole. A Mills-knife tool is later inserted by hydraulically cut perforations into the casing after it has been driven.

Caliche: A hard, crusty, whitish rock that accumulates in place as calcium carbonate and other minerals that are precipitated in pore spaces in gravel, especially in arid regions; calcareous materials commonly found in layers on or near the surface of stony soils of arid and semi-arid regions.

Capillary Fringe: The partly saturated zone immediately above the water table in which water is held above the water table by capillary forces.

Cementing: The process of placing a cement slurry in the annular space in a well to provide a seal against shallow subsurface waters of poor quality.

Change in Storage: The amount of available water extracted from or added to the zone of saturation.

Character of Water: A classification of water based on determination of the predominant anions and cations in equivalents per million (epm). Specifically, the name of an ion is used where its chemical equivalent constitutes one-half or more of the total ions for its appropriate group. For example, sodium chloride water is water in which the sodium is equal to or greater than 50 percent of the cations; sodium calcium-chloride water is water in which the sodium is more abundant than the calcium, but is less than 50 percent of the total cations; and sodium chloride-sulfate water is water in which chloride exceeds sulfate but is less than 50 percent of the total anions.

Cienega: A marshy area where the ground is wet from seepage or springs.

Clay: A very fine-grained pasty sediment, plastic when wet, consolidating into claystone or shale.

Confined Groundwater: A body of groundwater overlain by material sufficiently impervious to sever free hydraulic connection with overlying groundwater except at the recharge area. Confined groundwater moves in conduits under pressure due to the difference in head between the intake and discharge areas of the confined water body.

Conformable: Parallel strata or beds lying one above another in unbroken order are said to be conformable.

Connate Water: Water entrapped in the interstices (pore spaces) of a sedimentary rock at the time it was deposited. This water may be fresh, brackish, or saline in character.

Consumptive Use: The amount of water used by the vegetative growth of a given area in transpiration or building of plant tissue and evaporated from the adjacent soil. It also includes the evaporation of precipitation intercepted by vegetative growth or impervious areas, and the water evaporated in industrial processes or household uses. Evaporation and transpiration from land areas only, excluding evaporation from lakes and reservoirs.

Contact: The plane or surface where two different kinds of rocks come together; also known as the geologic contact.

Contamination: Defined in the California Water Code: "An impairment of the quality of the waters of the State by sewage or industrial waste to a degree which creates an actual hazard to public health through poisoning or through the spread of disease."

Culture (Land Use): The land use or land cover existing under natural conditions or as modified by man.

Deep Percolation: The moisture which penetrates below the depths from which it may be used by plants; it represents that part of the water absorbed which exceeds the field capacity of the soil within the depth of root development.

Degradation: Impairment of the quality of water due to causes other than disposal of sewage and industrial waste.

Direct Rotary Drilling: A relatively rapid drilling method, whereby the borehole is drilled by rotating a drill bit within a bentonite mud slurry; cuttings are removed by continuous circulation of the drilling fluid as the bit penetrates the formation. Drill fluid is pumped down the drill pipe and out through ports (holes) in the bit; cuttings are lifted to ground surface in the annulus between the drill pipe and the formation walls.

Drainage Basin (Area): An area whose runoff is more or less separate from the runoff for adjacent areas so that it can be considered a distinct hydrologic unit.

Drainage Divide: The boundary line, along a topographic ridge or along a subsurface geologic formation, separating two adjacent drainage basins (areas).

Drawdown: The amount of lowering of the static (non-pumping) water level in a well by pumping; the difference (in feet) between the static and pumping levels in a well.

Driller's Log: A general record of the types of earth materials encountered at various depths during the drilling of a well and as recorded by the driller or his crew.

Drilling Fluid (Mud): A fluid used during direct rotary or reverse circulation drilling processes; the fluid may be either water alone, or water mixed with certain additives like clay (bentonite) and or polymers. Drilling fluids remove cuttings from the borehole, they cool and lubricate the drill bit, and control fluid losses from the borehole to the formation.

Effective Grain Size: The theoretical grain size of a homogeneous material of one grain size that would transmit water at the same rate at the material investigated. It is also defined as the diameter of a grain of such size that ten percent of the material (by weight) consists of smaller grains and 90 percent of larger grains.

Effluent Seepage: Flow from the groundwater to the ground surface.

Electric (Geophysical) Log: An objective record of the electrical resistivity of the earth materials encountered at various depths in a pilot hole/test hole; must be performed in an open hole prior to installing casing. Used to correlate potential aquifers from well to well in a groundwater basin. Extremely useful in assuring a good well design and well construction.

Electric Tape Sounder: A device which measures the depth to water in a well and which consists of an electrode and a graduated wire cable; an engineer's tape is used to interpolate readings between the standard graduations.

Entitlement: A right or claim.

Eolian: Created or acted upon by wind.

Ephemeral: A stream that flows only in direct response to rainfall; it receives little or no water from springs and no long-continued supply from melting snow or other sources. Its channel is always above the water table.

Equivalents per Million (epm): Equivalent weights of solute contained in one million parts by weight of solution. For practical purposes, epm is the same as milli-equivalents per liter.

Evaporation: The process by which water passes from a liquid state to a vapor.

Evapotranspiration: That portion of the precipitation returned to the atmosphere through direct evaporation or by transporation of vegetation.

Export: Water that is piped or channeled out of the drainage area in artificial conduits for use in other areas.

Extraction: The amount of groundwater pumped from the zone of saturation.

Extrusive Rock: Igneous rock that cooled on the surface; also called volcanic rock.

Fault: A break in solid rock along which rocks on either side have moved relative to each other.

Fluvial: Belonging to a river or produced by river action.

Formation: An assemblage of rock masses grouped together into a time unit that is convenient for field mapping or description.

Fossil: Any remains or traces of plants or animals preserved in rock, including hard parts, tracks or trails, and impressions.

Geologic (Mud) Log: A detailed log and description, by geologists, of earth materials (drill cuttings) encountered during the drilling of a pilot or test hole; often includes information on drilling penetration rates, the properties of the drilling fluids, and the size and shape of sands and gravels in major aquifers.

Graben: A block, generally long compared to its width, that has been downthrown along faults relative to the rocks on either side.

Granite: A coarse-grained intrusive igneous rock with feldspar and quartz as the principal minerals; often considered as the basement complex.

Gravel Pack: In well construction, a several-inch thick envelope of generally coarse sand or fine gravel placed in the annular space between the casing and the drilled hole; acts like a filter material to stop formation materials from entering the well through the casing perforations.

Groundwater: That part of the subsurface water in the zone of saturation; occurs in pore spaces between sedimentary grains, or in fractures or joints.

Groundwater Barrier: a body which has low permeability that impedes the horizontal movement of groundwater.

Groundwater Basin: An area underlain by water-bearing sediments capable of storing and yielding a groundwater supply to wells.

Groundwater Divide: A line, on each side of which, the groundwater flows outward in two opposing directions.

Groundwater in Storage: The volume of groundwater, in acre-feet, contained in the interstices (pore spaces) in water-bearing sediments or in the fractures/joints in relatively nonwater-bearing rocks, and as calculated at a particular period of time using a specific set of water levels.

Groundwater Inventory: A detailed estimate of the amount of water added to the groundwater reservoir of a given area (increment) balanced against estimates of amounts extracted from the groundwater reservoir for any selected period of time.

Groundwater Mound: A mound-shaped addition to the groundwater body built up by seepage, percolation, or recharge.

Groundwater Production: Extraction (verb) or amount (noun) of groundwater pumped by wells.

Horst: A block, generally long compared to its width, that has been uplifted along faults relative to the rocks on either side.

Hydraulic Gradient: Under unconfined groundwater conditions, it is the slope of the profile of the water table. Under confined groundwater conditions, it is the slope of the line joining the elevations to which water would rise in wells perforated in a confined aquifer.

Hydrograph: A graphic plot of changes in the flow of water or in elevation of the water level versus time.

Igneous Rocks: Rocks formed by cooling of molten magma; generally considered to be the basement complex.

Import: Water supplied from a source outside the area.

Infiltration: The flow or movement of water through the soil surface into the ground.

Inflow: Water that enters the basin.

Intermittent Stream: A stream which flows part of the time, as after a rainstorm.

Intrusive Rock: Ingeous rock that cools and hardens slowly below the surface.

Isohyetal Line: A contour line on the ground surface along which all points receive the same amount of precipitation.

Joint: A fracture in rock along which no appreciable movement has occurred; can become filled with groundwater.

Lava: Magma that reaches the surface, or rock hardened from it.

Magma: Molten rock in or from the earth's interior.

Member: A subdivision of a formation.

Metamorphic Rocks: Rocks formed from older rocks that have been subjected to great heat and/or pressure or to chemical changes; generally considered as basement complex.

Metasedimentary Rock: Rock altered by heat and pressure but still recognizable as having been sedimentary in origin.

Miners Inches: 1/50 cubic foot per second; approximately 9 gallons per minute (gpm) in southern California and 11.2 gpm in other parts of California.

Monitoring Well: A nonpumping well completed with perforated casing used to monitor water levels and/or to obtain water samples for analysis.

Mud (Fluid) Pit: Drilling fluids are usually mised and stored adjacent to the drilling rig in mud (fluid) pits. Such pits are either excavated into the ground or may be steel tanks situated at ground surface.

Nonwater-Bearing: A term relating to the relative ability of geologic materials to yield water to wells; here, these materials are generally consolidated or cemented sedimentary rocks or crystalline bedrock. Sustained yields are questionable.

Observation Well: A water well or a monitoring well used to obtain water level measurements during an aquifer test.

Outflow: Water that exits or leaves the basin.

Perched Groundwater: Groundwater occurring in the saturated upper zone separated from the main groundwater body by impervious material.

Percolation: The predominantly downward movement of water through the interstices (voids) of a soil or other porous media.

Permeability: The ability of a rock or soil to transmit a fluid. The degree of permeability depends upon the size and shape of the pores, and upon the size, shape, and extent of the pore interconnections. Units are gallons per day per square foot (gpd/ft^2).

Phreatophyte: A plant which customarily feeds on shallow (high) groundwater or the capillary fringe.

Pilot Hole (Test Hole): The initial borehole typically drilled by either direct rotary or reverse circulation rotary methods from which drill cuttings are collected and logged by a geologist or driller and in which an electric log survey typically is performed.

Planimeter: To measure an area.

Porous: Containing voids or pores (interstices).

Precipitation: Discharge of water as rain, snow, hail, or sleet out of the atmosphere.

Pyroclastics: General term applied to detrital volcanic material that was explosively or aerially ejected from a volcanic vent.

Ream (Reaming): The process of inserting a large diameter drill bit into the pilot hole in order to increase the final wellbore diameter to the size necessary to accommodate the well casing and gravel pack.

Recharge: The process of replenishment of the groundwater reservoir through natural or artificial means.

Reverse Circulation (Reverse Rotary) Drilling: Very similar to direct rotary drilling, except here: the drilling fluid tends to be mainly water; fluid circulation is down the annulus between the drill pipe and the formation walls;

cuttings are lifted to ground surface inside the drill pipe; the pilot hole is typically larger in diameter than direct rotary.

Rhyolite: Light-colored silicic volcanic rock containing very small or microscopic crystals of quartz, feldspar, and mica; may contain groundwater within fractures and joints.

Runoff: That portion of surface water flow which flows to stream channels over the surface of the ground.

Saturation, Zone of: The zone below the water table in which all interstices are filled with groundwater.

Sediment: Solid soil/earth materials that have been eroded and transported from their original points of origin by water, ice, or air.

Sedimentary Rocks: Rocks resulting from consolidation of loose sediment that has accumulated in layers; may or may not be considered as water-bearing.

Shale: A fine-grained sedimentary rock formed by consolidation of clay, silt, or mud, characterized by fine stratification so that it breaks into flat sheets; generally nonwater-bearing.

Specific Capacity: The ratio of the pumping rate in a well (in gallons per minute) to the amount of drawdown in that well (in feet) while it is pumping at the particular rate. The ratio is affected by the type of well construction, its development, the type of well casing, and the age and condition of the well and pump.

Specific Conductance: The electrical conductivity (EC) of a water sample at 25°C expressed in micro-ohms per centimeter; to approximate the total dissolved solids content (in mg/l, or ppm) of the water, multiply the EC by about 0.6 to 0.7.

Specific Yield: Percent of the total volume of pore water which can be yielded by the force of gravity.

Spread Water: Native or imported water discharged into spreading basins for the purpose of percolating to the zone of saturation.

Static Level: The distance from ground surface to the water level in a nonpumping well, outside the area of influence of any adjacent pumping well. This level registers one point on the water table in a water table well or one point on the pressure surface in a confined or artesian well.

Storage: Water artificially impounded in surface or underground reservoirs for future use.

Storage Capacity: Generally relates to the theoretical maximum capacity of groundwater, in acre-feet, contained within a groundwater reservoir.

Storativity (Storage Coefficient): The volume of groundwater an aquifer releases from or takes into storage per unit of surface area of the aquifer per unit change in head. Units are cubic feet per square feet per foot.

Stratigraphic Horizon: A single layer or strata within a group of stratified rocks used for description, mapping, etc.

Stratigraphy: Branch of geology dealing with the formation, composition, sequence, and correlation of stratified rocks.

Strike: The direction or bearing of a horizontal line in the plane of an inclined strata.

Subsidence: Lowering of the ground surface due to consolidation of subsurface sediments. One major cause is the overdraft of the groundwater reservoir.

Syncline: A fold in rocks in which the strata dip inward from both sides toward a common axis; a fold that is convex downward.

Total Dissolved Solids (TDS): The dry residue from the dissolved matter in an aliquot of a water sample remaining after evaporating the sample at a definite temperature.

Transmissivity: The characteristic property of the entire saturated portion of an aquifer to transmit water. Also represents the product of the field permeability multiplied by the thickness of the saturated portion of the aquifer being studied. Typically measured in units of gallons per day per vertical foot of aquifer (gpd/ft).

Tuff: A volcanic rock formed of small diameter, compacted volcanic fragments.

Unconfined Groundwater: Groundwater in the zone of saturation not confined beneath an impervious formation and moving under the control of the water table slope.

Unconformity: A surface of erosion or non-deposition separating younger from older strata.

Underflow: Relatively horizontal movement of water through saturated granular material under hydraulic gradients commonly developed underground.

Water Quality: Those physical, chemical, biological, and radiological characteristics of water affecting its suitability for beneficial uses.

Water Spreading: Retention of water behind dams or in basins, maintenance of flow in ditches or stream channels, or feeding water down wells in order to develop influent seepage to the water table for purposes of recharge.

Water Table: The upper surface of the body of free groundwater, where the water completely fills all openings in a granular material.

Water-bearing: Capable of generally producing water in sufficient quantity to yield water to water supply wells; typically comprised by sedimentary materials that are not well consolidated or cemented.

Watershed: The topographic divide separating one drainage basin from another. Also means the entire drainage base or catchment area.

Welded Tuff: Volcanic ash hardened by the original heat of the ash and its gases.

Well Interference: The additional drawdown effects created in a well by pumping from a nearby well.

Well Yield: The volume of water per unit time discharged from a well by pumping. Commonly measured in gallons per minute.

Zone of Aeration: The zone above the groundwater level in which voids are partially filled with air.

Zone of Saturation: The zone below the groundwater level in which voids are completely filled with water.

GEOLOGIC TIME SCALE

RELATIVE TIME			SPECIFIC TIME ESTIMATES
Era	**Period**	**Epoch**	**Years at opening of:**
Cenozoic	Quaternary	Holocene	10 thousand
		Pleistocene	1.6 million
	Tertiary	Pliocene	5.3 million
		Miocene	23.5 million
		Oligocene	36.6 million
		Eocene	57.8 million
		Paleocene	66.4 million
Mesozoic	Cretaceous		144 million
	Jurassic		208 million
	Triassic		245 million
Paleozoic	Permian		286 million
	Pennsylvanian		320 million
	Mississippian		360 million
	Devonian		408 million
	Silurian		438 million
	Ordovician		505 million
	Cambrian		570 million
Pre-Cambrian			3800 million
Origin of the earth			4600 million

Adapted from the Geological Society of America

APPENDIX D

PROFESSIONAL QUALIFICATIONS

RICHARD C. SLADE & ASSOCIATES

CONSULTING GROUNDWATER GEOLOGISTS

STATEMENT OF QUALIFICATIONS

RICHARD C. SLADE

Major fields of hydrogeologic emphasis for Mr. Slade include groundwater resource development (basin-wide studies, and water well design and construction), and groundwater contamination investigations (landfills, volatile organics, gasoline, etc.). Principal projects have involved groundwater resource development, basin evaluation, aquifer test analyses, assessment of water quality problems and groundwater degradation, well design, monitoring of all phases of water well construction, locating and designing groundwater monitoring networks, and providing expert witness testimony for groundwater litigation. Considerable work has also been performed for numerous vineyards and wineries in both the Central Coast and Northern California regions; types of work have included feasibility studies for determining optimum locations for new wells, designing new wells, to monitoring of new wells, working with drilling contractors, and in evaluating down-hole problems (such as sanding) in existing wells.

Hydrogeologic studies have also involved evaluation of hazardous wastes such as acid mine drainage from inactive and proposed open pit mines, leachate from sanitary landfills, and groundwater degradation resulting from leaking underground storage tanks containing various chemicals and organic compounds. Numerous groundwater studies and monitoring projects have involved volatile organics (TCE, PCE, MEK, etc.) and subsurface gasoline spills. Hydrogeologic assessments and definition of appropriate mitigation measures for environmental impact analyses have been provided also. Important to Mr. Slade's broad background is the experience gained while being a participant with other geologists on international geologic study tours to Europe, the Soviet Union, South America, the People's Republic of China, Africa, New Zealand and Australia, and studying local groundwater and surface water features, large faults and landslides, mines, and oil fields in those areas.

Registrations

Registered Professional Hydrogeologist, American Institute of Hydrology (Charter Member)

Registered Geologist, State of California

Certified Engineering Geologist, State of California

Education

University of California at Los Angeles, B.A., Geology, 1966

University of Southern California, M.S., Engineering Geology, 1974

Memberships

National Groundwater Association, Association of Groundwater Scientists
American Water Works Association
California Groundwater Association

Experience

RICHARD C. SLADE & ASSOCIATES, CONSULTING GROUNDWATER GEOLOGISTS. Independent consulting practice established in 1983 to provide technical, professional, and direct personal services to the groundwater industry. Hydrogeologic projects have included assessment of groundwater contamination from gasoline spills, volatile organics, and leachate from sanitary landfills; groundwater resource development; locating and designing water wells; assessing potential degradation resulting from existing sanitary landfills and from proposed open pit mines; conducting water level and water quality monitoring from monitoring networks; defining aquifer characteristics from long-term aquifer tests in active wells; observation and monitoring of water well construction; providing expert witness testimony for hydrogeologic litigation; and providing hydrogeologic elements and mitigation measures for environmental assessments.

GEOTECHNICAL CONSULTANTS, INC., 1970-1983. Joined the firm in 1970 as an engineering geologist and hydrogeologist. Advanced to Associate in 1975. Participated in and supervised geotechnical and hydrogeologic projects of various complexity, from the feasibility level through final design. His investigation and reports have analyzed faults and seismicity, earth materials, and groundwater problems for such facilities as dams, reservoirs, treatment plants, tunnels, industrial and residential buildings, sanitary landfills and groundwater basins. Major experience has involved field mapping, logging of bore holes, monitoring of groundwater observation holes, data analyses, and report writing.

Since 1972, Mr. Slade was the responsible hydrogeologist for several major groundwater basin projects including locating and designing of new wells and well redevelopments, calculations of groundwater in storage, determination of aquifer parameters, and evaluation of dewatering criteria. Several studies utilized emplacement of deep exploratory drill holes, analyses of geologic and geophysical data, and monitoring and analyses of groundwater levels, quality and pollution, and assessment of leachate and gases at existing landfills.

In addition, he conducted and supervised groundwater pollution studies and evaluation of several active and proposed sanitary landfill sites; he has supervised geologic and hydrogeologic studies for the evaluation and abatement of acid mine drainage from a large, inactive sulfur mine; and he has participated in assessing groundwater, geologic, and geotechnical parameters which affect sewer infiltration and inflow.

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA, Los Angeles, 1967-1970. Performed hydrologic and hydrogeologic studies along pipeline and tunnel routes for State Water Project, conducted field mapping and exploration along tunnel routes, conducted and supervised aquifer tests for calculations of dewatering parameters for tunnel routes and dam sites. Served as Resident Geologist in charge of tunnel mapping and tunnel conditions for the Newhall and Castaic tunnels, excavated by tunnel boring machines.

Publications, Papers, and Professional Presentations

Pipkin, B. P., Gisler, P. M., and Slade, R. C., 1969, "Electrical Conductance of Soils Under Stress": paper presented as Association of Engineering Geologists, Twelfth Annual National Meeting, San Francisco.

Misen, R. T., and Slade, R. C., 1973, "Hydrogeology Investigation, Carpinteria Ground Water Basin, California": paper presented at Association of Engineering Geologists, Sixteenth Annual National Meeting, Los Angeles.

Slade, R. C., 1975, "Hydrogeological Investigation of Carpinteria Ground Water Basin, Santa Barbara County, California": unpublished M.S. Thesis, Engineering Geology, University of Southern California.

Slade,R. C., 1975, "Utilization of Subsurface Oil Industry Data in Ground Water Basin Studies--Three Southern California Case Histories": paper presented at National Water Well Association, Technical Division, Annual Meeting, paper presented at New Orleans.

Hill, R. L., Sprotte, E., Bennett, J., and Slade, R., February 1979, "Fault Location and Fault Activity Assessment by Analysis of Historic Level Line Data, Oil Well Data, and Ground Water Data, Hollywood Area, California": abstract published in Tectonophysics, Vol. 52, No. 1-4, Special Issue; paper presented at 1977 International Symposium on Recent Crustal Movements, Stanford University.

Hill, R. L., Sprotte, E. C., Chapman, R. H., Chase, G. W., Bennett, J. H., Real, C. R., Slade, R. C., Borchardt, G., and Weber, F. H., Jr. 1979, Earthquake hazards associated with faults in the greater Los Angeles metropolitan area, Los Angeles County, California, including faults in the Santa Monica-Raymond, Verdugo-Eagle Rock, and Benedict Canyon fault zones: California Division of Mines and Geology Open-File Report 79-16 L.A.

Panelist and Participant, February 1980 and April 1980, Seminar on the Application of Innovative Approaches to Infiltration/Inflow Studies: Seminar sponsored by Camp Dresser McKee, Inc.; provided engineering geologic, hydrogeologic, and geotechnical parameters to I/I studies.

Gardner, D. A., and Slade, R. C., 1981, "Effect of Nitrogen Loading and Irrigation Rate on Amount of Nitrogen Leached to Ground Water, San Martin, South Santa Clara Valley, California": paper presented at 24th Annual Meeting of the Association of Engineering Geologists, Portland, Oregon.

Slade, R. C., 1981, "Hydrogeologic Conditions in the Mission Creek Subbasin, Upper Coachella Valley, California": presented in Guidebook No. 9, Annual Field Trip, Geology of the San Jacinto Mountains; published by South Coast Geological Society.

Slade, R. C., 1981, "Hydrogeology of Carpinteria Ground Water Basin, Santa Barbara County, California": paper submitted for publication in the Guidebook of the Southern California Section of the Association of Engineering Geologists, Annual Field Trip, Ventura-Santa Barbara Area, California.

Slade, R. C., 1982, "Basin-Wide Studies and Thorough Specifications Lead to a Good Well," The Johnson Drillers Journal, pages 13-17, Third-Fourth Quarter 1982.

Runyon, K., Slade, R.C., Leitzell, C. R., and Fall, E. W., 1982, "Red Hill Disposal Site, A Case Study": paper presented at Fifth Annual Madison Conference of Applied Research and Practice on Municipal Industrial Waste: University of Wisconsin-Extension, September 1982.

Speaker and Panelist, March 1984, Groundwater and Wells Symposium: Seminar sponsored by Johnson Screens, Orange, California; provided details of groundwater monitoring, monitoring network design, and groundwater sampling.

Slade, R. C., 1984, "Hydrologic and Geologic Highlights--Past and Present, Northwestern South America": paper presented at Fall Conference, American Water Works Association, October 1984, Reno, Nevada.

Whitten, M. G. and Slade, R. C., 1986, "Some Considerations in Groundwater Monitoring": paper presented at 82nd Annual Meeting, Cordilleran Section, The Geological Society of America, Abstracts with Programs, Los Angeles, March 1986.

Guest Lecturer, March 1988. Toxic and Hazardous Materials Control and Management Certificated Program: University of California at Los Angeles Extension; Groundwater Monitoring, Protection and Cleanup.

Speaker, September 1988. Presented professional talk entitled "Groundwater Resource Development," Paper presented at the Arizona-California-Nevada Water and Pollution Control Association Tri-State Seminar; Laughlin, Nevada.

Slade, R. C., April 1991, "Perspectives on Groundwater Contamination": paper presented at 63rd Annual Conference of California Water Pollution Control Association, Pasadena, California.

Smith, L., Slade, R. C., and Childress, A., May 1993, "Paleochannel Features and Their Possible Influence on Contaminant Migration in Groundwater": paper presented at the AAPG-Pacific Section Annual Conference, Long Beach, California.

Guest Lectures: January, April, and October, 1991, "Design, Sampling and Monitoring of Monitoring Wells," for University of California at Los Angeles Extension Class; Groundwater Monitoring, Protection and Cleanup.

Special Field Studies

October, November 1974. One of 34 delegates in the National Water Well Association Goodwill People-to-People Working Travel Program to Europe and the Soviet Union. Trip included England, Holland, Switzerland, Germany, and the Soviet Union.

June, July 1982. One of 18 geological participants in the "Geology of the Andes" Summer Study Tour to Bolivia, Peru, Ecuador, and the Galapagos Islands.

June, July 1984. One of 24 geological participants in the "Geology of The People's Republic of China" Summer Study Tour. Trip also included Hong Kong, Japan, and Korea.

July 1985. One of 20 geological participants in the "Geology of Iceland and Norway" Summer Study Tour.

December 1986. One of several geological participants in a geologic field study tour of New Zealand and Australia.

July, 1988. One of several geologic participants in a geologic field study tour of the East African Rift Zone in Kenya and Tanzania.

LIST OF
SIGNIFICANT HYDROGEOLOGIC PROJECTS

And

TYPES OF HYDROGEOLOGIC ANALYSES

	Horizontal and Vertical Basin Definition	Aquifer and Water Quality Characterization	Pollution Investigation	Groundwater Monitoring	Well Design and Construction	Perennial Yield Determination	Aquifer Testing	Determine Storage Capacity
1) Santa Clara River Valley	*	*		*	*		*	*
2) Bunker Hill Groundwater Basin	*	*					*	*
3) Antelope Valley Basin	*	*		*	*		*	
4) Ventura River Basin	*	*			*	*		*
5) Napa Valley Groundwater Basin	*	*		*	*		*	
6) City of Chino	*	*	*		*			
7) City of Redlands	*	*	*		*		*	
8) Santa Clarita Valley	*	*	*			*		*
9) Montecito Basin	*	*		*	*		*	
10) Beverly Hills-Hollywood Basin	*	*		*	*	*	*	
11) Yucaipa Basin	*	*	*		*			*
12) Chino Groundwater Basin	*	*	*					*
13) Mound Basin	*	*		*	*		*	
14) Palm Springs Subarea	*	*			*	*	*	
15) Acton Basin	*	*			*			*
16) Carpinteria Basin	*	*		*	*	*	*	
17) Claremont Heights Basin	*	*	*		*		*	*
18) Llagas Basin	*	*	*	*				
19) Oxnard Plain Basin		*	*					

1. Santa Clara River Valley, Los Angeles County.

Detailed evaluation of hydrogeologic characteristics of the Saugus Formation. Monitor static levels in all deep wells in basin and evaluate current and historic groundwater quality from this formation. Utilize many E-logs of wildcat oil wells to define base of fresh water and correlation of key aquifers. Evaluate water level trends and conduct aquifer tests in selected wells to quantify transmissivity. Identify complex subsurface stratigraphy via detailed cross sections. Identify total thickness of all potentially water-bearing aquifer sands in the basin using E-logs. Calculate usable quantity of groundwater in the formation to depths of 2500 ft and/or the base of fresh water, whichever is encountered first.

2. Bunker Hill Groundwater Basin, San Bernardino County.

As part of a major groundwater litigation case, we collected and reviewed masses of groundwater data for the entire Bunker Hill Basin. Active water wells were identified; their history of annual groundwater extractions were evaluated vs historic water level fluctuations. Annual extractions by various agencies were graphed and compared, and then reviewed in terms of long-term rainfall trends. The history of artificial recharge (spreading) was evaluated relative to resulting water level impacts on the basin and to the locations of active downstream water wells. Correlations of individual aquifers were made using available electric logs, and cross sections were prepared along with geologic maps to help evaluate the 3-0 configuration of the groundwater reservoir.

3. Antelope Valley Groundwater Basin, Los Angeles County, California.

A series of detailed groundwater investigations in various portions of this large groundwater basin. Work has included numerous tasks including: collection and review of subsurface data; detailed correlation of electric log signatures together with evaluation of drillers' logs to provide an accurate assessment of the location and continuity of the "blue clay" and of granitic basement rocks underlying the groundwater reservoir; providing optimum well locations and designs for new wells; evaluating water quality in specific aquifers; monitoring construction; geological logging of drill cuttings and review of E-log; conducting aquifer tests of completed wells.

4. Ventura River Basin, Ventura County, California.

A detailed study of this major groundwater basin was conducted as part of a comprehensive Environmental Impact Report for a site in the basin. Work conducted during this study included: establishment of base-period hydrologic conditions; review, compilation, and analysis of hydrologic and hydrogeologic data collected from various water agencies in the area; analysis of temporal changes in water levels and water quality in the basin; analysis of temporal changes in groundwater extractions in the basin; calculation of basin groundwater storage and impact of additional groundwater extractions, from the basin, on groundwater levels, groundwater in storage, other

groundwater extractions, and groundwater quality; impact of surface water flows in the Ventura River and the impact of groundwater extractions on these flows; and assessment of various impacts and potential mitigation measures for the proposed project.

5. Napa Valley, Napa County, California.

Numerous individual water resource analyses and water well siting studies have been conducted for vineyard and winery facilities located throughout the valley and the adjoining hillsides. These studies have generally encompassed: evaluations and investigations of hydrogeologic conditions in the valley; technical overside and consulting activities associated with drilling, installation, design, and testing of irrigation wells for the wineries and vineyards; and supervision of aquifer testing of existing irrigation wells for the wineries and detailed analysis of the testing data to determine impact on surrounding irrigation wells. Included also has been making formal presentations on several of these groundwater projects to various public agencies such as City councils, County commisioners and supervisors, and Planning Commissions.

Additional projects have involved the City of St. Helena in their efforts to purchase two separate existing water wells. Work has entailed reviewing available drillers' logs, water levels and water quality data for the wells, reviewing available well testing data, recommending and reviewing video logs of the wells, conducting special down-hole water quality testing in one well, and preparing reports (with documentation) regarding the hydrogeologic feasibility of acquiring the wells by the City.

Another project involved providing detailed hydrogeologic input to a local engineering firm regarding the feasibility of acquiring an existing well by the City of Napa. Work here included field reconnaissance, hydrogeologic review of data, and preparation of testing guidelines and cost estimates for contractor work necessary to conduct long-term aquifer tests in the well.

6. City of Chino, San Bernardino County.

A detailed well siting and design study for the eventual construction of municipal-supply wells. Data reviewed included oil well electric logs and logs of City wells, together with aquifer test and water quality data. Geologic interpretations of aquifer correlation and the base of fresh water were made; water level and water quality maps were prepared. Detailed cross sections were presented, and well sites were selected. Based on reconnaissance of potential sites, the City was provided with various logistical concerns for well drilling and construction (such as proximity of nearby active well, or the lack of a nearby fire hydrant water supply for drilling purposes).

7. City of Redlands, Bunker Hill Groundwater Basin, San Bernardino County.

A detailed hydrogeologic study of the City's portion of the basin to define new municipal well sites. Major concerns were proximity to active faults, shallow thicknesses of water-bearing sediments, extremely difficult drilling conditions due to the abundance of boulders and cobbles, contamination from volatile organic compounds like TCE, PCE,

and DBCP (a fumigant), and nitrates (due to the citrus industry). Drill sites were selected, local wells were sampled and monitored, and detailed technical specifications for well construction were prepared. Two new wells were drilled under these specifications, with our personnel providing geologic logging, monitoring of casing/gravel pack installation and monitoring of all well development and testing. Electric log interpretation defined well screen placement. Neither well has any contaminants and the wells are now on-line.

8. Santa Clarita Valley, Los Angeles County.

This detailed study examined the hydrogeologic characteristics of the alluvial aquifer system of the Santa Clara River; also evaluated were the characteristics of the underlying Saugus Formation. Work included determining groundwater flow directions, current water levels and levels at the beginning of our selected hydrologic base period, water quality assessments, review of annual and historic groundwater production by well and by aquifer system, calculations of groundwater in storage for various time periods, quantification of the perennial yield based on the change-in-storage method, calculations of recoverable water from 13 major tributaries, and determination of sites for future artificial recharge basins.

9. Montecito Groundwater Basin, Santa Barbara County, California.

Several phases of work were recommended and ultimately completed to evaluate the three-dimensional configuration of this coastal basin. Specifically identified were the location, nature, and continuity of potential aquifers; the locations of several fault-induced groundwater barriers and their effects on groundwater quality and seawater intrusion; and the quantitative evaluation of aquifer characteristics based on aquifer tests. A test hole drilling exploration program was conducted to update limited subsurface data; several wells were subsequently located, designed and drilled; and two older wells were redeveloped and rehabilitated. In addition, consultation was provided as needed, and test holes drilled for bedrock wells.

An additional, separate comprehensive and detailed assessment and investigation encompassed a perennial yield study for the basin. Work for this study included: examination and assessment of temporal changes in water levels in water wells throughout the basin and the impact of these changes on future water supply; calculation of potential groundwater in storage and temporal changes in this storage; selection of a hydrologic base period of analysis; and determination of groundwater in storage versus annual groundwater extraction by all pumpers in the basin.

10. Beverly Hills-Hollywood Groundwater Basins, Los Angeles County, California.

Detailed hydrogeologic studies in the highly urbanized Hollywood and Central Groundwater Basins were conducted to provide recommendations for new municipal wells. Essential, too, were preparation of specifications for selected water well redevelopments and abandonments. Definition of water quality problems by hydrogeologic methods was conducted because of known mineralogic and bacteriologic problems and industrial pollution. Hydrologic studies were conducted simultaneously to define the

perennial yield of each basin. Much of the work was based on detailed analyses of considerable amounts of subsurface oil well data which provided the key to identifying the geologic structure of the basin. Site locations and designs for future test holes and water wells were provided also.

11. Yucaipa Groundwater Basin, San Bernardino County.

A major hydrogeologic study of Yucaipa Basin and its adjoining fault-induced subbasins. Work included defining the lateral and vertical depths of the basins, correlating well logs, defining fault-barrier effects on water levels and quality, calculating the amounts of recoverable water from local major tributary watersheds, and identifying methods and sites for artificial recharge operations. Calculations were also made of groundwater in storage in the various subbasins for different periods of time. Aquifer parameters of transmissivity and storativity were also evaluated; future well sites and drilling methods were established.

12. Chino Groundwater Basin, Los Angeles and San Bernardino Counties, California.

The basin represents one of the largest groundwater basins in southern California and was studied to evaluated its potential, from a hydrogeologic standpoint, to accept recharge of 30,000 acre-feet per year of reclaimed water from local wastewater treatment facilities. Detailed hydrogeologic maps and cross sections were prepared along with contour maps of current and historic water level and water quality (total dissolved solids and nitrate concentrations). Long-term water level hydrographs and water quality chemographs were prepared and compared together with precipitation data. The surface definition of the basin was revised using fault-related groundwater barriers. Other important products included a depth to groundwater map, definitions of groundwater storage zones in the basin, calculations of potential storage volumes in the unsaturated zone for reclaimed water, and maps depicting potential sites for new spreading basins, spread pump-back schemes and injection wells.

13. Mound and Santa Paula Groundwater Basins, Ventura County, California.

This study was conducted to verify the horizontal extent and vertical depth of the groundwater reservoir, to provide for monitoring of water levels and quality in deep, unexplored aquifers, and to provide the locations and designs of new production wells. A major portion of the work involved designing, providing technical specifications, and geologically logging test holes to 3000-foot depths. Down-hole tests were conducted to obtain water samples for water quality characterization. Subsequent work has involved considerable expert witness work concerning results of the study.

14. Palm Springs Groundwater Basins, Riverside County, California.

This major study of the basins underlying Palm Springs was conducted to: define the areal extent and vertical depth of the groundwater-bearing sediments; identify the source of bacterial precipitates in a few active wells; define the locations and designs

for new, high-capacity wells. Hydrogeologic work included: data research; updating of water level and specific capacity data by field work and aquifer tests of select wells; determining the three-dimensional configuration of the basin and the continuity of aquifers; calculating the total and usable amounts of groundwater in storage; determining aquifer characteristics; assessing existing computer model data; defining fault-related groundwater barriers; and assessing the potential impacts of continuing water level declines on existing wells.

15. Acton Basin, Los Angeles County.

Geologically map the surface extent of the alluvial deposits and terrace deposits which comprise this groundwater basin. Identify the approximate maximum thicknesses of these materials. Prepare hydrographs of key wells and analyze the historic fluctuations in water levels vs time and vs the long-term rainfall record in the area. Provide detailed calculations of groundwater in storage in each of the two aquifer systems. Identify locations for future municipal supply water wells. Assess the magnitude of annual recharge to the basin.

16. Carpinteria Groundwater Basin, Santa Barbara County, California.

A long-term study involving several phases of work to define groundwater conditions in the basin and to determine the optimum sites for new production wells. Included in the study were: providing correlation of boring logs and electric logs of water and oil wells; collection, analyses and updating of water quality and water level data; recommending a basin-wide subsurface drilling exploration program; conducting a basin-wide water well survey to obtain well characteristics and well efficiencies; preparing elevation contours on four major aquifers encountered during test hole drilling to depths of 1500 feet; selecting sites, designing, and preparing technical specifications for new wells; detailed geologic logging of all test holes and wells; assessing the safe yield of the basins; monitoring of individual water levels and quality from each of the major aquifers in the basin; providing monitoring and control of all well completion, well development and well testing operations done by the drilling contractor; and detailed aquifer testing and mathematical analyses of aquifer characteristics. Drilling exploration utilized multiple-aquifer techniques and air-lifting methods to obtain water samples and aquifer coefficients.

17. Claremont Heights Basin, Los Angeles County.

A hydrogeological evaluation of this basin and its nearby basins that are separated from one another by faults and/or water level barriers. Groundwater flow directions, historic and current water levels/water quality were identified, and sites for new high-capacity wells to supply a treatment facility were identified. The impact of the new extractions on basin-wide water levels were evaluated, as were related effects on all proximal active wells. Aquifer test data were reviewed and realistic values for transmissivity and storativity were identified. Groundwater in storage was calculated for the several adjoining groundwater basins.

18. Llagas Groundwater Basin, Santa Clara County, California.

As part of the San Martin Water Quality Management Project, this study was essential to define the hydrogeologic and hydrologic conditions in the local Llagas Groundwater Basin. For this study, water supply and waste discharge characteristics were identified and evaluated, as were present and future water quality problems and water quality problem areas. Major types and sources of contamination were found to be nitrate concentrations created by return flows from agriculture practices and return flows from individual septic tank systems which proliferate in the region. A detailed nitrate monitoring program was developed as was a system to locate improperly sealed or abandoned water wells.

19. Oxnard Plain Groundwater Basin, Ventura County, California.

This study represents an evaluation of the long-term salt build-up in soils within and adjacent to the Oxnard Air Force Base. The study included: detailed examination of old topographic maps, aerial photographs, construction documents and boring logs for various phases of runway and taxiway construction; assessment of shallow auger hole logs and salinity test data obtained by others; and presentation of reports for expert witness testimony. Shallow soils display high salt concentration reflective of a shallow perched water table, flat topography, poor drainage, blockage of subsurface and surface drainage by construction, and low permeability of the shallow earth materials.

RICHARD C. SLADE & ASSOCIATES
CONSULTING GROUNDWATER GEOLOGISTS

REPRESENTATIVE WATER WELL DESIGN AND CONSTRUCTION PROJECTS (Municipal Wells)

Location	Well Size	Scope of Work
Coastal Plain Basin City of Orange	1175 feet deep; 16-inch well screen	Review site location and specifications; design well from electric log and cuttings; construction monitoring.
Santa Rosa Groundwater Basin City of Sebastopol	750-foot pilot hole; 16-inch well screen	Review site logistics, provide technical-specifications, review bids, construction to begin soon.
Santa Clarita Basin Los Angeles County Santa Clarita Water Co.	200-foot deep, shallow alluvial well; 16-inch	Design the well, monitor construction and testing well screen.
Yucaipa Basin San Bernardino County	750 feet deep; 16-inch well screen	Provide design and technical specifications; full-time monitoring of construction and well testing.
Antelope Valley Los Angeles County ASL Consulting Engineers	750 feet deep; 16-inch louvered casing	Detailed study with recommendations for well site and well final design; review cuttings and E-log and provide casing recommendations.
Mill Creek Basin City of Redlands San Bernardino County	300 feet deep; 20- to 16-inch diameter cable	Siting, design, and specifications for the well; and part-time construction monitoring.
Napa Valley Groundwater Basin City of St. Helena	400-foot deep existing well, 10-inch casing	Review original construction and testing data, provide recommendations for re-testing for quantity and quality; prepare report for accepting well.
Santa Clarita Basin Valencia Water Co. Los Angeles County	1600 feet deep; 18-inch louvered casing	Siting, design, and providing specifications for construction; full-time monitoring of construction and testing.

Location	Well Site	Scope of Work
Orange County Groundwater Basin, City of Fullerton, Orange County	1350 feet deep; 20- to 16-inch well screen	Provide design and technical specifications; full-time monitoring of construction and testing.
Bunker Hill Basin San Bernardino County City of Redlands	560 feet deep; 16-inch well screen	Detailed study, site selection, prepare specifications, design well with E-log and cuttings; monitor construction.
Coastal Plain Basin Orange County Water Desalter Project Wells	Four new wells, 700 to 900 feet deep, 16-inch well screen	Assist in reviewing site locations and specifications; review E-logs and cuttings; log the cuttings; monitor construction; aquifer testing.
Bunker Hill Basin San Bernardino County City of Redlands	470 feet deep; 14-inch well screen	Feasibility report, specifications, design well with E-log and cuttings; monitor construction, provide summary of operations report.
Orange County Groundwater Basin City of Orange	1500 feet deep; 16-inch well screen	Specifications, design, interference criteria; construction monitoring.
Orange County Groundwater Basin City of Anaheim	1200 feet deep; 16-inch well screen	Site selection, review of specifications and design; monitor construction and provide summary of operations report.
Montecito Basin Santa Barbara County	Bedrock well, to 550 feet deep; 8-inch PVC screen	Site selection criteria, prepare specifications; construction monitoring; airlift testing and aquifer testing.
Antelope Valley Los Angeles County L. A. County Waterworks District	500 to 800 feet deep; 12- to 16-inch casing	Siting studies, provide final criteria for well sites and preliminary design for wells.
Chino Basin City of Chino	800 feet and 1000 feet deep; 18-inch well screens; two wells	Detailed groundwater study, select drill site, prepare technical specifications, log cuttings, design final well with E-logs, monitor all construction and testing.
Orange County Groundwater Basin Irvine Water District	900 feet deep; 16-inch well screen	Assist in providing design and reviewing specifications; prepare final design based on E-log and cuttings; monitor final construction; monitor destruction of former onsite well.

Location	Well Site	Scope of Work
Santa Clarita Basin Northern Los Angeles County	1500 to 1800 feet deep; 18- to 20-inch screen; two deep wells	Detailed studies to locate and design deep wells; prepare technical specifications; monitoring construction; provide final design based on cuttings and E-log; perform aquifer tests.
Orange County Groundwater Basin City of Santa Ana	1300 feet deep; 18-inch 18-inch well screen	Design well, prepare technical specifications, log cuttings, monitor all construction, provide casing completion, conduct aquifer tests.
San Timoteo Basin/Yucaipa Basin, San Bernardino and Riverside Counties	400 to 700 feet deep; 8- to 10-inch casing	Well locations and preliminary designs for three wells.
Coastal Plain Basin Orange County City of Orange	1100 feet deep; 16-inch well screen	Electric log analysis, final design of casing, gravel pack, and cement seals.
Montecito Basin Santa Barbara County	500 to 600 feet deep; 8- to 10-inch louvered casing	Locations, designs, specifications, and construction monitoring of three wells.
Palm Springs Basin Riverside County	900 to 1300 feet deep; 12- to 16-inch casing	Well location and preliminary design for three wells.
Mound Basin Ventura County	2845-foot deep pilot hole with 1800-foot deep stainless steel completion	Well location and design, prepare specifications, full-time monitoring of construction.
Coastal Plain Basin Orange County Water District, City of Irvine	800 feet deep; 16-inch screen	Review technical specifications, logging of cuttings, review electric logs, monitor construction of well, aquifer testing; prepare final report.
Central Basin and Hollywood Basin Los Angeles County	800- to 1300-foot deep wells; 10- to 14-inch	Well locations and preliminary designs; specifications, and monitoring of well rehabilitation.
Mojave Basin San Bernardino County	800 to 1000 feet deep; 14-inch casing	Well location, preliminary designs, and construction methods.
San Francisco San Francisco County	300 feet deep; 10-inch well screen	Well location and design for dewatering test well.

Location	Well Site	Scope of Work
Santa Clara Valley Los Angeles County	800 feet deep; 14-inch casing	Siting, design and specifications, review E-log, monitor all construction and testing.
Mission Creek Basin Riverside County	600 to 900 feet deep; 10- to 14-inch casing	Well locations and designs for four wells.
Santa Barbara Basin Santa Barbara County	700 to 900 feet deep; 10-inch well screen	Locations, design, specifications, and construction monitoring.
Carpinteria Basin Santa Barbara County	800 to 1200 feet deep; 12- to 14-inch well screen	Locations, design, specifications; and construction monitoring of four wells.
Central Basin Los Angeles County	800 feet deep; 14-inch casing	Well locations and preliminary designs.
San Fernando Groundwater Basin Los Angeles County	600 feet deep; 14-inch casing	Provide siting criteria, perliminary design and cost estimates for well in area known to have VOC contamination.
Santa Clarita Basin Los Angeles County Santa Clarita Water Co.	180 feet deep, shallow alluvial well; 14-inch	Provide siting, design and cost estimate, review E-log, monitor during construction.
Santa Clarita Basin Los Angeles County Valencia Water Co.	1700 feet deep; 18-inch casing	Provide well location, detailed well specifications and cost estimate, review E-log, monitor all construction.
Acton Basin Los Angeles County L. A. County Waterworks District	200 to 250 feet deep wells; 12- to 16-inch casing	Detailed well siting studies, select optimum sites, provide preliminary design criteria, and cost estimates for well construction.

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REPRESENTATIVE WATER WELL SITING AND/OR CONSTRUCTION PROJECTS FOR VINEYARDS AND WINERIES

Location and Client	Scope of Work
Carneros Vineyard Mondavi Winery Sonoma/Napa Counties	Conduct site reconnaissance, evaluate locations of and conditions within offsite wells; obtain oil well electric log data for correlation purposes, determine site geology, identify groundwater flow directions, determine optimum sites for new wells, review electric log and provide final well design parameters.
Rancho San Antonio Vineyard Santa Barbara County Beringer (Wine World) and Hampton Farming	Conduct aquifer tests and sample water quality from existing wells; review down-hole photos of wells; identify nature of sanding problems and of problems with over-production from wells; correlate electric logs; define locations and designs for wells; make recommendations for reconstructing existing wells, and monitor construction of two new wells and reconstruction of two existing wells.
Silverado Ranch and Soda Canyon Property Napa County William Hill Wine Co.	Collect and analyze data for local wells; identify sites and drill depths for new wells, provide preliminary designs and cost estimates for new wells; define feasibility of obtaining additional groundwater supplies.
Liparita Vineyard Napa Valley Vineyard Engineering, Inc.	Perform long-term aquifer tests and water level monitoring in onsite wells; identify water quality; determine recharge potential to property; identify potential water level impacts on nearby wells; make presentations to County Planning Commission.
Villa Zapu Winery Napa County Dickenson, Peatman & Fogarty, Attorneys	Monitor water levels in onsite wells, identify groundwater flow directions in this bedrock watershed, assess groundwater usage in the local region, evaluate magnitude of recharge to bedrock from rainfall, design and monitor aquifer tests, identify possible impacts on onsite wells, prepare report with mitigation measures for winery use permit application.

Location and Client	Scope of Work
Meridian Winery San Luis Obispo County For WineWorld	Perform fast-track evaluation of existing winery-use well just prior to crush; provide emergency guidelines for rapid recompletion of existing downhole problems; monitor recompletion work in field and provide recommendations for test pumping and aquifer testing. All work performed in extremely tight time schedule to meet crush needs.
Clos Pegase/Carneros Vineyard, Napa County Walsh Farming, Inc. and Napa Valley Vineyard Engineering, Inc.	Conduct a site reconnaissance, identify local geology and groundwater conditions, determine groundwater flow directions and local groundwater quality, recommend optimum sites for new wells, identify drill methods and drill depths.
Staglin Family Vineyards Napa County Mr. & Mrs. Garen Staglin	Conduct site visit to ascertain logistics for monitoring onsite and proximal offsite wells, meet with County staff to discuss proposed tests, design and conduct aquifer test onsite and monitor two other proximal wells, evaluate water level impacts, identify offsite water usage, prepare report with mitigations for winery use permit applications.
Riverbench Vineyards Santa Barbara County WineWorld	Review data available for onsite wells, determine which wells to destroy, utilize oilfield electric logs to identify subsurface geology and define base of fresh water, select and prioritize three new drill depths and anticipated well design and pumping rates.
Fulton Ranch Santa Barbara County Pacific Vineyard Co.	Determine potential for developing new groundwater supply for Ranch, conduct site reconnaissance, evaluate potential water quality problems, assess optimum locations for new well.
Beringer Winery Napa County WineWorld	Site reconnaissance and review conditions in existing wells; correlate electric logs; define optimum sites and depths for new wells; identify existing problems and make recommendations for mitigating down-hole problems in existing wells.
Mountain Lake Vineyard Lake County Beringer (WineWorld)	Perform site reconnaissance of proposed vineyard property; evaluate aquifer testing in new well, identify site hydrogeologic conditions and determine optimum sites for new wells; provide recommendations for well depths and drill methods.

Location and Client	Scope of Work
Howell Mountain Vineyard Napa County Beringer (WineWorld)	Perform field reconnaissance of property, identify existing offsite wells, prepare report with conclusions and recommendations regarding feasibility of developing a groundwater supply for vineyard development; identify drill sites, drill methods, and drill depths.
Cat Canyon Vineyard Santa Barbara County Beringer (WineWorld) and Hampton Farming	Monitor water levels and quality in existing wells; identify down-hole problems; correlate electric logs; define groundwater flow directions; provide locations and designs for new wells.
White Hills Vineyard Santa Barbara County Hampton Farming Co.	Provide designs for two new wells, provide liaison with drilling contractor during construction, review E-logs and identify final well design and pumping guidelines.
Ink Grade/Howell Mountain Napa County Heitz Cellars and Jack Neal Farming Co.	Conduct geologic field mapping and aerial photograph interpretation to verify available data, map contact of two formations, prepare report, evaluate feasibility of obtaining groundwater, and prioritize three sites for drilling water wells for vineyard supply.
Hanna Winery/Bismark Ranch, Sonoma County Napa Valley Vineyard Engineering, Inc.	Perform limited field mapping, assess subsurface formations for providing water to wells, identify groundwater flow directions, define key sites for test holes and water wells. Monitor construction of a deep test hole, review drill cuttings, analyze electric log and provide final casing design for well, develop test pump guidelines for contractor, and conduct aquifer test of newly completed well.
East Mesa, et al. Vineyard Santa Barbara County Mesa Vineyard Management, Inc.	Conduct field visit, monitor water levels, correlate electric logs of oil wells and water wells, identify aquifer characteristics, select and prioritize three water well sites for vineyard, provide details for drilling and constructing new wells. Monitor construction of two new wells, review electric logs, provide final casing design for each well, and provide recommendations for development and for pumping tests.

Location and Client	Scope of Work
Soda Canyon Ranch Napa County, for Mr. William Hill	Based on our detailed hydrogeologic study of property. We selected well site, negotiated costs and construction guidelines with driller, monitored construction activities, selected zones to receive casing, analyzed aquifer tests.
Prospective Vineyard Stanislaus County Mr. Donald Panoz	Perform site reconnaissance, assess feasibility of developing onsite groundwater supply, test and evaluate existing shallow water wells.
Domaine Mumm, Inc. Sterling/Carneros Vineyard, Napa County	Conduct site reconnaissance, prepare report for well feasibility, identify drill site and drill depths, review electric logs, provide liaison with drilling contractor during construction, provide final well design.
Bien Nacido Vineyards Santa Barbara County Mr. Stephen Miller Thornhill Ranches	Obtain water levels, correlate electric logs of oil wells and water wells, identify base of fresh water, evaluate aquifer capabilities, select and prioritize two drill sites with drill depths and drilling requirements.
Chateau Soverain Sonoma County WineWorld	Identify logistics for drilling, review reports prepared by others, identify sites for a test hole, and provide guidelines for drilling the test hole.
Codorniu-Napa Carneros Vineyard Napa County Codorniu-Napa, Inc.	Limited evaluation and review of existing reports for vineyard; provide independent assessment, and recommend different location for a new well.
Raymond Vineyard Napa County Wheeler Lane Investors, Inc.	Conduct site reconnaissance, evaluate groundwater development feasibility for the property, prepare a report with priority ranking of potential test hole/water well sites.
Tamagni Ranch/ Nolasco Ranch Napa County Sterling Vineyards	Collect and review available subsurface information, conduct site reconnaissance, identify potential groundwater quality problems, define optimum sites to drill new wells.
Pym Rae Vineyard Napa County Mr. Robin Williams	Conducted site reconnaissance within difficult hillsite terrain underlain by poor aquifers, monitored springs, selected methods to rehabilitate existing onsite springs via drilling horizontal wells at key locations.

SELECTED GROUNDWATER BASIN ANALYSES
ARID AND SEMI-ARID ENVIRONMENTS

LOCATION AND CLIENT	DESCRIPTION
Antelope Groundwater Basin Los Angeles County, California for ASL Consulting Engineers	Conducted a series of detailed groundwater investigations in various portions of this large groundwater basin in the Mojave Desert. Tasks included: collection and review of subsurface data; detailed correlation of E-logs together with evaluation of driller's logs to locate and assess the continuity of subsurface geologic units; provided optimum locations for new wells; and evaluated groundwater quality in specific aquifers.
Acton Groundwater Basin Los Angeles County, California for ASL Consulting Engineers	Conducted geologic mapping of the surface extent of alluvial and terrace deposits, identified the approximate thickness of these deposits, analyzed historic fluctuations in water levels vs time and vs. the long-term rainfall record in the area, and provided detailed calculations of groundwater in storage for the basin.
Palm Springs Groundwater Basin Riverside County, California for Desert Water Agency	Defined the areal extent and vertical depth of groundwater-bearing sediments in the basin, identified the source of bacterial precipitates in active water-supply wells, and located sites for and designed new water-supply wells. The tasks required for this study consisted of; groundwater and surface water data collection, review, and analysis; determining the three-dimensional configuration of aquifers; calculating groundwater in storage, and; defining fault-related groundwater barriers.
Bunker Hill Groundwater Basin San Bernardino County, California for City of Redlands	Conducted detailed hydrogeologic studies to located new municipal water-supply wells sites and the effect of recharging the basin on downstream artesian areas. Hydrogeologic parameters assessed were: shallow thickness of water-bearing sediments; proximity to active faults; contamination of potential water resource areas by DNAPLs, pesticides, and nitrates; and assessing long-term water level changes in the basin. Select well sites to avoid known contamination from a variety of industrial and agricultural usages.

ANTELOPE VALLEY PROJECTS

ANTELOPE VALLEY GROUNDWATER BASIN, LOS ANGELES COUNTY

CLIENT REFERENCES

1. Mr. Terry Kerger, Assistant Division Manager
   ASL Consulting Engineers.
   (818) 447-4494

2. Mr. Dean Efstathiou, Assistant Deputy Director
   Waterworks and Sewer Division
   Department of Public Works,County of Los Angeles
   (818) 458-7115.

Richard C. Slade & Associates has developed a detailed and comprehensive understanding of the aquifer systems and their hydrogeologic characteristics as a result of numerous detailed groundwater investigations in various portions of this large Antelope Valley Groundwater Basin. Work has included numerous tasks including: collection and review of subsurface data; detailed correlation of electric log signatures together with evaluation of drillers' logs to provide an accurate assessment of the location and continuity of the "blue clay" and of granitic basement rocks underlying the groundwater reservoir; providing optimum well locations and designs for new wells; conducting aquifer tests and defining well interference criteria; evaluating the feasibility of groundwater development for future wells; evaluating water quality in specific aquifers; monitoring construction; geological logging of drill cuttings and review of electric logs for several new wells; and conducting aquifer tests of completed wells.

As a result of our hydrogeologic work, both published and unpublished, we have collected and correlated, in detail, a large number of the available electric logs and even drillers' logs. With these data, we believe we have uniquely developed a detailed understanding of the location and areal extent of the upper and lower aquifer system, and the "blue clay" throughout much of the Antelope Valley.

PROJECT DESCRIPTIONS:

1. HYDROGEOLOGIC ASSESSMENT OF WESTERN LANCASTER REGION for Los Angeles County Waterworks District No. 4.

   This project included an approximately 80-square-mile area west of Lancaster but focused on the detailed hydrogeology of a 10-square-mile area between approximately 60th Street West and 110th Street West. Included herein was an assessment of the areal extent and thickness of water-bearing sediments; assessment of the gross feasibility of developing a few to several thousand gallons per minute of additional groundwater supply from the detailed project area; an evaluation of the number of new wells that might be drilled in that area; providing optimum location(s), drill depth(s), and anticipated production rates for future well(s); and providing general guidelines for construction and testing of the newly recommended wells.

   Detailed correlation of electric logs and driller's logs was performed, with particular reference to the location of thickness of the "blue clay" and of the upper and lower aquifer systems, and of the depth to the underlying basement was performed. We currently have in our office files a sizable number of drillers' logs of historically-drilled wells in the valley, together with numerous electric logs of both historically and more recently drilled wells.

2. HYDROGEOLOGIC ASSESSMENT OF A PORTION OF THE PALMDALE AREA, for ASL Consulting Engineers.

   This detailed study was undertaken to evaluate hydrogeologic conditions within the study area and to assess the hydrogeologic impact of constructing a new municipal-supply water well on adjoining wells owned by others. Our work scope involved substantial data collection (water levels, water quality, drillers' logs, and electric logs); reviewing data on water levels, casing perforations, and pumping rates in existing County Waterworks District Nos. 4 and 34 water wells; conducting a site reconnaissance to identifying the locations and ownerships of nearby wells owned by private mutual water companies; performing detailed hydrogeologic analyses of the data; preparing the preliminary design for the new well in terms of anticipated drilling depths and future pumping rates; and identifying potential hydrogeologic impacts of the new wells on proximal wells.

3. HYDROGEOLOGIC ASSESSMENT OF THE SERVICE AREA OF WATERWORKS DISTRICT NO. 35 for ASL Consulting Engineers.

This study evaluated the groundwater characteristics of the approximately 95-square-mile service area of Waterworks District No. 35 in the western Mojave Desert region. Hydrogeologic work tasks included evaluating historic water levels and groundwater flow directions, assessing water quality and water quality problem areas, reviewing basin boundaries, assessing aquifer characteristics, and defining locations for new water wells. Specific well locations were identified, together with anticipated drilling depths, drilling conditions, and future pumping rates and pumping levels.

4. HYDROGEOLOGIC ASSESSMENT OF THE SERVICE AREA OF WATERWORKS DISTRICT NO. 38 for ASL Consulting Engineers.

This study area, also known as the Lake Los Angeles District, comprises approximately several square miles in the Lovejoy Buttes/Alpine area of Antelope Valley. From a hydrogeologic perspective, our work was to: assess the areal extent and thickness of the water-bearing sediments; evaluate the feasibility of developing anew groundwater supply for municipal use in the area; provide optimum locations for new wells; select drilling depths and drilling methods for the new wells; and provide estimates of anticipated pumping rates, pumping levels, and groundwater quality from the new wells.

5. HYDROGEOLOGIC ASSESSMENT OF THE SERVICE AREA OF WATERWORKS DISTRICT NO. 39 for ASL Consulting Engineers.

This study investigated the hydrogeologic conditions of Waterworks District No. 39 (also known as the Rock Creek District) which is located in the Pearblossom portion of Antelope Valley. The actual study area encompassed nearly 30 square miles because the local municipal purveyor revealed that future well sites selected by our firm could be located in other waterworks districts surrounding District No. 39.

For our work, we compiled and correlated drillers' logs and available electric logs, reviewed historic and current water level and water quality data, developed an understanding of the nearby major faults on groundwater and geologic conditions, prepared and evaluated hydrographs of historic water

levels, assessed aquifer characteristics, and selected specific drill sites for future wells. Anticipated drill depths, drill methods, pumping rates, and pumping for future wells were provided also.

WATER WELL CONSTRUCTION PROJECTS - ANTELOPE VALLEY

Richard C. Slade & Associates has been involved in the design and actual construction of several new municipal-supply water wells in the Antelope Valley. These projects have been performed for various consulting engineers and/or the County Waterworks District. Our tasks have involved such varied work as: reviewing the drill cuttings and preparing geologic logs of these cuttings; reviewing the electric logs of each pilot hole and correlating these electric logs into our valley-wide data base; providing final casing recommendations to the drilling contractor, including casing diameters, slot sizes, gravel pack gradation, and the depth placements for the casing perforations; and evaluating data from pumping tests.

Specific wells in the Lancaster-Palmdale area for which we have provided well design and construction services include:

a) Waterworks District No. 4, Well No. 50;
total casing depth = 510 ft
total pilot hole depth = 756 ft.

b) Waterworks District No. 4, Well No. 51;
total casing depth = 510 ft
total pilot hole depth = 884 ft.

c) Waterworks District No. 4, Well No. 58;
total casing depth = 1230 ft
total pilot hole depth = 1250 ft.

d) Waterworks District No. 4, Well No. 59;
total casing depth = 1240 ft
total pilot hole depth = 1262 ft.

APPENDIX J

ANTELOPE VALLEY WATER RESOURCE STUDY

DRAFT REPORT

Antelope Valley Water Resource Study

Antelope Valley Water Group

August 1994
K/J 934620.00

ANTELOPE VALLEY WATER RESOURCE STUDY
ANTELOPE VALLEY WATER GROUP
K/J 934620.00

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CHAPTER 1

EXECUTIVE SUMMARY

As rapid development has increased the demand for both more water and higher quality water in the Antelope Valley, the competition for available water supplies has increased. Recent water resource studies by individual water purveyors have attempted to provide a technical foundation and/or management strategy for the area's water resources. However, these attempts have generally been met with criticism and mistrust. The Antelope Valley Water Group (AVWG) was formed in 1991 to provide a means of communication for the Valley agencies with an interest in water. Water Group members include the Cities of Palmdale and Lancaster, Edwards Air Force Base (Edwards AFB), Antelope Valley - East Kern Water Agency (AVEK), Antelope Valley United Water Purveyors Association (AVUWPA), Los Angeles County Waterworks Districts, (LACWW), Palmdale Water District (PWD), Rosamond Community Services District (RCSD), and County Sanitation Districts of Los Angeles County (CSDLAC). In an attempt to prepare a water resource study with a regional focus, rather than an individual focus, the AVWG initiated the Antelope Valley Water Resource Study.

STUDY AREA CHARACTERISTICS

The Antelope Valley, as defined for the purposes of this report, encompasses approximately 2,400 square miles in northern Los Angeles County, southern Kern County and western San Bernardino County. (See Figure ES-1.) The Valley is bordered on the southwest by the San Gabriel Mountains, on the northwest by the Tehachapi Mountains, and on the east by a series of hills and buttes that generally follow the San Bernardino County line. Major communities within the Valley include Boron, Edwards AFB, Lancaster, Mojave, Palmdale and Rosamond. Mean daily summer temperatures range from 63° Fahrenheit (F) to 93° F, and mean daily winter temperatures range from 34° F to 57° F. Precipitation ranges from 5 inches per year along the northern boundary of the Valley to 10 inches per year along the southern boundary.

The Antelope Valley is a closed basin. Surface water from the surrounding hills and from the Valley floor flow primarily toward three dry lakes on Edwards AFB: 1) Rosamond Lake, 2) Buckhorn Lake and 3) Rogers Lake. The most hydrologically significant streams include Big Rock Creek, Little Rock Creek, and Amargosa Creek. Except during the biggest rainfall events of a season, surface water flow towards the Valley from the surrounding mountains, quickly percolating into the stream bed and recharging the groundwater basin. Surface water flows that reach the dry lakes are generally lost to evaporation. The Littlerock Creek is the only developed surface water supply in the Valley. The Littlerock Reservoir, jointly owned by PWD and LCID, collects run-off from the San Gabriel Mountains. The Dam currently has a useable storage capacity of 600 acre-feet of water,

however PWD and LCID are planning modifications to the dam which will increase the storage capacity to 3,500 acre-feet.

The Antelope Valley Groundwater Basin is comprised of two primary aquifers; 1) the principal aquifer and 2) the deep aquifer. The principal aquifer is an unconfined aquifer. Separated from the principal aquifer by clay layers, the deep aquifer is generally considered to be confined. In general, the principal aquifer is thickest in the southern portion of the valley near the San Gabriel Mountains, while the deep aquifer is thickest in the vicinity of the dry lakes on Edwards AFB. The Antelope Valley Groundwater Basin is divided into twelve subunits. The subunits are Finger Buttes, West Antelope, Neenach, Willow Springs, Gloster, Chaffee, Oak Creek, Pearland, Buttes, Lancaster, North Muroc, and Peerless.

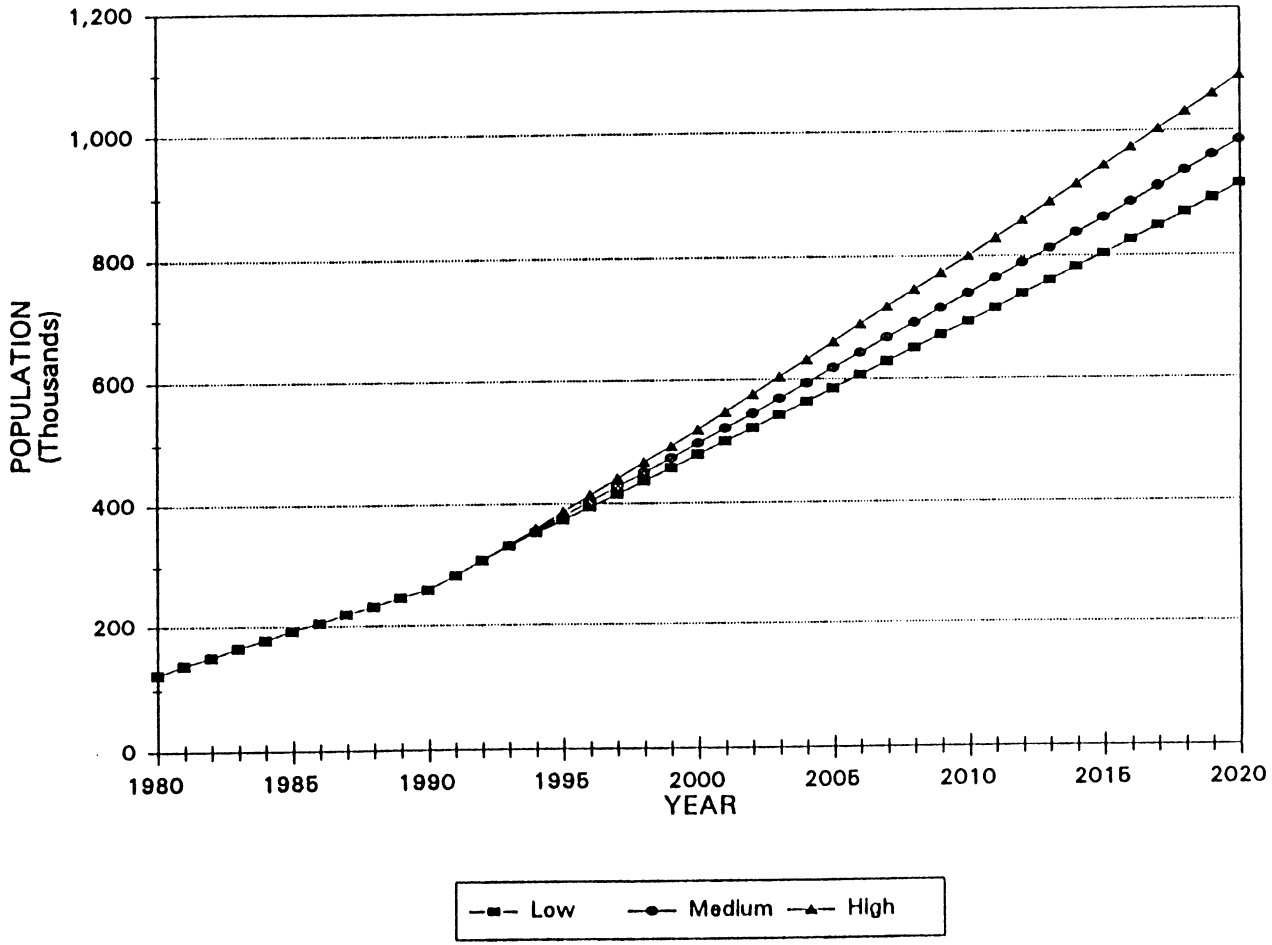
Historically, land uses within the Valley have focused primarily on agriculture; however, the Valley is in transition from predominantly agricultural uses to predominantly residential and industrial uses.

Growth in the Antelope Valley proceeded at a slow pace until 1985. However, between 1985 and 1990, the growth rate increased approximately 1,000 percent from the average growth rate between the years 1956 to 1985. Historical and projected population for the Antelope Valley are shown in Table ES-1 and depicted on Figure ES-2. The medium populatin curve is selected for use in this report. Projections indicate that approximately 986,000 people will reside in the Valley by the year 2020. This represents an increase of approximately 177 percent from the current population. Areas of concentrated population within the Valley include Lancaster, Palmdale, Edwards AFB, Rosamond, Mojave, and Boron.

ASSESSMENT OF WATER RESOURCES

Historical water demands were 192,600 acre-feet in 1975, 246,000 acre-feet in 1980, 167,000 acre-feet in 1985 and 144,000 acre-feet in 1988 (USGS, 1994a). Water demands decreased between 1950 to late 1980s due to decreasing irrigated acreage. However, due to the population growth beginning in the mid 1980s, water demands are rapidly increasing. Projected water demands for the Antelope Valley are shown on Figure ES-3. Projections were based on the summation of the individual water demand projections for the City of Palmdale, City of Lancaster, RCSD, Other and Agricultural.

The total available water deliveries for the Antelope Valley was 192,600 acre-feet in 1975, 144,000 acre-feet in 1980, 107,000 acre-feet in 1985 and 118,000 acre-feet in 1989 (USGS, 1994a). Historical water supplies were made of a combination of local surface water from Littlerock Reservoir, SWP water, groundwater, and reclaimed water. Table ES-2 shows the current and projected water supplies in Antelope Valley. As shown in the table, the current estimated water supply ranges between 212,900 to 240,800 acre-feet, and the 2020 estimated water supply ranges between 275,700 and 303,600 acre-feet. The water supplies identified in Table ES-2 do not include potential reductions in deliveries due to hydrologic conditions.



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Population Projections–Antelope Valley

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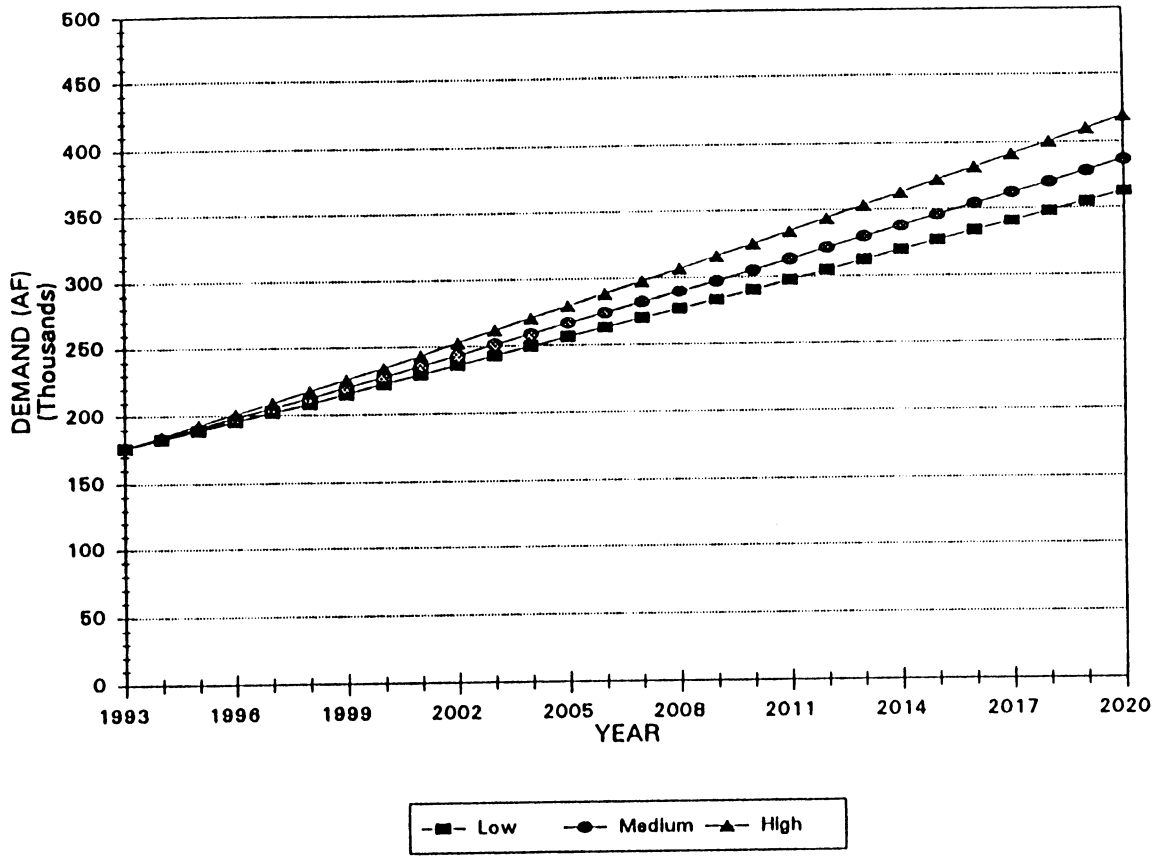
Figure ES–2

Figure ES–2



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Water Demand Projections
Antelope Valley

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Figure ES–3

Figure ES–3

TABLE ES-1

ANTELOPE VALLEY
HISTORICAL AND PROJECTED POPULATION

Area	1980	1990	2010	2020 [1]
Lancaster	48,027	97,291	212,138 [2]	269,558
Palmdale	12,277	68,842	245,341 [3]	326,815
Edwards AFB	8,554	7,423	7,671	7,671
Rosamond	2,869	9,969 [4]	39,256 [5]	52,696
Mojave	2,886	3,793 [8]	8,737	11,209
Boron	2,815	2,903	3,071	3,155
Other	46,922	70,179 [6]	221,787 [6]	314,896 [6]
Total	124,350	260,400	738,000 [7]	986,000 [7]

(1) Extrapolated based on 1990 and 2010 populations except for Palmdale, Edwards AFB, Rosamond and Other. Palmdale is extrapolated based on 1993 and 2010 populations. Rosamond is extrapolated based on 2000 and 2010 populations. Edwards AFB 2020 population is maintained at 2010 level and Other is the difference between the total and the areas of concentrated population.
(2) From SCAG 1993 population projections.
(3) Average of City of Palmdale's General Plan projections and SCAG's 1993 projections.
(4) Interpolated based on 1980 and 1993 populations.
(5) Average of County of Kern's Rosamond Specific Plan projections and projections based on proposed Desert Highlands development.
(6) Difference between total and the areas of concentrated population.
(7) From DWR's November 1993 Draft California Water Plan Update (Bulletin 160).
(8) From Kern Council of Governments.

Groundwater is estimated to have a safe yield of approximately 31,200 to 59,100 acre-feet per year (USGS, 1993). SWP entitlements for the Antelope Valley are currently estimated to be approximately 153,800 acre-feet. Available storage from Littlerock Reservoir was 600 acre-feet, however, modifications to the Littlerock Dam is anticipated to increase the storage capacity to 3,500 acre-feet. According to the PWD, the average annual yield from the new reservoir is estimated to be approximately 7,000 acre-feet. The Palmdale, Lancaster, Rosamond, Edwards AFB, and Mojave WRPs represent the plants with the highest probability of developing a reclaimed water system. The combined 1993 and projected 2020 flow from these five plants represent nearly 98 percent of the total potential supply for the entire Valley and is estimated to be 18.7 mgd (20,900 acre-feet) and 74.7 mgd (83,700 acre-feet) respectively.

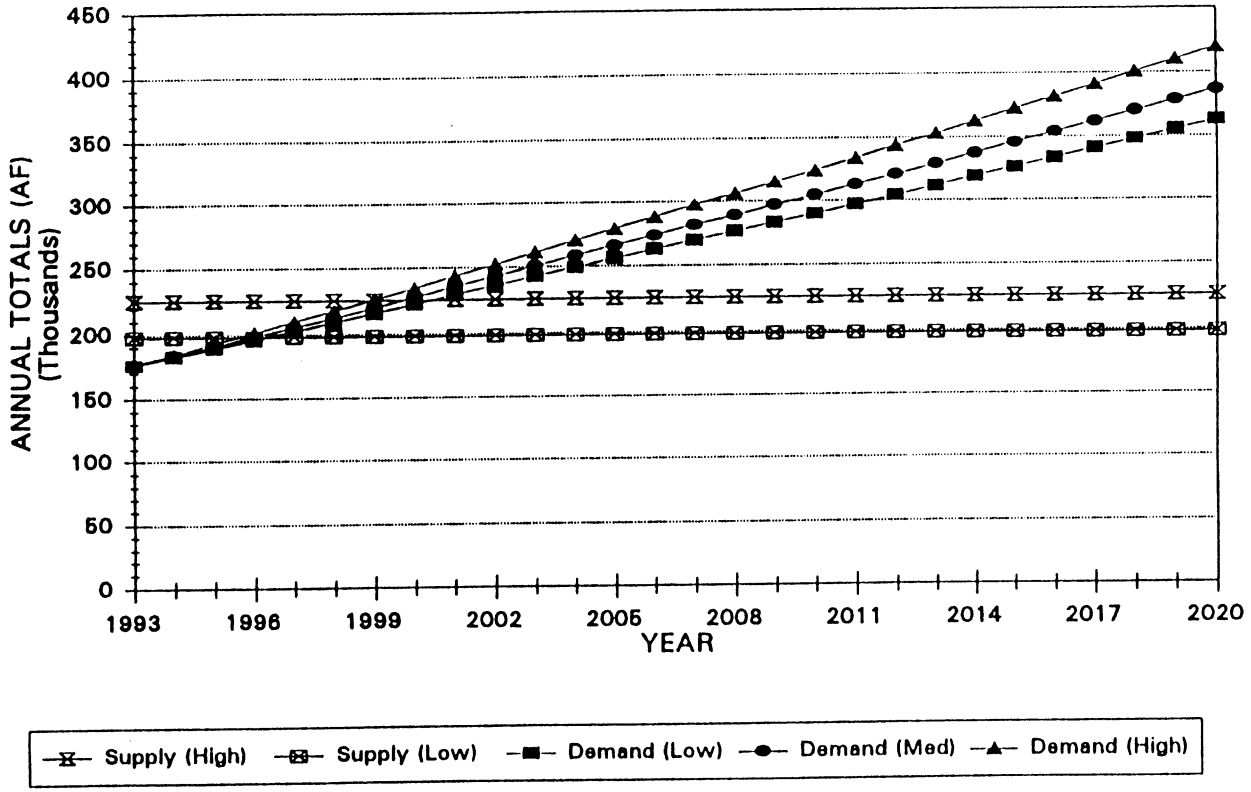
TABLE ES-2

POTENTIAL ANNUAL WATER SUPPLY
FOR THE ANTELOPE VALLEY [1]

Source	1993 Potential Supply (acre-feet)	2020 Potential Supply (acre-feet)
Groundwater [2]	31,200 to 59,100	31,200 to 59,100
State Project Water		
AVEK [3]	134,200	134,200
LCID	2,300	2,300
PWD	17,300	17,300
Subtotal	153,800	153,800
Littlerock Reservoir [4]	7,000	7,000
Reclaimed Water [5]	20,900	83,700
Total [6]	212,900 to 240,800	275,700 to 303,600

(1) Supplies listed have not been adjusted to account for potential reductions in deliveries due to hydrologic conditions.
(2) Estimates of natural recharge from USGS "Study Plan for the Geohydrologic Evaluation of Antelope Valley, and Development and Implementation of Ground-Water Management Models."
(3) Based on historical deliveries of approximately 3 % to areas outside the Antelope Valley, subtracted from AVEK's total entitlement of 138,400 acre-feet per year.
(4) PWD estimates that average yield from the reservoir following modifications to the dam will be 7,000 acre-feet per year.
(5) The numbers shown are current and projected production for Palmdale, Lancaster, Rosamond, Edwards AFB, and Mojave WRPs.
(6) Potential useable stormwater is not included in the total.

Figure ES-4 depicts the high and low water supply projection along with the low, medium and high water demand projection for the Valley to the year 2020. The high and low water supply projection are based on Table ES-2 with one exception, the potential reclaimed water supply listed in Table ES-2 for 1993 and 2020 are not included. Instead, the reclaimed water supply for both 1993 and 2020 is taken as the current reclaimed water use (approximately 6,500 acre-feet). Therefore, the 1993 and 2020 potential supply ranges between 198,500 and 226,400 acre-feet per year. For purposes of the reliability analysis, the high supply curve and medium demand curve is selected. The supply curve does not take into account the issue of reliability and the effects that reliability will have on the yield of each water supply source.



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Potential Supply and Projected Demand
(Without Delivery Reductions)

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Figure ES–4

Figure ES–4

Figure ES-5 depicts the effects that reliability will have on the yield of the water supplies. The medium demand and projected supply estimates at the 50, 80 and 90 percent probability levels is shown on Figure ES-5. The most optimistic supply assumption (i.e. delivery of 100 percent of available water supplies) is also shown. As shown on the figure, the estimated 1993 water demand is met approximately 73 percent of the time. For comparison, the Metropolitan Water District of Southern California (MWD) has established the following levels of service objectives:

Percentage of Demand	Percentage of the Time
80%	100%
90%	92%
100%	90%

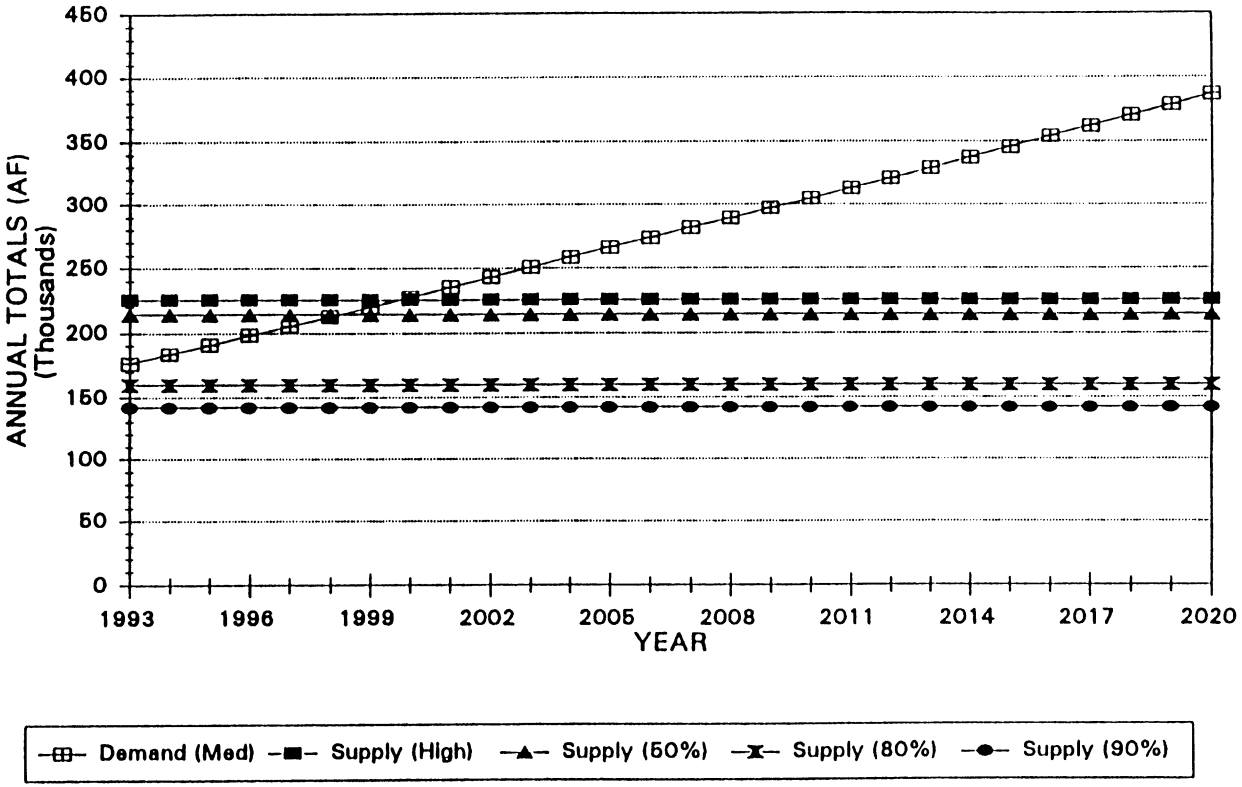
Based on the result of Figure ES-5, the purveyors in the Antelope Valley currently provide a water supply reliability that is currently below MWD's objectives. By the year 1998, 100 percent of the water demand is estimated to be met only 50 percent of the time. In the year 2000, without overdrafting the groundwater basin, 100 percent of the potential water supplies would be required to meet the water demand.

To assess the effects of SWP deliveries on groundwater levels, areas that receive SWP deliveries were compared with areas that did not. By comparing the hydrographs from areas that remained in similar land uses, the effect on groundwater levels would be from SWP deliveries and not by other causes (i.e. land use transitions). Hydrographs in areas that do not receive SWP water indicate groundwater levels are generally remaining level, whereas hydrographs in areas that do receive SWP water generally indicate a rising of groundwater levels.

To assess the effects on groundwater levels due to transition from agricultural to urban land uses, hydrographs in areas of agriculture that had transitioned to urban were compared with hydrographs in areas of agriculture that had not transitioned. The rate of decline in water levels prior to 1977-1978 was noticeably more than the rate of decline after 1977-1978 when SWP deliveries started to significantly contribute to the Valley's water supply. Importation of SWP water generally has a beneficial effect on groundwater levels and urbanization generally has an adverse effect on groundwater levels. However, it is likely that the increased use of SWP water could mitigate these adverse effects.

WATER CONSERVATION

Water conservation programs existing in the Antelope Valley are primarily directed at urban areas. These programs are provided through agencies like the City of Lancaster, the LACWW, PWD and RCSD. Urban water conservation programs in the Antelope Valley include ordinances, literature and advertising, and phased water conservation plans. The Agricultural Stabilization and Conservation Service (ASCS) office provides agricultural conservation programs for farmers and ranchers. The



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Supply and Projected Demand
(Includes Delivery Reductions)

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Figure ES-5

Figure ES-5

ASCS provides an Agricultural Conservation Program (ACP) which offers cost sharing to farmers and ranchers to encourage conservation practices on agricultural land that will result in long-term benefits. The Federal Government pays up to 80 percent of the cost of needed conservation practices.

Urban water conservation measures are identified in the September 1991 Memorandum of Understanding Regarding Urban Water Conservation in California and the Urban Water Management Planning Act. The Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California was entered into in 1991 by urban water suppliers, public advocacy organizations and other interested groups who recognized the need for conservation due to increasing water demands for urban, agricultural and environmental uses. Urban water conservation practices or Best Management Practices (BMPs) identified in the MOU are intended to reduce long-term urban water demands. In addition to identifying BMPs, the MOU also included Potential Best Management Practices (PBMPs). The intent of the MOU was to study and then determine whether or not the PBMP's met the criteria designated as BMPs. The Urban Water Management Planning Act requires urban water retailers supplying more than 3,000 acre-feet of water per year or serving more than 3,000 customers to prepare an Urban Water Management Plan (UWMP) to achieve conservation and efficient use of water. The Act requires the UWMP to evaluate specific water management practices.

Agricultural water conservation measures are identified in the Department of Water Resources (DWR) November 1993 draft "California Water Plan Update" (Bulletin 160). Enactment of the Agricultural Water Suppliers Efficient Water Management Act in 1990 requires the DWR to establish an advisory committee to evaluate Efficient Water Management Practices (EWMPs) for agricultural water suppliers. According to Bulletin 160, the advisory committee is working to develop a process for implementation of EWMPs through the agricultural water management plans required under the California Agricultural Water Management Planning Act. A current assessment of the impact of implementation of EWMPs is not available through the DWR.

Although not currently in operation in the Antelope Valley, the Mobile Agricultural Water Conservation Laboratory (Mobile Lab) program can be regarded as a potential conservation program for the Valley. The Mobile Lab operates under the leadership of the local Resource Conservation District, with technical and management assistance from the local Soil Conservation Services (SCS) Field Office. The Mobile Lab provides agricultural growers with individual, site-specific performance evaluations of their irrigation systems by measuring efficiency of the systems. Data are collected for the specific site for calculations on distribution uniformity and application efficiency. Based on an analysis of the results, recommendations or suggestions are made by the Mobile Lab team on management or physical changes to improve water use efficiency of the irrigation system. The program is voluntary and free of charge.

e measures recommended for inclusion in the water conservation plan for the ıtelope Valley are listed in Table ES-3. Because agricultural water use is expected decline significantly during the planning period (1994-2020), the plan consists marily of urban conservation programs developed for the City of Palmdale, City of ncaster and Community of Rosamond. Evaluation of urban water conservation easures was performed utilizing the DWR's WaterPlan computer software. Benefit cost (B/C) analyses were performed for each recommended urban water ınservation measure to determine cost effectiveness. The overall B/C ratios for e City of Palmdale, City of Lancaster, and Community of Rosamond were ılculated to be 4.7, 3.0, and 4.5 respectively.

ıe Agricultural Water Suppliers Efficient Water Management Practices Act requires e DWR to establish an advisory committee to evaluate EWMPs aimed at ıricultural water suppliers concerning conservation of irrigation water. Because the ıaluation of the EWWPs will require detailed planning by each water agency and ill include analysis of technical feasibility, social and district economic criteria and gal feasibility of each practice, an assessment of the impact of implementation of WPs (i.e., costs and water savings) is not currently available through the DWR. ıerefore, until DWR's assessment of the EWMPs is complete, analyses of potential ıricultural conservation measures for the Valley cannot be provided. However, ıased on the available case studies, an agricultural water conservation program can ə recommended on a preliminary basis. It is recommended that a Mobile Lab ·ogram be established to serve agricultural areas in the Antelope Valley.

ın implementation schedule as well as the estimated water savings for each ɔnservation measure selected for the Antelope Valley is also shown in Table ES-3. nplementation of the urban conservation measures is assumed to begin in 1994 nd continue through the year 2020. Estimated water savings from the urban ıeasures range from 0.67 to 87,356 acre-feet for the City of Palmdale, 0.34 to 3,775 acre-feet for the City of Lancaster, and 0.34 to 7,821 acre-feet for the :ommunity of Rosamond. The estimated water savings is shown as the total mount of water saved over the entire implementation period (1994 to 2020). nplementation of the agricultural conservation measure is assumed to begin in 995 and continue through the year 2020. Estimated water savings for the gricultural measure is 68,800 acre-feet over the entire implementation period 1995 to 2020).

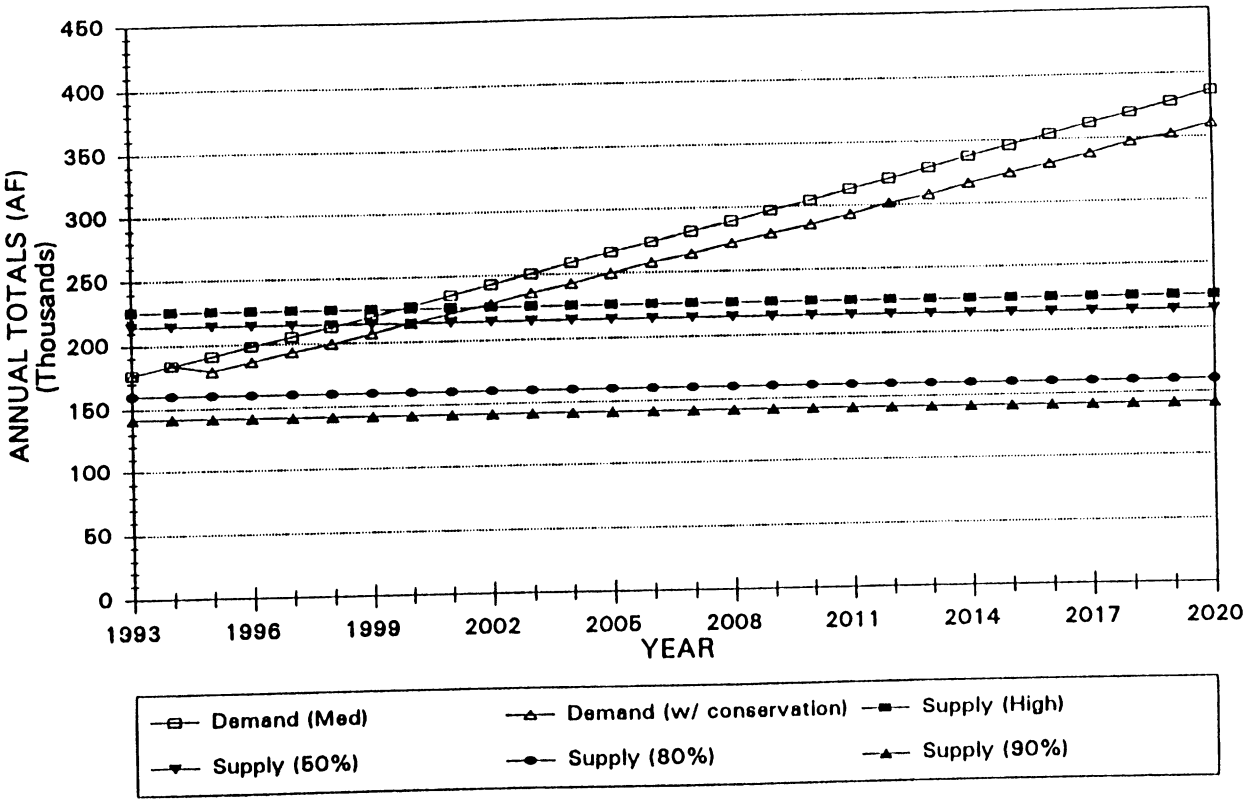
'igure ES-6 depicts the medium demand with and without implementation of :onservation measures and projected supply estimates at the 50, 80, and 90 ɔercent probability levels. The most optimistic supply assumption (i.e., delivery of 100 percent of available water supplies) is also shown. Figure ES-6 is identical to 'igure ES-5 with one exception, a second demand curve is provided to show the ıffect on the projected water demands from implementation of the conservation ɔrogram discussed in this chapter. As shown on Figure ES-6, the estimated 1993 water demand is met approximately 73 percent of the time. Without a :onservation program, by the year 1998, 100 percent water demand is estimated to ɔe met only 50 percent of the time and by the year 2000, 100 percent of the

TABLE ES-3

IMPLEMENTATION SCHEDULE
AND ESTIMATED WATER SAVINGS

Conservation Measure	Implementation Years	Estimated Water Savings (acre-feet)
City of Palmdale		
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	1994-2020	0.67
• Standards for New Large Landscapes [1]		
• Retrofit Kit Program	1994-2020	40
• Information and Education, Residential	1994-2020	7,357
• Seasonal Rates, Residential	1994-2020	78,642
• Uniform or Increasing Block Rates, Residential	1994-2020	52,415
	1994-2020	87,356
Total		225,811
City of Lancaster		
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	1994-2020	0.34
• Standards for New Large Landscapes [1]		
• Information and Education, Residential	1994-2020	80
• Residential Water Audit and Retrofit Kit	1994-2020	25,233
• Seasonal Rates, Residential	1994-2020	1,245
• Seasonal Rates, Commercial	1994-2020	43,775
• Seasonal Rates, Industrial	1994-2020	6,575
• Uniform or Increasing Block Rates, Residential	1994-2020	10,927
• Uniform or Increasing Block Rates, Commercial	1994-2020	43,775
• Uniform or Increasing Block Rates, Industrial	1994-2020	10,961
• Large Turf Irrigation Audits	1994-2020	18,210
	1994-2020	9,325
Total		170,106
Community of Rosamond		
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	1994-2020	0.34
• Standards for New Large Landscapes [1]		
• Seasonal Rates, Residential	1994-2020	40
• Uniform or Increasing Block Rates, Residential	1994-2020	5,694
• System Water Audit, Leak Detection, and Repair	1994-2020	5,694
• Residential Retrofit Kit - Minimal	1994-2020	7,821
	1994-2020	2496
Total		21,745
Agricultural		
• Mobile Lab Program	1995-2020	68,800

(1) Existing regulations



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Supply and Projected Demand
(Includes Conservation)

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Figure ES-6

Figure ES-6

potential water supplies would be required to meet the water demand. With a conservation program, by the year 2000, 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2002, 100 percent of the potential water supplies would be required to meet the water demand.

USE OF RECLAIMED WATER

The Palmdale Water Reclamation Plant (WRP), Lancaster WRP, and Rosamond WRP, and Edwards AFB WRP have the greatest potential for expansion, as well as the highest projected flows in the year 2020. Therefore, discussion of reclaimed water use focussed on these four plants. Edwards AFB WRP is discussed to a lesser extent than the other three plants because design of water reclamation facilities are already underway.

The Palmdale WRP is an undisinfected secondary treatment facility with a capacity of 8.0 million gallons per day (mgd). The Lancaster WRP is currently the only facility in Antelope Valley supplying tertiary treated water (0.6 mgd design capacity). A majority of the plant's flow is treated to a secondary treatment level. Total capacity of the plant is 10.0 mgd. The Rosamond WRP is a 2.0 mgd primary treatment facility. RCSD is planning to convert the existing system to a 2.0 mgd tertiary treatment facility in 1996. The Edwards AFB WRP is a 1.5 mgd primary treatment facility. Edwards AFB is designing a 2.5 mgd tertiary treatment facility scheduled to be constructed in 1995.

The average daily wastewater flow in the year 2020 is estimated to be 37.2 mgd for the Palmdale WRP and 29.8 mgd for the Lancaster WRP. The average daily wastewater flow in the year 2020 for the Rosamond WRP and the Edwards AFB WRP is estimated to be 3.0 and 2.5 mgd respectively.

Table ES-4 presents a list of high potential reclaimed water users identified in the report. The estimated annual, peak month, peak day and peak hour demands for the high potential reclaimed water users are also shown. The total annual reclaimed water demand is approximately 35,600 acre-feet per year. Total peak month demand is estimated to be approximately 6,300 acre-feet, and total peak day demand is estimated to be 74 million gallons or 216 acre-feet.

The recommended conceptual plan is divided into 4 main reclaimed water systems:

- Palmdale and Lancaster Tertiary System (Tertiary System)
- Palmdale and Lancaster Secondary System (Secondary System)
- Rosamond System
- Edwards AFB System

The tertiary system would serve tertiary treated reclaimed water to approximately 34 users in three service zones. Service zone maximum water surface elevations are 2,620, 2,840 and 2,920 feet above sea level. The secondary system would serve secondary treated reclaimed water to approximately 23 users in one service

TABLE ES-4

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
	Palmdale/Lancaster Tertiary System										
	2840 ZONE										
101	Palmdale High School	Existing	Tertiary	138	25.3	0.82	265.9	7	12 am - 6 am	6	739
102	Desert Aire Golf Course	Existing	Secondary-D	120	22.0	0.71	231.2	7	10 pm - 8 am	10	385
104	McAdam Park	Existing	Tertiary	72	13.2	0.43	138.7	7	10 pm - 8 am	10	231
105	Courson Park	Existing	Tertiary	23	4.1	0.13	43.4	7	10 pm - 8 am	10	72
118	Desert Rose Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
120	Tumbleweed Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
122	Cactus K-8 School	Existing	Tertiary	36	6.7	0.22	70.1	7	12 am - 6 am	6	195
124	Mesa Intermediate School	Existing	Tertiary	52	9.5	0.31	100.2	7	12 am - 6 am	6	278
	2840 ZONE TOTAL			493	90.4	2.92	949.7				2,179
	2920 ZONE										
65A	Palmdale Business Park	Future	Tertiary	118	16.6	0.54	174.6	7	12 am - 6 am	6	485
65B	Palmdale Business Park Golf Course	Future	Secondary-D	453	50.9	1.64	535.3	7	12 am - 6 am	6	1,487
100	Antelope Valley Country Club	Existing	Secondary-D	375	68.8	2.22	722.5	7	10 pm - 6 am	8	1,505
107	Desert Sands Park	Existing	Tertiary	68	12.5	0.40	131.0	7	10 pm - 8 am	10	218
121	Yucca Elementary School	Existing	Tertiary	23	4.3	0.14	45.1	7	12 am - 6 am	6	125
128	Highlands High School	Existing	Tertiary	100	18.3	0.59	192.7	7	12 am - 6 am	6	535
134	Summerwind Elementary School	Future	Tertiary	42	7.6	0.25	80.2	7	12 am - 6 am	6	223
	2920 ZONE TOTAL			1,179	179.0	5.77	1,881.4				4,579
	2620 ZONE										
52	Lancaster Business Park	Existing	Tertiary	55	10.0	0.32	105.6	7	12 am - 6 am	6	293
53A	Serrano Ranch	Future	Tertiary	329	60.3	1.95	633.9	7	12 am - 6 am	6	1,761
53B	Serrano Ranch Golf Course	Future	Secondary-D	633	116.1	3.74	1,219.7	7	12 am - 6 am	6	3,388
54	K&B Development (Tract 49864)	Future	Tertiary	47	8.6	0.28	90.2	7	12 am - 6 am	6	250
64	Fox Airfield Commercial Development	Future	Tertiary	1,920	352.0	11.35	3,699.5	7	12 am - 6 am	6	10,276
152A	Lancaster City Park	Existing	Tertiary	150	23.5	0.91	295.0	8	10 pm - 6 am	8	615

TABLE ES-4

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
152B	Lancaster City Park	Future	Tertiary	32	5.9	0.23	73.5	6	10 pm - 6 am	8	153
153	Jane Reynolds Park	Existing	Tertiary	30	5.2	0.20	64.6	6	10 pm - 6 am	8	135
154	Mariposa Park	Existing	Tertiary	28	6.2	0.24	78.3	6	10 pm - 6 am	8	163
155	Eastside Park	Existing	Tertiary	71	10.3	0.40	129.5	6	10 pm - 6 am	8	270
156	El Dorado Park	Existing	Tertiary	40	6.5	0.25	81.0	6	10 pm - 6 am	8	169
158	Skytower Park	Existing	Tertiary	48	8.8	0.34	110.3	6	10 pm - 6 am	8	230
159	Apollo Lakes County Park *	Existing	Tertiary	129	30.4	1.44	470.0	7	12 am - 6 am	6	1,306
160	Antelope Valley High School	Existing	Tertiary	130	23.8	0.77	250.5	7	12 am - 6 am	6	696
161	Desert Winds High School	Existing	Tertiary	8	1.4	0.05	14.8	7	12 am - 6 am	6	41
163	Parkview Intermediate High School	Existing	Tertiary	65	11.9	0.38	124.9	7	12 am - 6 am	6	347
169	Mariposa Elementary School	Existing	Tertiary	38	7.0	0.22	73.1	7	12 am - 6 am	6	203
170	Joshua Elementary School	Existing	Tertiary	56	10.3	0.33	108.7	7	12 am - 6 am	6	302
171	El Dorado Elementary School	Existing	Tertiary	25	4.6	0.15	48.6	7	12 am - 6 am	6	135
172	Linda Verde Elementary School	Existing	Tertiary	28	5.1	0.16	53.6	7	12 am - 6 am	6	149
175A	Joshua Memorial Park	Existing	Secondary-D	90	16.5	0.53	173.4	7	12 am - 6 am	6	482
175B	Joshua Memorial Park	Future	Secondary-D	21	3.9	0.12	40.5	7	12 am - 6 am	6	112
186	New Vista Elementary School	Future	Tertiary	43	7.9	0.26	83.2	7	12 am - 6 am	6	231
	2620 ZONE TOTAL			4,016	736	25	8,022				21,706
	Tertiary System Total			5,688	1,006	33	10,853				28,463
	Palmdale/Lancaster Secondary System										
2	Alfalfa Farm	Existing	Secondary-U	1,151	214.6	7.40	2,627.4	7	12 am - 12 am	24	1,825
2A	Alfalfa Farm	Existing	Secondary-U	1,306	243.6	8.40	2,982.4	7	12 am - 12 am	24	2,071
4	Grain & Alfalfa Farm	Existing	Secondary-U	2,895	540.6	18.90	6,553.8	7	12 am - 12 am	24	4,551
5	Alfalfa Farm	Existing	Secondary-U	2,706	504.6	17.40	6,177.9	7	12 am - 12 am	24	4,290
6A	Alfalfa Farm	Existing	Secondary-U	1,866	348.0	12.00	4,260.6	7	12 am - 12 am	24	2,959
6B	Alfalfa Farm	Existing	Secondary-U	1,120	208.8	7.20	2,556.4	7	12 am - 12 am	24	1,775
8	Nebeker Ranch *	Existing	Secondary-U	4,229	788.8	27.20	9,657.3	7	12 am - 12 am	24	6,706
9	Alfalfa Farm	Existing	Secondary-U	1,617	301.6	10.40	3,692.5	7	12 am - 12 am	24	2,564
9A	Alfalfa Farm	Existing	Secondary-U	746	139.2	4.80	1,704.2	7	12 am - 12 am	24	1,184
11	Alfalfa Farm	Existing	Secondary-U	1,244	232.0	8.00	2,840.4	7	12 am - 12 am	24	1,973
12A	Christmas Tree & Landscape Farm *	Existing	Secondary-U	81	18.8	0.80	233.9	7	12 am - 12 am	24	162

zone (maximum water surface elevation of 2,680 feet). The Rosamond system would serve tertiary treated water to approximately 20 users in one service zone (maximum water surface elevation of 2,620 feet).

Main pump stations would be located at the reclaimed water supply. Each of the service zones would contain storage reservoirs, distribution system piping, and booster pump stations.

The estimated construction cost of the reclaimed water system is shown in Table ES-5. As shown in the table, the treatment facilities for the tertiary and the Rosamond systems are $24,417,000 and $7,731,000 respectively. The distribution facilities for the tertiary, secondary, and Rosamond systems are $36,456,000, $67,486,000, and $8,296,000 respectively. The total cost for construction of the entire regional system is approximately $144,386,000 (1994 dollars). Construction costs include 15 percent for contractor overhead and profit, 20 percent for engineering/administration and 25 percent for contingencies.

Edwards AFB is currently designing a 2.5-mgd tertiary wastewater treatment plant. The following is a list of facilities for the planned reclaimed water distribution system:

- A 3,125-gpm main pump station at the wastewater treatment plant.
- A 3,125-gpm booster pump station.
- A 2.2-mg storage reservoir.
- Approximately 31,740 feet of PVC pipe ranging from 4 to 18 inches in diameter.

The estimated capital cost of the planned distribution facilities is $6,300,000. Operation and Maintenance (O&M) costs were estimated to be $140,000 per year.

Table ES-6 shows the unit cost of the reclaimed water distribution facilities and the unit cost of the treatment facilities for each system. As shown in the table, the unit cost for the distribution facilities for the tertiary, secondary and Rosamond systems are $858, $359 and $1,218 per acre-foot respectively (includes annualized capital). The unit cost for the treatment facilities for the tertiary and Rosamond systems are $999 and $1,649 per acre-foot respectively (includes annualized capital). Total unit cost (distribution and treatment) for the tertiary, secondary and Rosamond systems are $1,857, $359 and $2,867 per acre-foot. These costs assume construction of the project is financed at market rates instead of low interest loans. The unit costs would be reduced if low interest loans were utilized for construction financing.

Figure ES-7 depicts the medium demand with and without implementation of conservation measures and projected supply estimated at the 50, 80, and 90 percent probability levels. The most optimistic supply assumption (i.e., delivery of

TABLE ES-5

PRELIMINARY COST ESTIMATE

COMPONENT	ESTIMATED COST (1994 Dollars)	COMPONENT	ESTIMATED COST (1994 Dollars)
I. Treatment Facilities			
A. Tertiary System		B. Secondary System	
Palmdale - 3.0 mgd	$ 6,200,000	1. Main Pump Stations	
Lancaster - 8.0 mgd	9,061,000	Palmdale - 25,800 gpm	$ 2,591,000
		Lancaster - 15,700 gpm	1,846,000
SUBTOTAL	$ 15,261,000		
Contractor's OH & Profit (15%)	2,289,000	2. Booster Pump Stations	
Engineering/Admin (20%)	3,052,000	No. 6 - 3,000 gpm	$ 421,000
Contingency (25%)	3,815,000		
TOTAL (Tertiary System)	$ 24,417,000	3. Open Reservoir	
		No. 6 - 400 AF	$ 9,123,000
B. Rosamond System		No. 7 - 565 AF	3,682,000
Rosamond - 2.0 mgd	$ 4,832,000		
		4. Distribution Pipelines	
SUBTOTAL	4,832,000	42-inch D.I. (43,100 LF)	$9,051,000
Contractor's OH & Profit (15%)	725,000	36-inch D.I. (48,800 LF)	8,784,000
Engineering/Admin (20%)	966,000	24-inch D.I. (15,840 LF)	1,901,000
Contingency (25%)	1,028,000	20-inch D.I. (14,700 LF)	1,470,000
TOTAL (Rosamond System)	$ 7,731,000	16-inch D.I. (5,400 LF)	432,000
		14-inch D.I. (18,700 LF)	1,309,000
TOTAL (Treatment Facilities)	$ 32,148,000	12-inch D.I. (5,500 LF)	330,000
		10-inch D.I. (20,500 LF)	1,025,000
II. Distribution Facilities		6-inch D.I. (1,300 LF)	39,000
A. Tertiary System			
1. Main Pump Stations		5. System Flushing and Testing	$ 174,000
Palmdale - 2,000 gpm			
Lancaster - 5,600 gpm	$ 518,000	SUBTOTAL	$ 42,178,000
	1,004,000	Contractor's OH & Profit (15%)	6,327,000
2. Booster Pump Stations		Engineering/Admin (20%)	8,436,000
No. 1 - 1,320 gpm		Contingency (25%)	10,545,000
No. 2 - 1,520 gpm	$ 249,000	TOTAL (Secondary System)	$ 67,486,000
No. 3 - 5,660 gpm	275,000		
No. 4 - 8,935 gpm	648,000	C. Rosamond System	
No, 5 - 5,600 gpm	875,000	1. Main Pump Station	
	648,000	Rosamond - 1,050 gpm	$ 324,000
3. Reservoirs			
No. 1. - 1.0 mg		2. Booster Pump Stations	
No. 2. - 2.0 mg	$ 500,000	No. 7 - 1,611 gpm	$ 288,000
No. 3. - 1.0 mg	1,000,000		
No, 4. - 2.4 mg	500,000	3. Reservoirs	
No. 5. - 4.6 mg	1,200,000	No. 9 - 1.5 mg	$ 750,000
	2,300,000		
4. Distribution Pipelines		4. Distribution Pipelines	
30-inch D.I. (100 LF)		16-inch PVC (2,200 LF)	$ 128,000
24-inch PVC (1,600 LF)	$ 15,000	12-inch PVC (39,200 LF)	1,882,000
18-inch PVC (93,800 LF)	154,000	10-inch PVC (19,400 LF)	776,000
16-inch PVC (9,500 LF)	6,754,000	8-inch PVC (21,800 LF)	698,000
14-inch PVC (43,700 LF)	608,000	6-inch PVC (8,600 LF)	206,000
12-inch PVC (27,600 LF)	2,447,000		
10-inch PVC (7,500 LF)	1,325,000	5. System Flushing and Testing	$ 91,000
8-inch PVC (7,500 LF)	996,000		
6-inch PVC (12,800 LF)	240,000	SUBTOTAL	$ 5,143,000
	307,000	Contractor's OH & Profit (15%)	771,000
5. System Flushing and Testing		Engineering/Admin (20%)	1,029,000
	$ 222,000	Contingency (25%)	1,353,000
SUBTOTAL		TOTAL (Rosamond System)	$ 8,296,000
Contractor's OH & Profit (15%)	$ 22,785,000		
Engineering/Admin (20%)	3,418,000	TOTAL (Distribution Facilities)	$112,238,000
Contingency (25%)	4,557,000		
TOTAL	5,696,000		
	$36,456,000		
CONTINUED ON RIGHT			
		GRAND TOTAL	$144,386,000

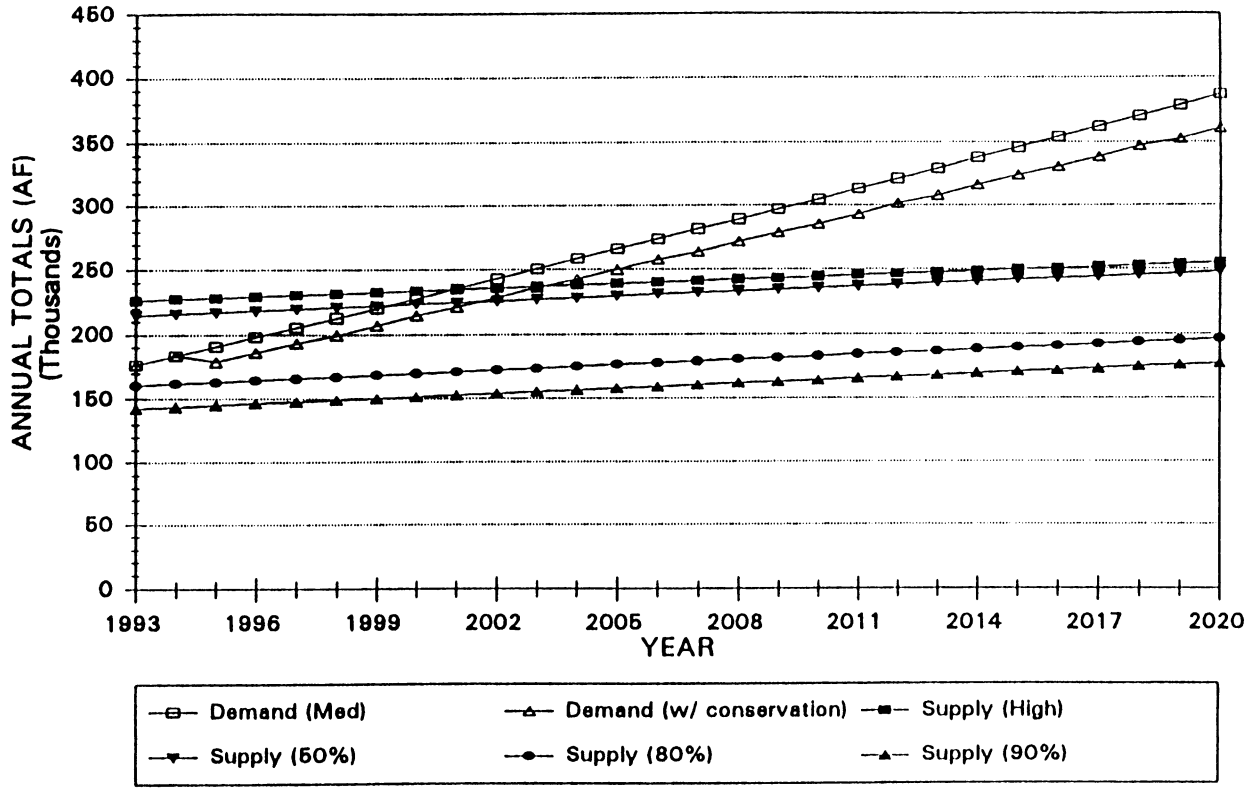
TABLE ES-6

ECONOMIC ANALYSIS OF THE RECLAIMED WATER SYSTEMS
(1994 DOLLARS)

Distribution Facilities	Reclaimed Water Demand (AR/YR)	Annualized Construction Cost [1]	Annual Water Purchases Cost [2]	ANNUAL O&M COST				Includes Annual Capital Cost		Excludes Annual Capital Cost	
				Pumping Cost [3]	Parts Cost [4]	Labor Cost [5]	Total O&M Cost	Total Annual Cost	Cost per AF	Total Annual Cost	Cost per AF
Tertiary System	5,688	$3,714,866	$341,280	$709,145	$84,725	$28,800	$822,670	$4,878,816	$858	$1,163,950	$205
Secondary System	26,493	$6,876,823	$1,589,580	$899,800	$120,024	$14,400	$1,034,224	$9,500,627	$359	$2,623,804	$99
Rosamond System	758	$845,363	$0	$55,200	$14,786	$7,200	$77,186	$922,549	$1,218	$77,186	$102
TOTAL	32,939	$11,437,052	$1,930,860	$1,664,145	$219,535	$50,400	$1,934,080	$15,301,992	$465	$3,864,940	$117

Treatment Facilities	Reclaimed Water Demand (AF/YR)	Annualized Construction Cost [1]	Annual O&M Cost [6]	Includes Annual Capital Cost		Excludes Annual Capital Cost	
				Total Annual Cost	Cost per AF	Total Annual Cost	Cost per AF
Tertiary System	5,688	$2,488,092	$2,195,370	$5,683,462	$999	$2,195,370	$386
Rosamond System	758	$787,789	$462,000	$1,249,789	$1,649	$462,000	$609
TOTAL	6,446	$3,275,881	$57,370	$6,933,251	$1,076	$2,657,370	$412

(1) Assumes 20 year period at 8%interest rate.
(2) For tertiary and secondary systems, cost to purchase reclaimed water from County Sanitation Districts of Los Angeles County. Current cost estimated to be $60/acre-feet. For Rosamond system; assumed RCSD operates WRP and purveys water.
(3) Assumes 80% pump efficiency, 90% motor efficiency, and electricity cost of $0.10 per Kwhr. Includes operation costs of booster and reuse pumps.
(4) Assumes annual parts cost to be 1% of construction costs of pumping stations, plus 0.1% of construction costs of storage reservoirs and pipelines.
(5) Assumes $25 per hour.
(6) From Dave Richards "A Summary of Wastewater Reclamation Costs in California".



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Antelope Valley Water Resources Study

Supply and Projected Demand
(Includes Reclaimed Water Use)

August 1994
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Figure ES-7

Figure ES-7

100 percent of available water supplies) is also shown. Figure ES-7 is based on Figures ES-5 and ES-6 with one exception, the reclaimed water supply for the year 2020 is taken as the supply that will meet the demand for the high potential reclaimed water users identified in Table ES-4 (approximately 35,600 acre-feet). As shown on Figure ES-7, the estimated 1993 water demand is met approximately 73 percent of the time. Without a conservation program and including the reclaimed water system identified in this report, by the year 1999, 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2001, 100 percent of the potential water supplies would be required to meet the water demand. With a conservation program and including the reclaimed water system, by the year 2002, 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2003, 100 percent of the potential water supplies would be required to meet the water demand.

AQUIFER STORAGE AND RECOVERY

Aquifer Storage and Recovery (ASR) include the following methods of storing and recovering water from the groundwater basin:

- Spreading/Infiltration - use of surface spreading basins to allow infiltration of water into the aquifer.

- Injection - use of new or existing wells for direct injection of water into the aquifer.

- In-lieu Use - use of an alternative source of water, other than groundwater, when available, and use of groundwater when the alternative source is unavailable.

The entire groundwater basin of the Antelope Valley is estimated to have 68 million acre-feet of storage of which 13 million acre-feet is currently available (DWR, 1980). Approximately 55 million acre-feet of groundwater was estimated to remain in storage as of 1975. This stored water, however, may not be accessible due to uneconomical pumping depths and distance between the groundwater basin and current users.

At present, the principal source of recharge of the groundwater in the Antelope Valley is runoff, principally recharged in the foothills of the mountains. Numerous studies have been conducted to estimate natural recharge since 1924, some based on little data. The most recent studies estimate natural recharge at 31,200 to 59,100 acre-feet per year (USGS, 1993).

There are a variety of source waters that could be available for recharge into the groundwater of the Antelope Valley. They include:

- SWP
  - Treated potable water
  - Untreated water directly from the California Aqueduct

- Reclaimed Water (for spreading only)
  - Secondary treatment
  - Tertiary treatment

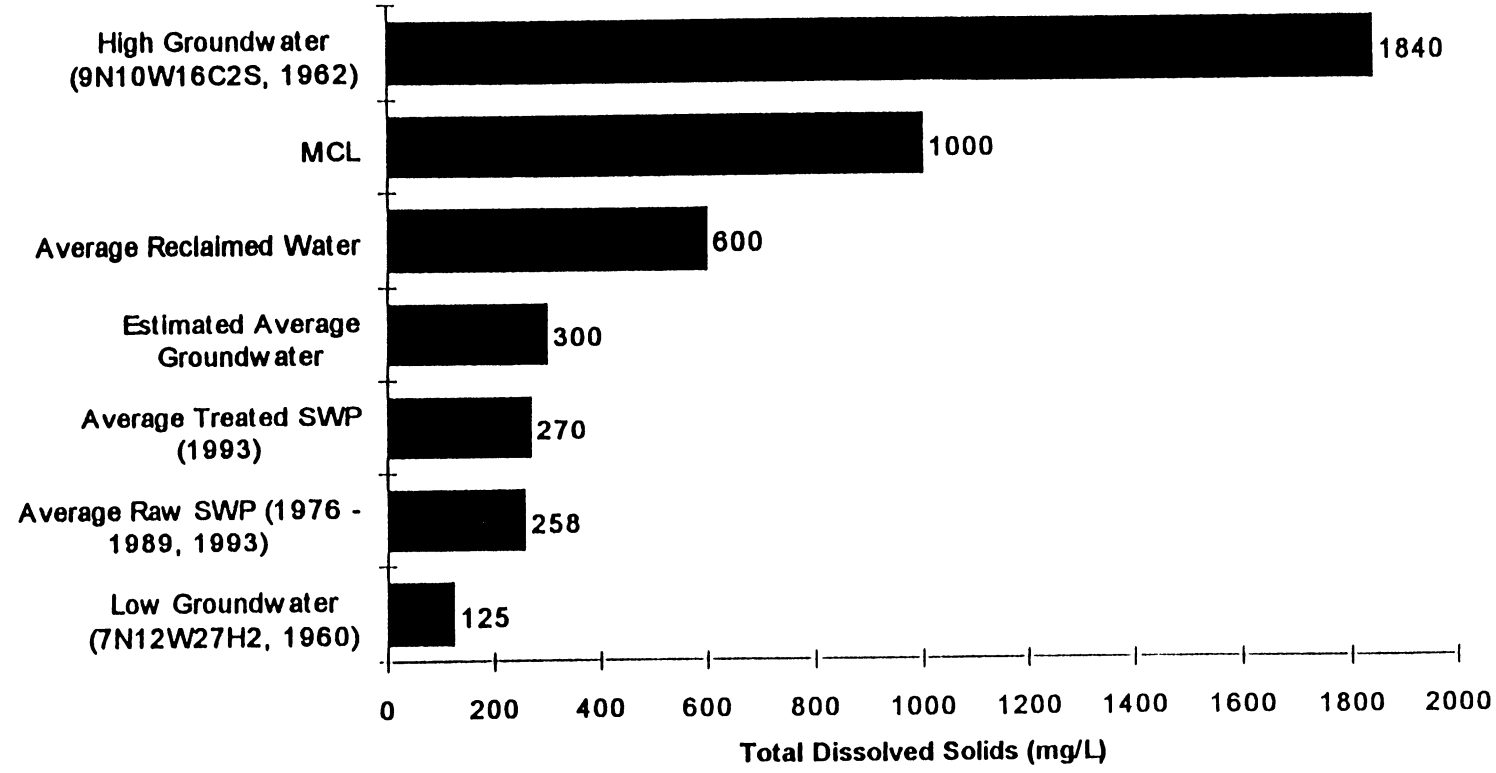
- Surface Water
  - Little Rock Creek and Little Rock Reservoir
  - Big Rock Creek
  - Amargosa Creek

The range in total dissolved solids (TDS) values of the potential sources of groundwater in the Antelope Valley is shown on Figure ES-8. The average raw SWP TDS values is an average of the annual average from 1976 to 1989 and 1993 (1993 TDS average is obtained from the average of January through June of 1993). The highest groundwater TDS level within the wells for which data were evaluated was 1840 mg/L in a well located on Edwards AFB where perched water tables and the accompanying high salts occur. The low groundwater TDS of 125 mg/L occurred in a well in the LACWW wellfield near Lancaster. The average TDS value was estimated at about 300 mg/L based on the wells for which water quality was evaluated.

Certain characteristics affect economic viability and technical feasibility and are a key to a successful ASR program. If the aquifer is unsuitable for groundwater extraction, it is likely to be unsuitable for groundwater infiltration or injection. The following characteristics are desirable for both infiltration and injection programs:

- Suitable surface and sub-surface hydrogeologic conditions
- Adequate storage capacity
- Proximity to potential recharge water sources
- Proximity to existing groundwater production sites
- Impermeable faults to impound groundwater
- Compatible water quality

Both infiltration and injection require aquifer materials that have a high ability to accept and transmit water. These materials include sands and gravels at the surface for rapid infiltration and in the subsurface for rapid acceptance of injected water. As previously mentioned, there is an estimated available storage of 13 million acre-feet in the Antelope Valley aquifer. In order to have a cost-effective recharge program, the potential recharge sites should be located within a reasonable distance and hydraulic gradient of the potential source waters. Potential infiltration and injection sites should be assessed relative to the location of the existing facilities in order to minimize capital costs. In certain instances where it is



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Water Quality Comparison in Antelope Valley

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K/J 934620.00

Figure ES-8

Note: Groundwater samples collected between 1960 - 1992 at wells in Antelope Valley

necessary to control the ultimate storage location of the infiltrated or injected groundwaters, fault and bedrock control of the groundwater impound may be a necessary characteristic that will need to be investigated further. In addition, it is important that the potential recharge site has good quality groundwater that will not compromise the quality of the water to be infiltrated or injected.

Based on the characteristics favorable to a good surface infiltration site and previous work that has been conducted in assessing infiltration sites, the following areas have been focussed on for more detailed analysis:

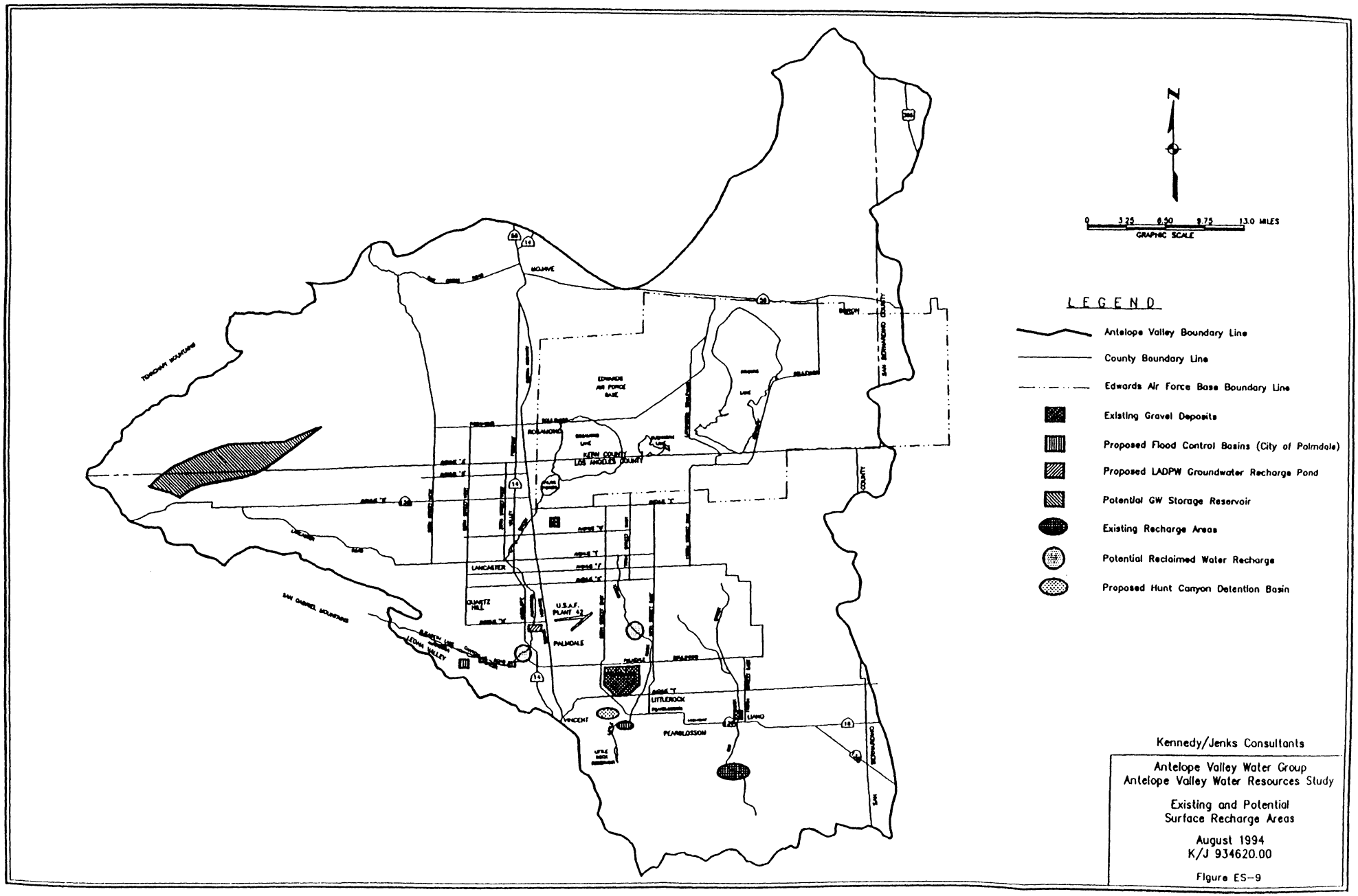
- Little Rock Creek
- Big Rock Creek
- Amargosa Creek
- West Antelope Subunit
- Groundwater recharge zones described in the Los Angeles County Flood Control District (LACFCD) "Comprehensive Plan of Flood Control and Water Conservation," dated June 1987.

The general location of existing and potential surface recharge sites can be found on Figure ES-9. Infiltration as a mechanism to recharge groundwater appears to be technically feasible. The sites with the highest potential for recharge by spreading appear to be:

- Amargosa Creek south of Avenue "N" between 10th Street west and Division Street (LACDPW Site).
- Little Rock Creek near Avenue "N" between 60th Street and 70th Street East (DOA Property).
- Amargosa Creek near Elizabeth Lake Road and 25th Street West.

There are several potential recharge sources including SWP, reclaimed water, and natural recharge waters which should be generally acceptable for infiltration from a water quality perspective. More detailed water quality analyses should be conducted at the potential recharge sites to gather current information on the condition of the aquifer in these specific locations. Until those data are available, comparisons of water quality with the potential recharge sources cannot be reliably made. If specific areas for recharge are selected that have water quality that is worse than the potential source waters, the recharge program may benefit the aquifer.

In addition, the potential formation of wetlands at the LACDPW site and the DOA site could result in increased wildfowl activity that could interfere with airfield


N
0 3.25 6.50 9.75 13.0 MILES
GRAPHIC SCALE
LEGEND
Antelope Valley Boundary Line
County Boundary Line
Edwards Air Force Base Boundary Line
Existing Gravel Deposits
Proposed Flood Control Basins (City of Palmdale)
Proposed LADPW Groundwater Recharge Pond
Potential GW Storage Reservoir
Existing Recharge Areas
Potential Reclaimed Water Recharge
Proposed Hunt Canyon Detention Basin
TEHACHAPI MOUNTAINS
SAN GABRIEL MOUNTAINS
MOJAVE
EDWARDS AIR FORCE BASE
ROSAMOND
KERN COUNTY
LOS ANGELES COUNTY
LANCASTER
QUARTZ HILL
U.S.A.F. PLANT 42
PALMDALE
LITTLEROCK
VINCENT
PEARBLOSSON
LLANO
SAN BERNARDINO COUNTY
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Existing and Potential
Surface Recharge Areas
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Figure ES-9

operations. Depending on the timing of the operation of spreading ponds at the sites, this concern could be mitigated or reduced by developing an operation plan that accounts for migration patterns of the wildfowl.

Overall, further investigation will be required at each of the specific sites and should include, at a minimum, the following:

- Water quality of source waters and groundwater.
- Quantity and timing of availability of source waters.
- Hydrogeologic characteristics including travel times through unsaturated zones and percolation rates.
- Concerns of wildfowl interference at airfield operations
- Location of extraction sites and travel times to those sites.

The municipal wellfields within the existing LACWW and PWD municipal wellfields were considered potential injection areas (See Figure ES-10). Specific areas within the wellfields that have been assessed include:

- Potential LACDPW wells at Avenue K-8 and Division Street.
- Wells in USGS/LACWW/AVEK Injection Study.

Injection has not been extensively studied in the Valley, however, groundwater recharge by injection appears to be technically feasible. The existing wellfields could provide both the injection and extraction facilities necessary to conduct such a program. The specific areas that should be explored further because of their proximity to the distribution system and potential treated SWP water are:

- LACWW wells located:
  - South of Avenue "K" between 10th Street West and Division Street (where USGS is conducting its injection study).
  - South of Avenue "L" between 10th Street West and Division Street (adjacent to the area above).
- PWD wells south of Avenue "P" between 20th Street East and 40th Street East.

It appears that treated SWP water should be generally acceptable for injection from a water quality perspective. The presence of trihalomethanes (THMs) in the treated SWP water may require treatment and/or alternative disinfection methods.

However, more detailed water quality analyses will have to be conducted at the potential injection sites to gather current information on the condition of the aquifer water quality in these specific locations. Until those data are available, comparisons of water quality with the potential recharge source cannot be reliably made. If specific areas for recharge are selected that have water quality that is worse than the potential source waters (i.e. higher nitrates), the recharge program may benefit the aquifer.

Depending on the results of the USGS's injection study, significant additional work will be required and should include, at a minimum, the following:

- Estimation of the actual volumes that could be injected at each site.
- Evaluation of aquifer behavior during injection and extraction and a determination of aquifer characteristics at specific sites.
- Evaluation of potential ground surface effects during injection and extraction.
- Determination of upgrades that may be required at each well and pump station.
- Evaluation of the operation of the injection/extraction system based on the availability of treated SWP water.
- Evaluation of the potential changes to water treatment plant operations that may be required to continue injection and extraction over the long-term.

EFFECTS OF CHANGES IN GROUNDWATER LEVELS

According to the USGS, groundwater levels in the Lancaster area have declined by as much as 200 feet from 1915 to 1988 (USGS, 1994). Conversely, well hydrographs maintained by AVEK indicate groundwater levels in portions of the Valley have risen in recent years. Declining groundwater levels over a long period of time generally indicate over-extraction from a groundwater basin; conversely, increasing groundwater levels over a long period of time may indicate under-extraction from a basin (or recovery from over-extraction). In addition to these obvious indications, changes in groundwater levels are of concern, because a variety of damages can result.

Potential damages attributable to changes in groundwater levels include land subsidence, increased pumping costs, waterlogging, and water quality degradation. Damages can range from minor structural damage to major physical damage to the ground surface rendering land virtually useless. Table ES-7 lists potential damages attributable to changes in groundwater levels. As indicated in Table ES-7, declining groundwater levels potentially result in two primary damages: 1) land subsidence and 2) increased pumping costs. Land subsidence is defined by USGS as the vertical lowering of the land surface over an area of many square miles (USGS,

TABLE ES-7

POTENTIAL DAMAGES ATTRIBUTABLE TO CHANGES IN GROUNDWATER LEVELS

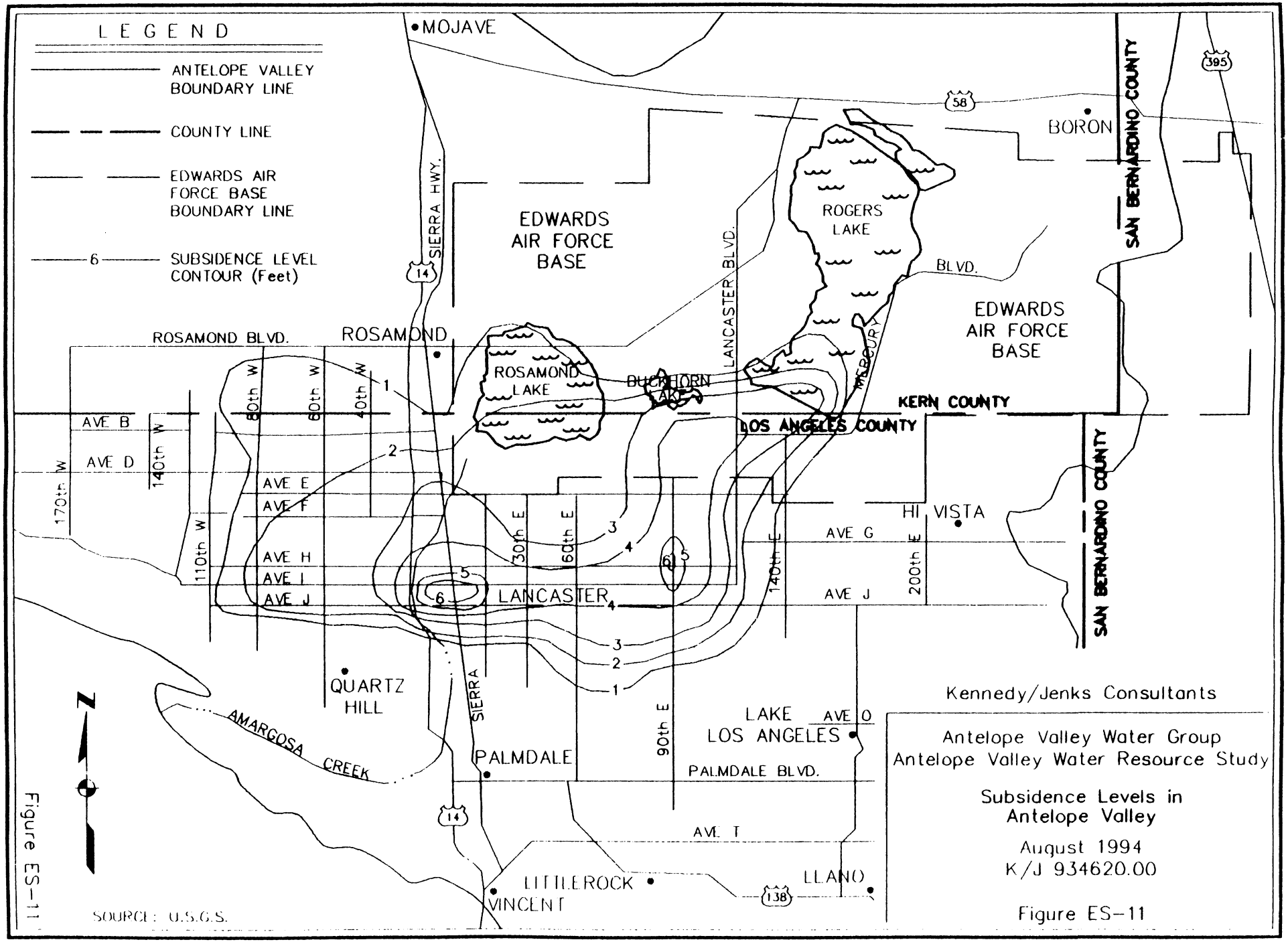
Declining Groundwater Levels	Increasing Groundwater Levels
Land subsidence resulting in the following: • Development of cracks, fissures, sinklike depressions and softspots. • Change in natural drainage patterns often resulting in increased areas of flooding or increased erosion. • Degradation of groundwater quality. • Reduction in groundwater storage. • Change in gradient in gravity pipelines (sanitary and storm sewers) or canals often resulting in lost capacity. • Damage to well casings, pipelines, buildings, roads, railroads, bridges, levees, etc. • Costs associated with repairs and rebuilding. • Costs associated with construction of new facilities such as pumping stations for gradient changes. • Reduction in land value. • Lawsuits. Increased pumping costs	Waterlogging resulting in the following: • Increased liquefaction potential. • Structural damage. • Rendering septic systems useless. • Costs associated with repairs and rebuilding. • Reduction in land value. Water quality degradation.

1991) and may be the result of a variety of causes. Regardless of the cause of land subsidence, the resulting damages are similar. In general, damages will be most pronounced when subsidence gradients (change in subsidence levels over a given distance) are high. Increased pumping costs result directly from declining groundwater levels. As the pumping lift increases so does the power cost to lift the water. As groundwater declines, additional pump bowls and larger motors may be necessary.

Potential damages attributable to increasing groundwater levels include waterlogging and water quality degradation. Waterlogging is defined as saturation of soil with water. The effects of waterlogging are dependent not only upon the elevation of the groundwater table but also on the soil type. Generally, the effects or waterlogging will be most noticeable in granular soils. Water quality degradation can result from nitrates being drawn down into the aquifers by rising groundwater levels and then being spread by depressions caused from overpumping. Nitrates are the end product of aerobic stabilization of organic nitrogen, and as such occur in polluted waters that have undergone self-purification. Nitrate in groundwater can come from fertilizer, poultry manure, or domestic wastewater. Nitrates can cause blue baby syndrome which can be fatal for infants.

Subsidence levels of up to 7 feet have occurred in some areas of Antelope Valley. (See Figure ES-11.) Conversations held with various agencies and companies indicate that within the Antelope Valley, the Lancaster and Edwards AFB areas are currently experiencing problems or damages that appear to be related to land subsidence. USGS (1992) reported that as much as 2 feet of land subsidence had affected Antelope Valley by 1967 and was causing surface deformations at Edwards AFB. Fissures, cracks and depressions on Rogers Lakebed were affecting the use of the lakebed as a runway for airplanes and space shuttles. A paper by Thomas L. Holzer and Malcolm Clark titled "Earth Fissure in T7N, R11W, Section 3 near Lancaster, California" in January 1981, identified a fissure measuring approximately 0.35 miles long, up to 7.5 feet deep and 3 feet wide located between Avenues G and H and between 50th and 60th Streets East. A study done by Geolabs - Westlake Village (1991) studied a 10 square mile area in Lancaster identified to have fissures and sinklike depressions. The report identified fissures ranging in width from one inch to slightly over one foot. The lengths of the fissures ranged mainly between 50-200 feet, with the longest continuous fissures in the 600-700 foot range. Sinkholes ranged mainly between one to five feet deep and less than four feet in diameter. One sinkhole measured 20 feet long and 15 feet wide. Other potentially significant damages identified and may or may not be attributable to land subsidence include structural damage to the wastewater treatment plant building on Edwards AFB, cracked sidewalks and pavement.

Increasing groundwater levels have occurred in portions of the Valley. For most of these areas, no damage related to these increases has been identified, due to the fact the groundwater level is still significantly below the ground surface. However, for the Leona Valley area in the southern portion of the Valley, damages potentially attributable to increasing groundwater levels were identified in April 1993. The


LEGEND
ANTELOPE VALLEY BOUNDARY LINE
COUNTY LINE
EDWARDS AIR FORCE BASE BOUNDARY LINE
6
SUBSIDENCE LEVEL CONTOUR (Feet)
MOJAVE
BORON
ROGERS LAKE
EDWARDS AIR FORCE BASE
SIERRA HWY.
LANCASTER BLVD.
MERCURY BLVD.
SAN BERNARDINO COUNTY
ROSAMOND BLVD.
ROSAMOND
ROSAMOND LAKE
BUCKHORN LAKE
KERN COUNTY
LOS ANGELES COUNTY
AVE B
AVE D
AVE E
AVE F
AVE H
AVE I
AVE J
AVE G
60th W
40th W
140th W
170th W
110th W
30th E
60th E
140th E
200th E
HI VISTA
LANCASTER
QUARTZ HILL
AMARGOSA CREEK
SIERRA
90th E
LAKE LOS ANGELES
AVE O
PALMDALE
PALMDALE BLVD.
AVE T
LITTLEROCK
VINCENT
LLANO
SOURCE: U.S.G.S.
Kennedy/Jenks Consultants
Antelope Valley Water Group
Antelope Valley Water Resource Study
Subsidence Levels in Antelope Valley
August 1994
K/J 934620.00
Figure ES-11
Figure ES-11

apparent damages appear to be typical and include waterlogging and water quality degradation. The Lake Elizabeth/Lake Hughes area experienced similar problems with the appearance of springs. Springs were discovered under homes and a number of leach fields for septic tanks were rendered useless, requiring residents to have the tanks pumped out weekly.

2.2 Interview each of the participating agencies for information on their concerns, ideas, and planned projects.

Task 3 - Assess Water Resources

3.1 Collect and review USGS data on past, present, and future water demands (USGS Elements I and II); past and present sources of supply; and future availability of local groundwater supplies.

3.2 Identify the available sources of reclaimed water, the quantity of reclaimed water available projected to the year 2020, and the current uses of reclaimed water.

3.3 Using probability analysis, assess the reliability of surface water provided by the Littlerock Dam and reclaimed water.

3.4 Collect the reliability analyses from the State Department of Water Resources and the Metropolitan Water District of Southern California and use these evaluations to assess the reliability of SWP water, based on both current SWP facilities and projects proposed to enhance the SWP yield.

3.5 Perform a risk analysis of the ability of local and imported water supplies, including reclaimed water and proposed SWP enhancement projects, to meet water demands to the year 2020.

3.6 Based on data gathered in subtask 3.1, assess the effects of variations in SWP water supply on groundwater levels by comparing historical groundwater levels to historical SWP water supplies.

3.7 Based on data gathered in subtask 3.1, assess the effects on groundwater levels of a transition from a predominantly agricultural demand (highly dependent upon groundwater) to a M&I demand.

Task 4 - Evaluate Feasibility of Implementing Aquifer Storage and Recovery Methods

4.1 Collect and review information from USGS (USGS Element III and IV) and existing studies on the hydrogeologic characteristics of the basin.

OBJECTIVES

The primary objective of AVWG's water resource study is to develop consensus on a water resource management plan that addresses the need of the M&I purveyors to reliably provide the quantity and quality of water necessary to serve the growth projected by the planning agencies while concurrently addressing the need of agricultural users to have adequate supplies of reasonable cost irrigation water.

In order to achieve this objective, the following specific goals were developed:

- To provide the technical foundation for the consensus plan.
- To develop an innovative water resource development plan that optimizes existing resources.
- To achieve an acceptable compromise between urban and agricultural objectives.
- To develop a water resource management strategy to implement the consensus plan.

SCOPE OF SERVICES

To accomplish the objectives, the following scope of services was developed:

Task 1 - Project Management

1.1 Attend a kick-off meeting to discuss the scope of work and applicable procedures for the project and to collect available background data from the meeting participants.

1.2 Prepare a monthly technical memorandum discussing project status, preliminary findings, and project direction to be distributed to the Technical Advisory Committee members and USGS for review.

1.3 Prepare an agenda and organize and chair meetings of the Technical Advisory Committee and USGS to discuss the technical memorandum and other issues.

1.4 Conduct public meetings on status and results of the study.

Task 2 - Collect and Review Available Studies

2.1 Collect and review available studies.

4.2 From data gathered from USGS and supplemental information gathered from Los Angeles County and Department of Water Resources, inventory wells within the basin.

4.3 Based on data collected in subtask 4.1, identify areas suitable for groundwater recharge by surface infiltration or subsurface injection.

4.4 Review the basin plan prepared by the Regional Water Quality Control Board.

4.5 Based on information collected in subtask 4.1 and 4.4, assess the effect on groundwater quality of recharge of treated and untreated potable water.

4.6 Based on information collected in subtask 4.1 and 4.4, assess the effect on groundwater quality of recharge of reclaimed water.

Task 5 - Evaluate the Feasibility of Use of Reclaimed Water

5.1 Identify potential users of reclaimed water and their corresponding water demands.

5.2 Evaluate the cost and feasibility of converting the existing wastewater treatment plants to tertiary treatment.

5.3 Evaluate the cost and feasibility of constructing a backbone reclaimed water system.

5.4 Based on subtasks 4.6 and 5.1 through 5.3 , develop a conceptual plan for use of reclaimed water.

Task 6 - Develop and Evaluate Water Conservation Alternatives

6.1 Collect and review information on conservation programs existing in the Valley.

6.2 Review state mandated water conservation measures (best management practices) for applicability to the Antelope Valley.

6.3 Based on other water conservation programs throughout the State and information from the DWR including Water Plan program, assess the effectiveness of existing and applicable state mandated water conservation measures in terms of cost versus water savings.

6.4 Develop a regional water conservation program that may include, but is not limited to, landscape programs, interior water use, and agricultural use.

6.5 Develop an implementation plan for the recommended regional water conservation program, including suggestions for manuals and literature to be developed for the public use.

Task 7 - Assess Effects of Changes in Groundwater Levels

7.1 Collect and review USGS/County of Los Angeles data (USGS Element V) on current land subsidence and water quality.

7.2 Survey the effects of fluctuating groundwater levels in other areas such as the Santa Clara Valley in Northern California and Santa Rosa Valley in Riverside County.

7.3 Based on information from subtasks 7.1 and 7.2, assess existing and potential damages attributable to groundwater level declines and waterlogging.

7.4 Based on information compiled in subtasks 7.1 and 7.2, assess existing and potential water quality degradation attributable to groundwater level declines.

Task 8 - Review Alternative Plans for Water Resource Protection

8.1 Review the studies collected in subtask 2.1 and compile a list of proposed water resource protection measures.

8.2 Suggest additional methods of water resource protection.

8.3 Conceptually evaluate these measures based on physical, social, economic and environmental issues.

8.4 Evaluate potential water management structures.

Task 9 - Prepare Draft and Final Reports

9.1 Summarize the data and analyses performed in previous tasks.

9.2 Prepare a draft report and submit twenty (20) copies to AVWG.

9.3 Incorporate AVWG and USGS review comments into the report.

9.4 Prepare a public review draft report and provide a reproducible copy for distribution by AVWG.

9.5 Address public comments in report.

9.6 Prepare a final report and submit one hundred (100) copies to AVWG.

CONDUCT OF THE STUDY

The information developed in this second element of AVWG's water resource study is a result of review of existing studies; contact with the AVWG members, other water purveyors and cities within the Antelope Valley, USGS, Edwards Air Force Base personnel, and residents of the Valley; contact with a number of local, state, and federal agencies; field work; office analysis; and computer modeling. The initial phase of the project was concerned with the collection and evaluation of existing data and reports. Discussions with the planning, operations, and engineering staffs of the water purveyors, wastewater treatment plant owners, cities, and Edwards Air Force Base were conducted to assess current and future operations relating to water and reclaimed water. Data gathered and analyses generated by USGS during the first element of the water resource study were collected and reviewed during the first phase of the study.

Subsequent phases were concerned with evaluation of the data collected in light of Tasks 3 through 7 described previously in "Scope of Services" and development of a plan which increases the reliability of the available water supplies. Technical issues addressed include the following:

- The use of reclaimed water without adverse crop effects or groundwater degradation.
- The use of stormwater without adversely affecting flood control operations.
- Maximum groundwater use prior to water quality degradation.
- Optional use of state water when full entitlements are available.
- Optimal basin management to maximize conjunctive use opportunities, maintain water quality and avoid adverse impacts due to fluctuating groundwater levels.
- Implementation of water conservation opportunities without coercive measures.

Through analysis of data and development of water supply enhancement opportunities, a plan for optimizing existing water resources was developed. Capital costs were estimated and issues associated with implementation of these opportunities were discussed.

Throughout the study, regular meetings with the AVWG Technical Advisory Committee were held and progress reports were presented. Interim work products were submitted to the Committee for review and comments were received.

HYDROLOGIC FEATURES

Surface water and groundwater features of the Antelope Valley are discussed below.

Surface Water

The Antelope Valley is a closed basin. Surface water from the surrounding hills and from the Valley floor flow primarily toward three dry lakes on Edwards Air Force Base (AFB): 1) Rosamond Lake, 2) Buckhorn Lake and 3) Rogers Lake.

Surface water flows are carried by ephemeral streams. The most hydrologically significant streams begin in the San Gabriel Mountains in the southwestern edge of the Valley and include, from east to west, Big Rock Creek, Little Rock Creek, and Amargosa Creek. (See Plate 1.) Except during the biggest rainfall events of a season, surface water flow towards the Valley from the surrounding mountains, quickly percolating into the stream bed and recharging the groundwater basin. Surface water flows that reach the dry lakes are generally lost to evaporation. It appears that little percolation occurs in the Valley other than near the base of the surrounding mountains due to impermeable layers of clay overlying the groundwater basin. USGS estimates that nearly 1.4 million acre-feet of surface water in the Valley is lost to evapotranspiration each year (USGS, 1987).

The Littlerock Creek is the only developed surface water supply in the Valley. The Littlerock Reservoir, jointly owned by Palmdale Water District (PWD) and Littlerock Creek Irrigation District (LCID), collects run-off from the San Gabriel Mountains. (See Plate 1.) The Dam currently has a useable storage capacity of 600 acre-feet of water, however PWD and LCID are planning modifications to the dam which will increase the storage capacity to 3,500 acre-feet. These modifications are scheduled for completion in 1994. Historically, water stored at the Littlerock Dam has been used directly for agricultural uses within LCID's service area and for municipal and industrial (M&I) uses within PWD's service area following treatment at PWD's water purification plant.

Groundwater

The Antelope Valley Groundwater Basin is comprised of two primary aquifers; 1) the principal aquifer and 2) the deep aquifer. The principal aquifer, an unconfined aquifer actually provided artesian flows in 1909. Separated from the principal aquifer by clay layers, the deep aquifer is generally considered to be confined. In general, the principal aquifer is thickest in the southern portion of the valley near the San Gabriel Mountains, while the deep aquifer is thickest in the vicinity of the dry lakes on Edwards AFB.

The Antelope Valley Groundwater Basin is divided into twelve subunits as shown on Plate 1. The subunits are Finger Buttes, West Antelope, Neenach, Willow Springs, Gloster, Chaffee, Oak Creek, Pearland, Buttes, Lancaster, North Muroc, and

Peerless. Studies performed by the USGS and the State Department of Water Resources (DWR) indicate that groundwater levels appear to be generally dropping in the eastern areas of the basin and rising in the western areas. Groundwater quality is excellent within the principal aquifer but degrades toward the northern portion of the dry lake areas. Considered to be generally suitable for domestic, agricultural, and industrial uses, the water in the principal aquifer has a total dissolved solids (TDS) concentration ranging from 200 to 800 milligrams per liter (mg/L). The deeper aquifers typically have higher TDS levels. Hardness ranges from 50 to 200 mg/L and high fluoride, boron, and nitrates are a problem in some areas of the basin. The groundwater in the basin is used for both agricultural and M&I uses.

LAND USE

Historically, land uses within the Valley have focused primarily on agriculture; however, the Valley is in transition from predominantly agricultural uses to predominantly residential and industrial uses. USGS's 1994 draft report indicates that agricultural land use has decreased from 73,000 acres in the early 1950s to 9,633 acres in 1992. In addition, USGS projects that agricultural land use will decrease to approximately 900 acres in 2020. Historically, crops grown in the Valley have included alfalfa, wheat, barley and other livestock feed crops. In recent years, onions, turf and orchards have become more prominent. Broken down by the various types of crops, acreage in 1993 were 6,124 acres for alfalfa, 955 acres for pasture and turf, 835 acres for grain, 32 acres for field crops, 2,645 acres for truck crops and 2,263 acres for deciduous trees.

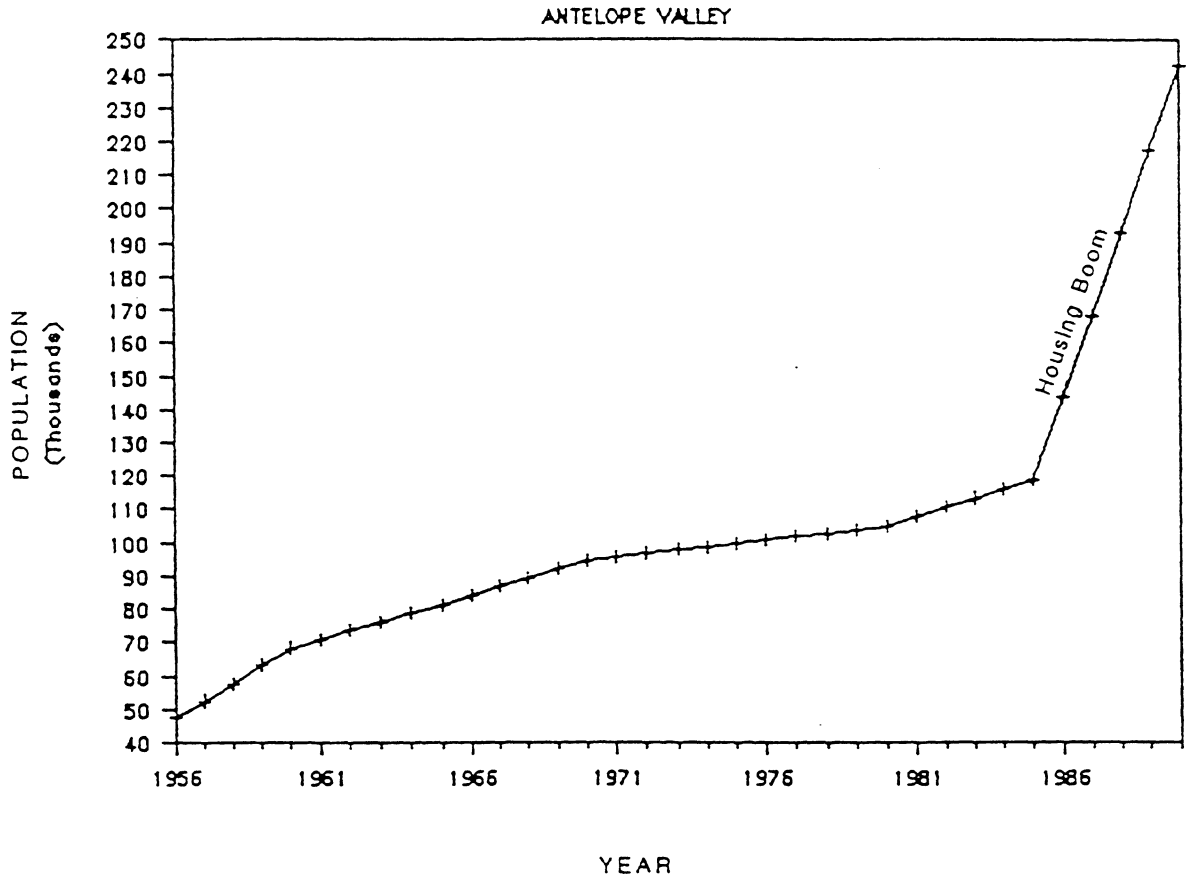
The increase in residential land use is evident from the population growth in the Valley which is discussed in the next section. With significantly lower prices than in Southern Los Angeles County, the Valley housing market has seen an increase in commuters to the Los Angeles area.

Industrial land use in the Valley consists primarily of manufacturing for the aerospace industry and mining. Edwards Air Force Base, and the U.S. Air Force Flight Production Center (Plant 42) provide a strong aviation and military presence. (Defense cuts may affect this presence). Mining of Borate in the northern areas of the Valley and salt extract, rock, gravel and sand in the southern areas of the Valley contribute to the Valley's industrial land uses.

POPULATION

Historically, growth in the Antelope Valley proceeded at a slow pace until 1985. However, between 1985 and 1990, the growth rate increased approximately 1,000 percent from the average growth rate between the years 1956 to 1985. (See Figure 3-3.)

Historical and projected population for the Antelope Valley are shown in Table 3-1 and depicted in Figure 3-4. Population data and projections were based primarily on information presented in USGS 1994 draft report. USGS 2010 and 2020



Source: Law Environmental November 25, 1991
"Water Supply Evaluation,
Antelope Valley, California"

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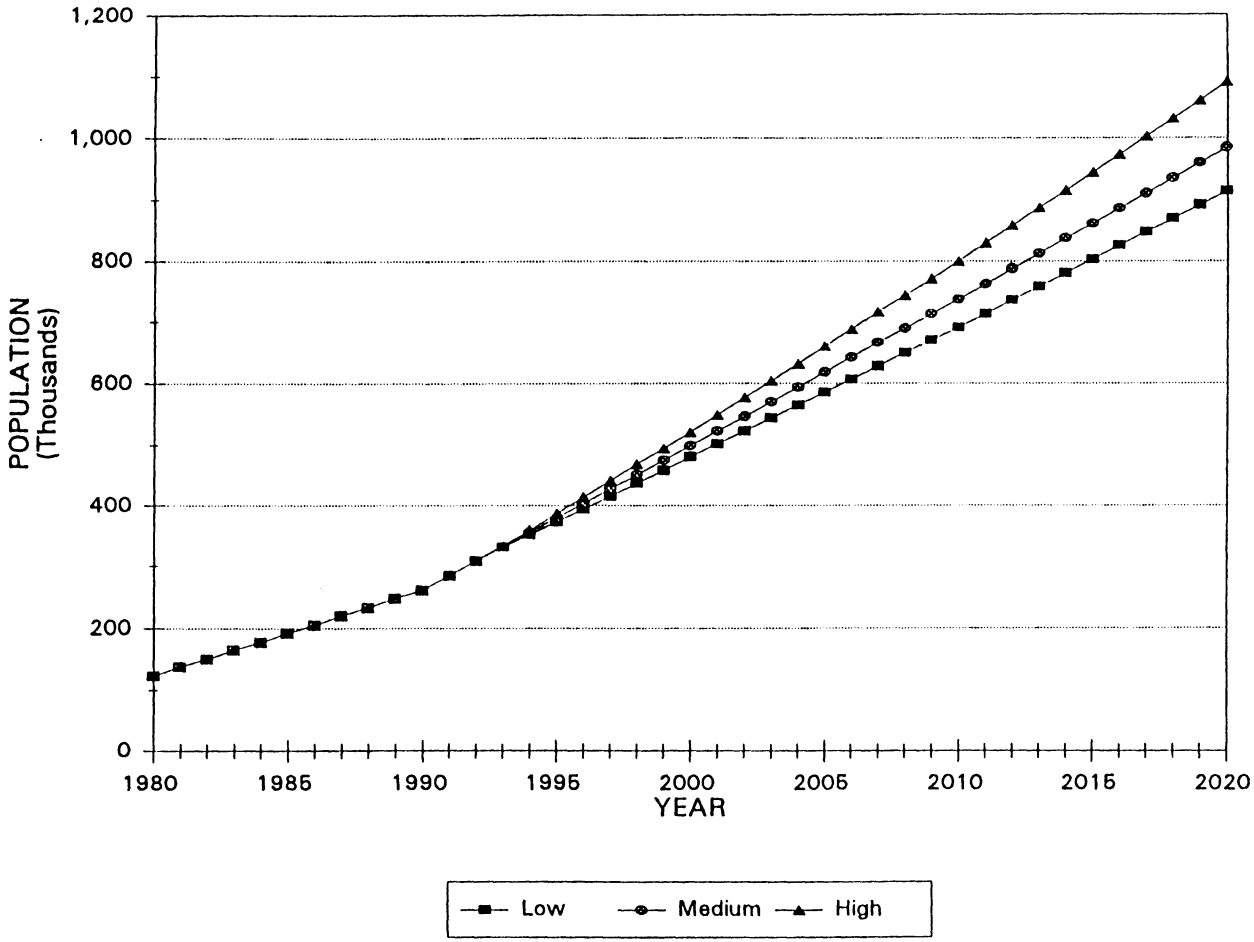
Antelope Valley Water Group
Antelope Valley Water Resource Study

Historical Population – Antelope Valley

August 1994
K/J 934620.00

Figure 3–3



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Population Projections–Antelope Valley

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Figure 3–4

Figure 3–4

projections for the Antelope Valley were provided by the Department of Water Resources (DWR) in a preliminary draft of Bulletin 160. However, in the Bulletin 160 draft dated November 1993, DWR revised the projections. Table 3-1 reflects these revisions. Projections indicate that approximately 986,000 people will reside in the Valley by the year 2020. This represents an increase of approximately 177 percent from the current population. Areas of concentrated population within the Valley include Lancaster, Palmdale, Edwards AFB, Rosamond, Mojave, and Boron.

TABLE 3-1

ANTELOPE VALLEY
HISTORICAL AND PROJECTED POPULATION

Area	1980	1990	2010	2020 (1)
Lancaster	48,027	97,291	212,138 (2)	269,558
Palmdale	12,277	68,842	245,341 (3)	326,815
Edwards AFB	8,554	7,423	7,671	7,671
Rosamond	2,869	9,969 (4)	39,256 (5)	52,696
Mojave	2,886	3,793(8)	8,737	11,209
Boron	2,815	2,903	3,071	3,155
Other	46,922	70,179 (6)	221,787 (6)	314,896(6)
Total	124,350	260,400	738,000 (7)	986,000(7)

(1) Extrapolated based on 1990 and 2010 populations except for Palmdale, Edwards AFB, Rosamond and Other. Palmdale is extrapolated based on 1993 and 2010 populations. Rosamond is extrapolated based on 2000 and 2010 populations. Edwards AFB 2020 population is maintained at 2010 level and Other is the difference between the total and the areas of concentrated population.
(2) From SCAG 1993 population projections.
(3) Average of City of Palmdale's General Plan projections and SCAG's 1993 projections.
(4) Interpolated based on 1980 and 1993 populations.
(5) Average of County of Kern's Rosamond Specific Plan projections and projections based on proposed Desert Highlands development.
(6) Difference between total and the areas of concentrated population.
(7) From DWR's November 1993 Draft California Water Plan Update (Bulletin 160).
(8) From Kern Council of Governments.

Projections to 2010 for Edwards AFB, Mojave, and Boron presented in the USGS report were utilized in Table 3-1, and revisions are described in the following sections. Population for Edwards AFB in the year 2020 was assumed to remain at the projected 2010 population. Projections to 2020 for Mojave and Boron were extrapolated from the actual 1990 and projected 2010 populations. USGS projections for Palmdale, Lancaster, and Rosamond were revised and are described in Table 3-1.

Descriptions of the method, assumptions and sources used to estimate the projections are discussed below.

Palmdale

Three population projections were done for the City of Palmdale. (See Figure 3-5.) The high curve was based on the City of Palmdale, January 25,1993 "General Plan." The City projected a population of 264,215 people by the year 2010. Based on this projection and the estimated 1992 population of 84,238, population for 2020 was extrapolated. The low curve was based on the Southern California Association of Government (SCAG) 1993 estimates of 161,203 person in 2000 and 226,465 persons in 2010, extrapolated to 2020. An average of the high and low curve provided a medium curve. The medium curve was selected for use in this report.

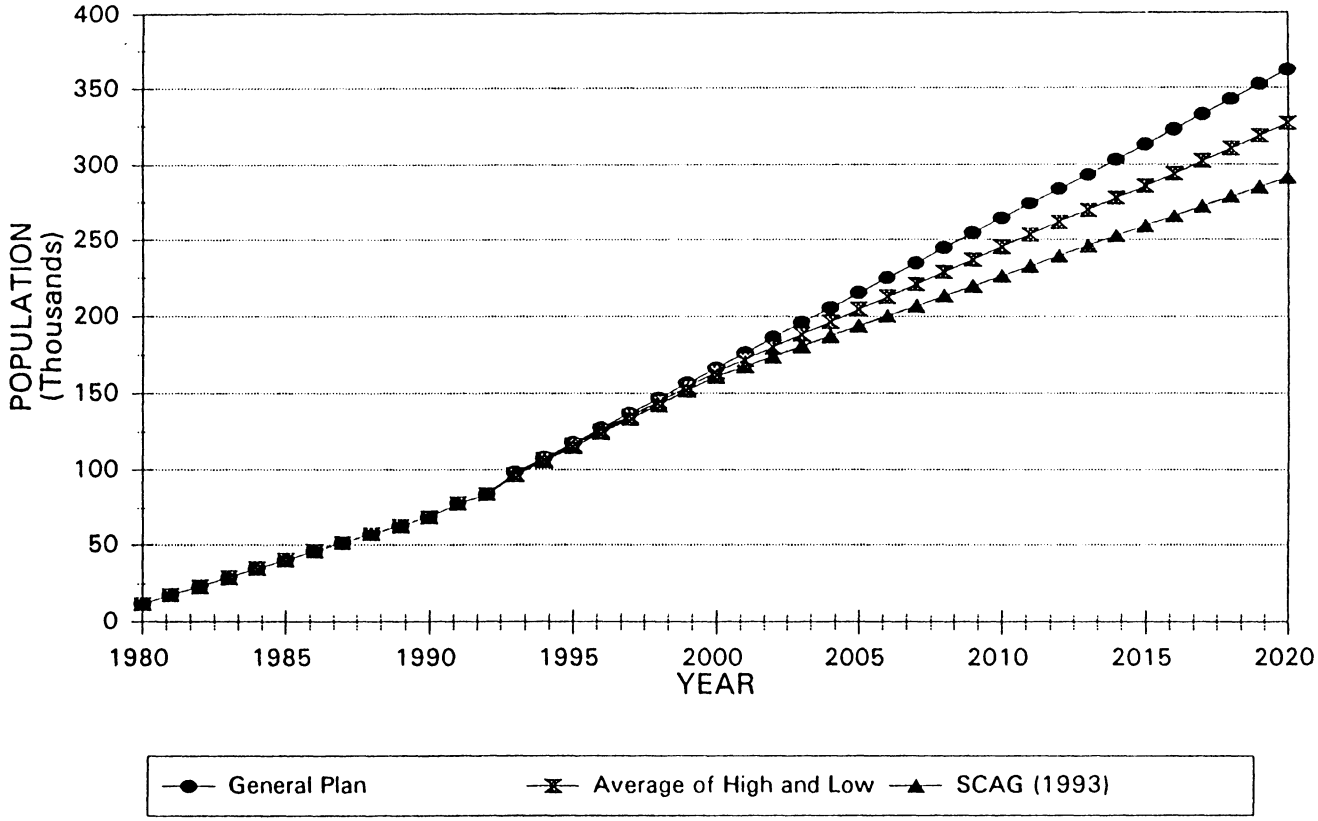
Lancaster

Three population projections were done for the City of Lancaster. (See Figure 3-6). The method used for estimating projections was obtained primarily from the City of Lancaster 1992 "State of the City Report" (SOC Report). The SOC Report provided a low, medium and high curve based on the average growth rate experienced by the City between 1980 and 1990 (low curve), the average growth experienced by the City between 1985 and 1990 (medium curve), and SCAG 1989 estimates (high curve). The average growth for the three curves were 4,071, 6,407, and 7,274 persons per year respectively.

The City's average growth rates for the three curves in the SOC Report have been revised for the purposes of this report for the following reasons: 1) the SOC Report used an estimate of 88,732 for the 1990 population but the U. S. Census Bureau reports a 1990 population of 97,291, and 2) in 1993 SCAG decreased its population estimates for Lancaster.

Using the most recent data available, the low curve was revised and is based on an average growth of 4,941 persons per year between 1980 and 1990. The medium curve is based on SCAG 2000 and 2010 estimates of 152,280 and 212,138, respectively, and extrapolated to 2020 based on an average growth rate of 5,742 people per year (average growth rate between 1990 actual and 2010 projected population).

The high curve is based on the City's average growth of 8,307 people per year between 1985 and 1990. The medium curve was selected for use in this report.



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Population Projections–City of Palmdale

August 1994
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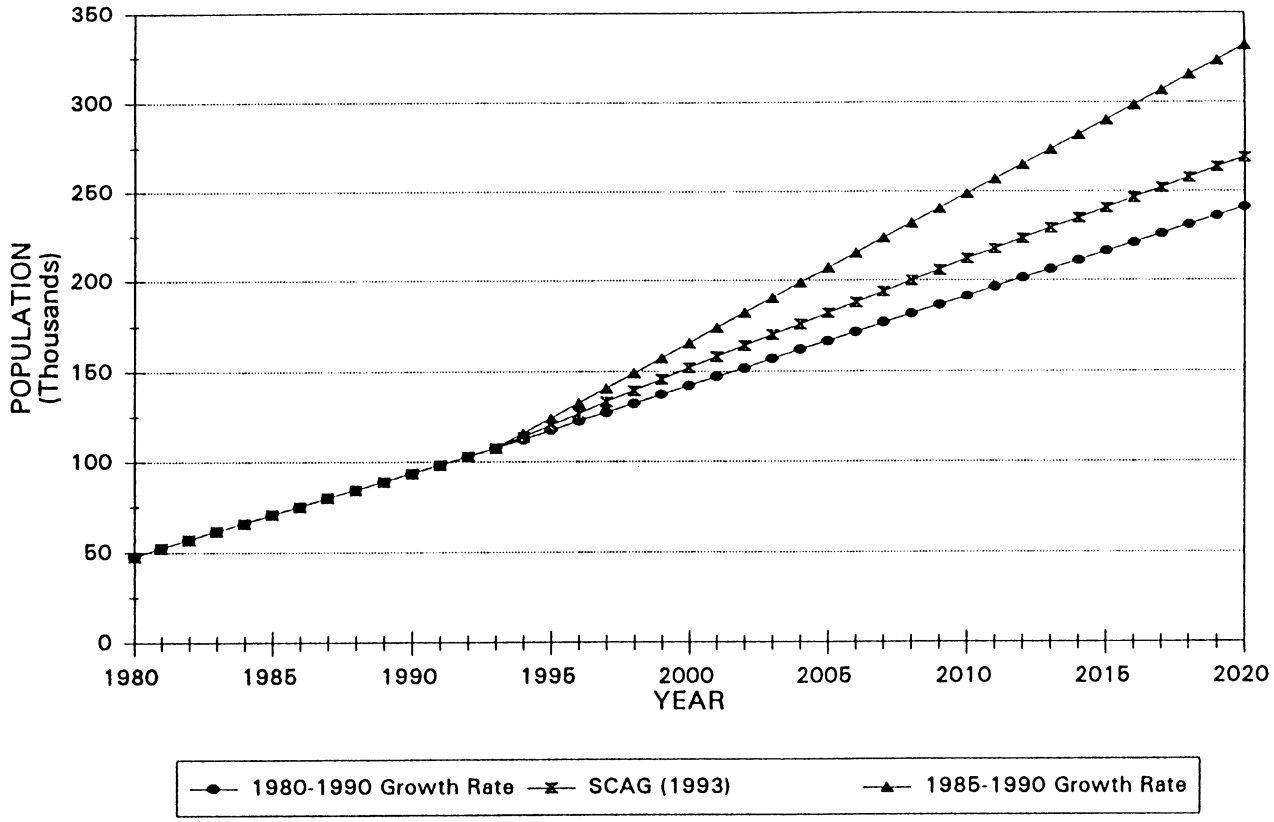
Figure 3–5

Figure 3–5



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Population Projections–City of Lancaster

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Figure 3–6

Figure 3–6

CHAPTER 4

ASSESSMENT OF WATER RESOURCES

This chapter assesses the ability of available water resources within the Antelope Valley to meet the water demands of the Valley through the year 2020. Elements of the chapter include a description of water demands and supplies, an evaluation of the reliability of water supplies, an assessment of the effects of State Water Project deliveries on groundwater levels, and an assessment of the effects on groundwater levels due to transition from a predominantly agricultural area to a predominantly urban area.

WATER DEMANDS

The following section discusses historical, current and projected water demands for the Antelope Valley. The United States Geological Survey (USGS) draft "Land Use and Water Use in the Antelope Valley, California" dated March 14, 1994 (1994 Draft Report) is the primary source of information for the Water Demands and Water Supplies sections.

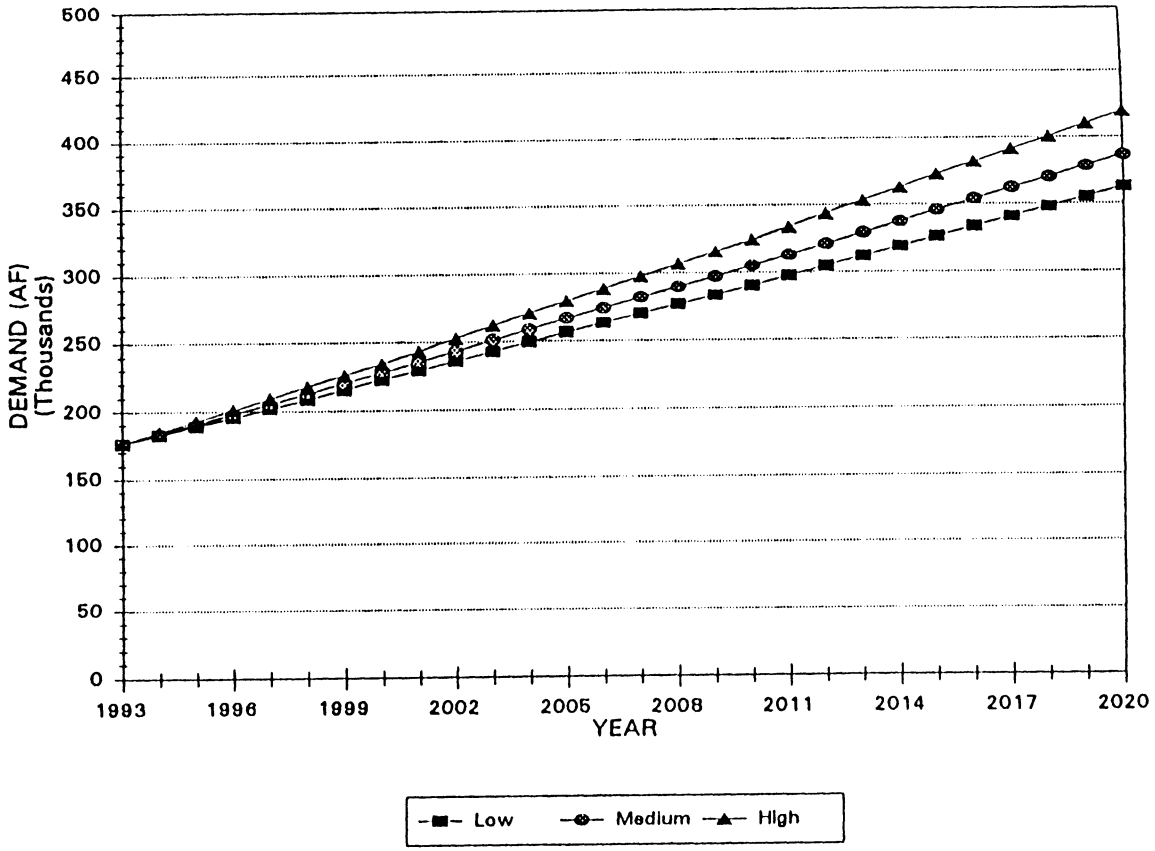
Historical Water Demands

Historical water demands were 192,600 acre-feet in 1975, 246,000 acre-feet in 1980, 167,000 acre-feet in 1985 and 144,000 acre-feet in 1988 (USGS, 1994a). Water demands decreased between 1950 to late 1980s due to decreasing irrigated acreage. However, due to the population growth beginning in the mid 1980s, water demands are rapidly increasing. Approximately 63 percent of total recorded water demands in 1990 were met by public water suppliers (USGS, 1994a).

Current and Projected Demands

Projected water demands for the Antelope Valley are shown on Figure 4-1. Projections were based on the summation of the individual water demand projections for the City of Palmdale, City of Lancaster, Rosamond Community Services District (RCSD), Other and Agricultural. These individual water demand projections are presented on Figures 4-2 to 4-6. Water demand projections to the year 2020 for the various cities\communities\categories are described below. Low, medium and high water demand projections are based on low, medium and high population projections presented in Chapter 3.

City of Palmdale. Water demand projections for the City of Palmdale are based on a per capita demand of 0.32 acre-feet per person per year derived from 1993 population and water use data from Palmdale Water District (PWD) and applied to the low, medium, and high population projections.



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Water Demand Projections
Antelope Valley

August 1994
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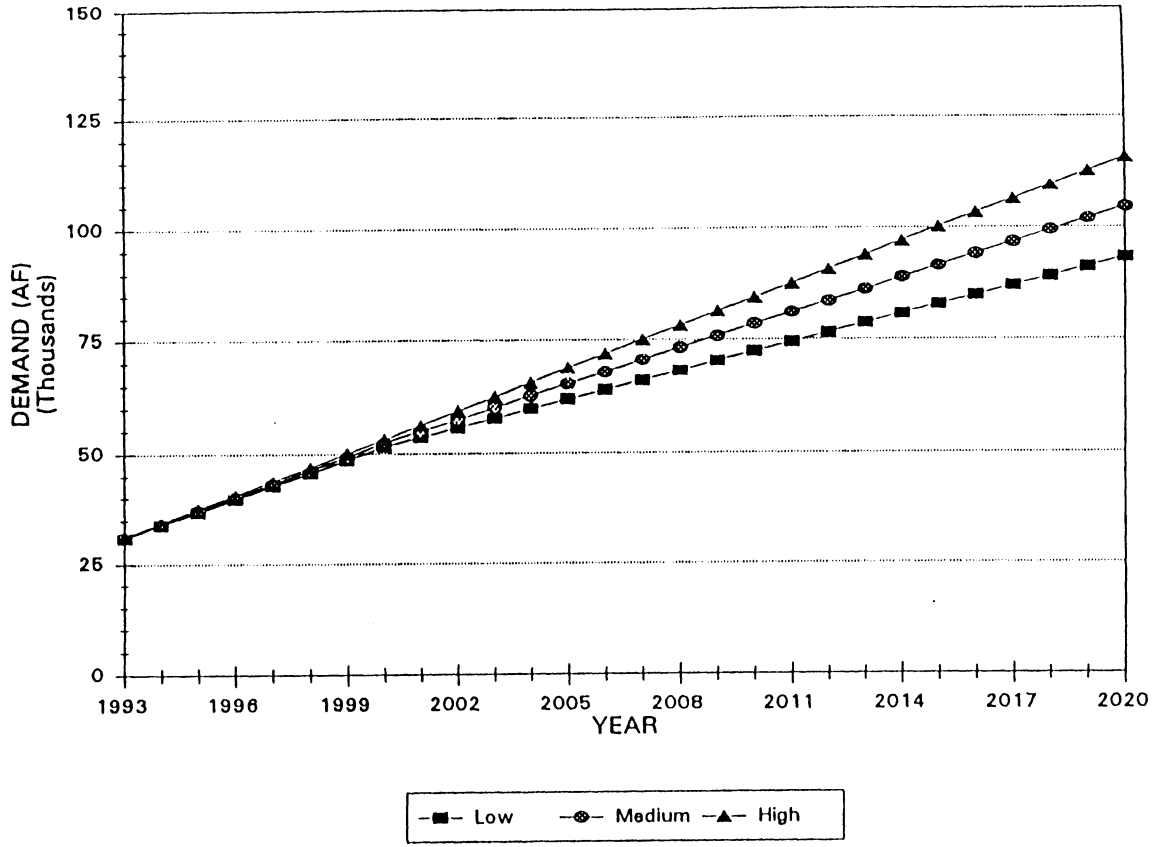
Figure 4–1

Figure 4–1



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Water Demand Projections
Palmdale

August 1994
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Figure 4–2

Figure 4–2

City of Lancaster. Water demand projections for the City of Lancaster are based on a per capita demand of 0.35 acre-feet per person per year derived from information provided in the City of Lancaster 1992 State of the City (SOC) report and applied to the low, medium, and high population projections (The City of Lancaster water demand is consistent with the Los Angeles County Waterworks water demand of 0.32 to 0.34 acre-feet per person per year).

RCSD. Water demand projections for the RCSD are based on a per capita demand of 0.17 acre-feet per person per year derived from 1993 population and water use data from RCSD and applied to the low, medium, and high populations.

Other. Water demand projections for the Other category are based on a per capita demand of 0.41 acre-feet per person per year derived from 1990 population and water use data provided by the Antelope Valley United Water Purveyors Association and applied to the population projection presented in Chapter 3. The Other category includes Edwards AFB, Mojave, Boron and Other from Table 3-1.

Agricultural. As shown in Table 4-1, current and projected 2020 agricultural water uses in the Antelope Valley are approximately 59,000 acre-feet and 39,100 acre-feet respectively. Current agricultural acreage were obtained from the USGS's 1994 Draft Report. Estimates of Agricultural acreage for the year 2020 are based on the acreage that would be necessary for reclaimed water use (i.e. identified as high potential reclaimed water users in Chapter 6) plus half of the existing agricultural acreage (not including the high potential reclaimed users). Water demands are based on typical water use data obtained from the Soil Conservation Service.

AVAILABLE WATER SUPPLIES

Available water resources in the Antelope Valley consists of local groundwater, surface water from Littlerock Reservoir, imported water from the State Water Project (SWP), and reclaimed water. Stormwater runoff, although not presently managed well or used, is a resource that has potential for greater use in the Antelope Valley (USGS, 1994a). This chapter focuses on water supplies from groundwater, Littlerock Reservoir, SWP and reclaimed water. A brief description of historical, current and projected water supplies for the Valley is presented below.

Historical Supplies

The total available water deliveries for the Antelope Valley was 192,600 acre-feet in 1975, 144,000 acre-feet in 1980, 107,000 acre-feet in 1985 and 118,000 acre-feet in 1989 (USGS, 1994a). Historical water supplies were made of a combination of local surface water from Littlerock Reservoir, SWP water, groundwater, and reclaimed water. Groundwater has supplied between 50 to 90 percent of the total annual water supply in the Antelope Valley in recent years. This may be due in part to the recent drought condition which affected deliveries from the SWP and diversions from the Littlerock Reservoir. The following sections describes historical water supplies for the Valley.

Groundwater. Historically, groundwater has been the primary water supply source for the Antelope Valley. Groundwater pumpage for the Los Angeles County portion of the Antelope Valley peaked in 1956 with 268,000 acre-feet, followed by a decline to 45,000 acre-feet in 1983 (USGS, 1994a). Since 1983, groundwater use increased to a high of 91,000 acre-feet in 1991. However, estimates of total pumpage may be low due to incomplete data obtained from the California State Water Resources Control Board. Apparently, all registered well owners in the Los Angeles County portion of the Antelope Valley have not consistently reported annual pumpage. In addition, pumpage data for much of the Kern County portion of the Valley were not available.

State Water Project. SWP deliveries to the Valley began in 1972. The Antelope Valley - East Kern Water Agency (AVEK), Palmdale Water District (PWD), and Littlerock Creek Irrigation District (LCID) provide SWP water to the Antelope Valley. As shown in Table 4-2, deliveries peaked in 1981 with approximately 80,000 acre-feet. Since 1981 however, deliveries have ranged between 14,000 and 58,000 acre-feet per year. SWP entitlements are also shown in Table 4-2. Between 1976 and 1982, total deliveries ranged between 19 and 92 percent of the total entitlements. Between 1983 and 1992, total deliveries ranged between 9 and 69 percent of the total entitlements.

Littlerock Reservoir. Historically, the available storage from Littlerock Reservoir was 600 acre-feet. As shown in Table 4-3, diversions from the reservoir ranged between 310 to nearly 7,700 acre-feet from 1956 to 1990. Current modifications to the dam is anticipated to increase the storage capacity to 3,500 acre-feet.

Reclaimed Water. Wastewater influent reached nearly 21,000 acre-feet in 1990 (USGS, 1994a). The combined wastewater flows from Edwards Air Force Base (Edwards AFB), the City of Palmdale and the City of Lancaster contributed to approximately 92 percent of the 21,000 acre-feet. According to the USGS, approximately 6,000 acre-feet was reused for irrigation and wetlands in 1990, and nearly 5,500 acre-feet was used for land disposal. Historical average daily flows from the Palmdale, Lancaster, Rosamond, and Edwards (AFB) Water Reclamation Plants (WRPs) is shown in Table 6-2.

Current and Projected Water Supplies

Table 4-4 shows the current and projected water supplies in Antelope Valley. As shown in the table, the current estimated water supply ranges between 212,900 to 240,800 acre-feet, and the 2020 estimated water supply ranges between 275,700 and 303,600 acre-feet. The only difference between the current and 2020 potential supply is the reclaimed water supply, which is expected to increase as the population in the Valley increases. The water supplies identified in Table 4-4 do not include potential reductions in deliveries due to hydrologic conditions. A brief description of each supply source is presented below.

TABLE 4-2

HISTORICAL DELIVERIES AND ENTITLEMENTS
(AVEK, PWD AND LCID)

Year	AVEK Deliveries (acre-feet)	AVEK Entitlements (acre-feet)	PWD Deliveries (acre-feet)	PWD Entitlements (acre-feet)	LCID Deliveries (acre-feet)	LCID Entitlements (acre-feet)
1972	53	20,000	0	1,620	338	170
1973	20	25,000	0	2,940	290	290
1974	1,259	30,000	0	4,260	400	400
1975	8,068	35,000	0	5,580	520	520
1976	27,782	44,000	0	6,900	589	640
1977	11,202	50,000	0	8,220	111	730
1978	44,137	57,000	0	9,340	208	920
1979	60,493	63,000	0	10,260	133	1,040
1980	72,407	69,200	0	11,180	191	1,150
1981	79,375	75,000	0	11,700	1,270	1,270
1982	50,291	81,300	0	12,320	0	1,380
1983	32,961	87,700	0	12,940	38	1,500
1984	32,662	35,000	0	13,560	1	1,610
1985	37,064	40,000	1,558	14,180	0	1,730
1986	32,449	42,000	3,096	14,800	163	1,840
1987	34,094	44,000	5,379	15,420	1,080	1,960
1988	34,079	46,000	1,770	16,040	419	2,070
1989	45,280	125,700	9,009	16,660	971	2,190
1990	47,206	132,100	8,608	17,300	1,747	2,300
1991	9,568	138,400	3,914	17,300	522	2,300
1992	37,490	138,400	6,600	17,300	1,143	2,300

Source: Department of Water Resources "Management of the California State Water Project", Bulletin 132-92, December 1992.

Groundwater. Groundwater is estimated to have a safe yield of approximately 31,200 to 59,100 acre-feet per year (USGS, 1993). Average natural recharge estimates from previous investigations were obtained by the USGS and adjusted according to factors such as diversion, evapotranspiration, and similar drainage area (natural recharge estimates from various investigations were calculated based on different interpretations of surface water drainage areas).

State Water Project. SWP entitlements for the Antelope Valley are currently estimated to be approximately 153,800 acre-feet. The entitlements of AVEK, PWD and LCID are 138,400, 17,300, and 2,300 acre-feet per year respectively. A small portion of AVEK entitlements have historically been delivered to areas outside the

Antelope Valley borders. Based on information provided by AVEK, it is estimated that approximately 3 percent of historical deliveries made to AVEK did not serve the Antelope Valley. For this report, it is assumed that 3 percent of future deliveries made to AVEK will continue to serve areas outside the Valley borders.

TABLE 4-4

POTENTIAL ANNUAL WATER SUPPLY
FOR THE ANTELOPE VALLEY (1)

Source	1993 Potential Supply (acre-feet)	2020 Potential Supply (acre-feet)
Groundwater (2)	31,200 to 59,100	31,200 to 59,100
State Project Water		
AVEK (3)	134,200	134,200
LCID	2,300	2,300
PWD	17,300	17,300
Subtotal	153,800	153,800
Littlerock Reservoir (4)	7,000	7,000
Reclaimed Water (5)	20,900	83,700
Total (6)	212,900 to 240,800	275,700 to 303,600

(1) Supplies listed have not been adjusted to account for potential reductions in deliveries due to hydrologic conditions.
(2) Estimates of natural recharge from USGS "Study Plan for the Geohydrologic Evaluation of Antelope Valley, and Development and Implementation of Ground-Water Management Models."
(3) Based on historical deliveries of approximately 3 % to areas outside the Antelope Valley, subtracted from AVEK's total entitlement of 138,400 acre-feet per year.
(4) PWD estimates that average yield from the reservoir following modifications to the dam will be 7,000 acre-feet per year.
(5) The numbers shown are current and projected production for Palmdale, Lancaster, Rosamond, Edwards AFB, and Mojave WRPs.
(6) Potential useable stormwater is not included in the total.

Littlerock Reservoir. Available storage from Littlerock Reservoir was 600 acre-feet. Modifications to the Littlerock Dam is anticipated to increase the storage capacity to 3,500 acre-feet. According to the PWD, the average annual yield from the new reservoir is estimated to be approximately 7,000 acre-feet.

Reclaimed Water. Table 4-5 lists the wastewater treatment facilities in the Antelope Valley with the 1993 and projected 2020 reclaimed water flow. Current users, if any, are also listed. As shown in the table, 1993 and projected 2020

TABLE 4-5

RECLAIMED WATER SOURCES

Facility Name	1993 Flow (mgd)	Projected 2020 Flow (mgd)	Current Users of Reclaimed Water
Palmdale WRP	7.4	37.2	Los Angeles City Department of Airports Pistachio Farm Chestnut Farm Christmas Tree Farm Landscape Plant Farm Barley Farm
Lancaster WRP	8.4	29.8	Apollo Lakes County Park - Aquatic Park Piute Ponds - Wetlands Nebeker Ranch - Alfalfa Farm
Rosamond WRP	0.8	3.0	None
Edwards AFB WRP	1.7	2.5	None
Mojave WRP (1)	0.4	2.2	None
Plant 42 WRP (2)	0.25	0.25	None
Desert Lake WRP (3)	0.08	0.4	None
Boron WRP (1)	0.12	0.6	None
Edwards AFB Missile Test Site WRP (2)	0.05	0.05	None
Edwards AFB N. Base WRP (2)	0.075	0.075	None
Boron Federal Prison WRP (2)	0.01	0.01	None
Total	**19.29**	**76.09**	**N/A**

(1) Projected reclaimed water supply is based on Mojave WRP's 1990 flow per capita (180 gallons/capita/day) applied to 2020 projected population.

(2) Projected reclaimed water supply is assumed to remain the same as existing supply.

(3) Projected reclaimed water supply is based on Mojave WRP's historical growth rate of 0.0124 million gallons per day per year (1980-1993).

N/A Not Applicable.

reclaimed water flows are estimated to be approximately 19.29 and 76.09 million gallons per day (mgd) respectively. Reclaimed water from the Palmdale WRP is currently used on the Department of Airport (DOA) property. A portion of the flow is used at various farms on the property. The remaining flow is currently spread over the 2600 acres of DOA land. Reclaimed water from the Lancaster WRP is used at Nebeker Ranch to irrigate alfalfa crops. A small portion is used at the Apollo Lake County Park, and the remaining flow is currently diverted to Piute Ponds.

The Palmdale, Lancaster, Rosamond, Edwards AFB, and Mojave WRPs represent the plants with the highest probability of developing a reclaimed water system. The combined 1993 and projected 2020 flow from these five plants represent nearly 98 percent of the total potential supply for the entire Valley and is estimated to be 18.7 mgd (20,900 acre-feet) and 74.7 mgd (83,700 acre-feet) respectively.

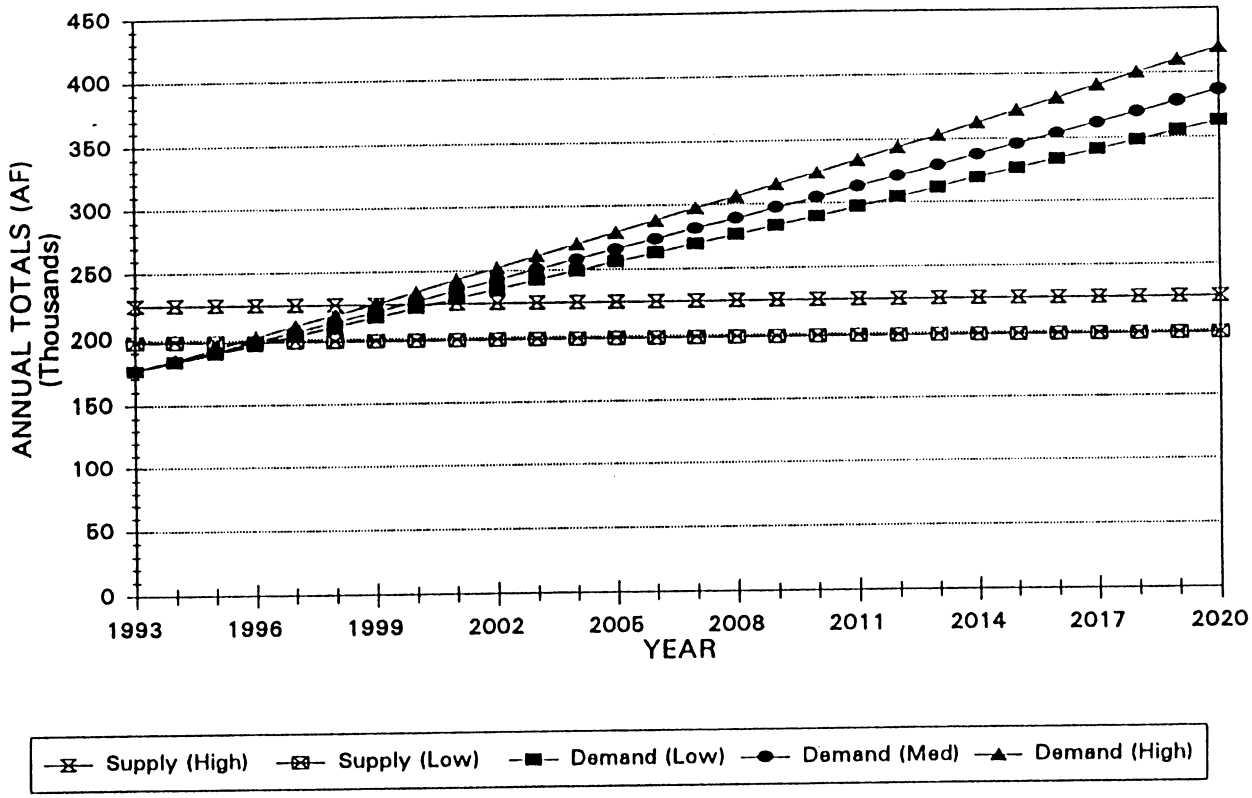
RELIABILITY OF WATER SUPPLIES

Figure 4-7 depicts the high and low water supply projection along with the low, medium and high water demand projection for the Valley to the year 2020. The high and low water supply projection are based on Table 4-4 with one exception, the potential reclaimed water supply listed in Table 4-4 for 1993 and 2020 are not included. Instead, the reclaimed water supply for both 1993 and 2020 is taken as the current reclaimed water use (approximately 6,500 acre-feet). Therefore, the 1993 and 2020 potential supply ranges between 198,500 and 226,400 acre-feet per year. For purposes of the reliability analysis, the high supply curve and medium demand curve is selected (See Figure 4-8). The supply curve does not take into account the issue of reliability and the effects that reliability will have on the yield of each water supply source. The following section assesses the reliability of SWP water, Littlerock Reservoir water and reclaimed water. Groundwater is considered 100 percent reliable when the amount considered available for withdrawal is less or equal to the estimated natural recharge amount.

Reliability of SWP Supply

The Department of Water Resources (DWR) utilizes a computer model called DWRSIM to simulate operation of the SWP. The model operates the SWP on a monthly basis, using the actual hydrology from 1922 through 1992. The output of the model provides an estimate of annual quantities of water that could be available to meet SWP entitlement requests. The model takes into account many variables and assumptions such as minimum Delta outflow requirements, facility improvements, and pumping operation at the Delta export pumps. The most significant factors that affect the SWP supply estimates are the future demand, Delta environmental requirements and future SWP facilities. Total entitlement of all SWP contractors is 4.2 million acre-feet per year.

The reliability of SWP water is currently undergoing significant changes. Pending actions from federal requirements are currently being discussed that will



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Potential Supply and Projected Demand
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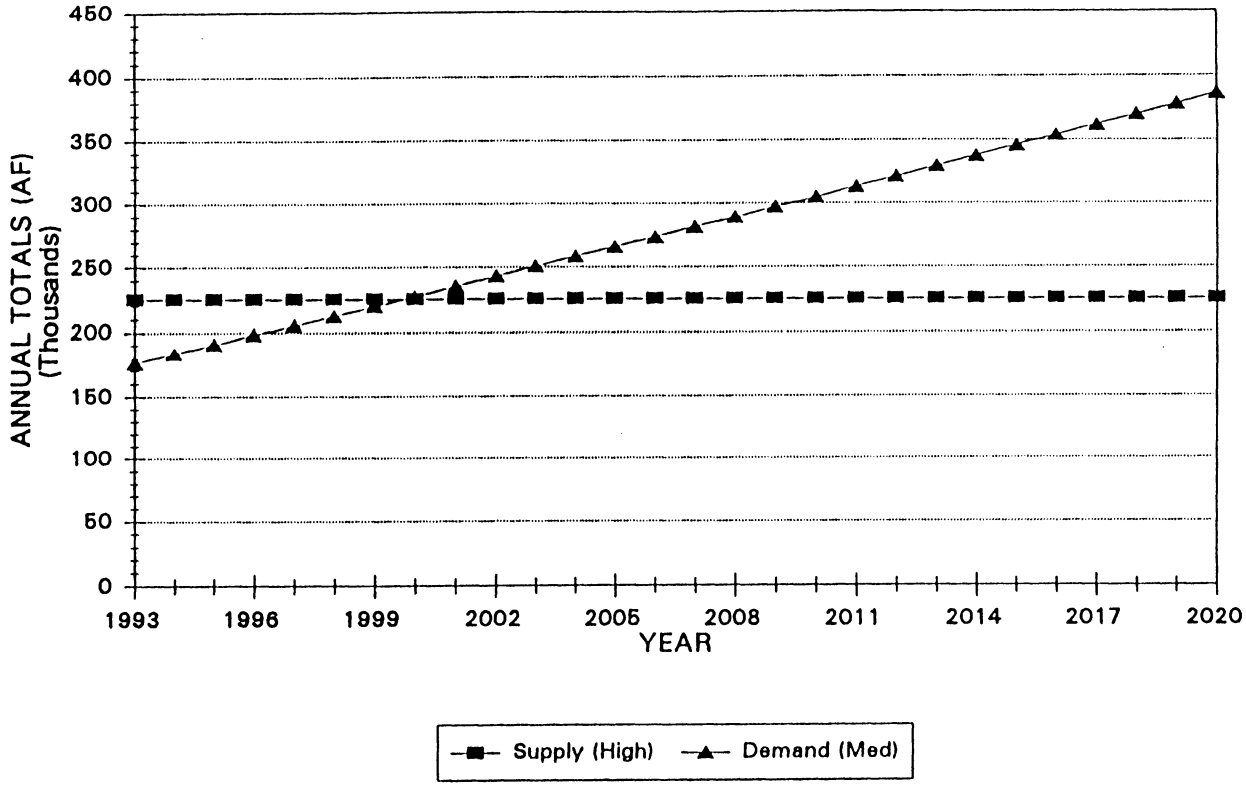
Figure 4–7

Figure 4–7



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Potential Supply and
Projected Demand
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Figure 4–8

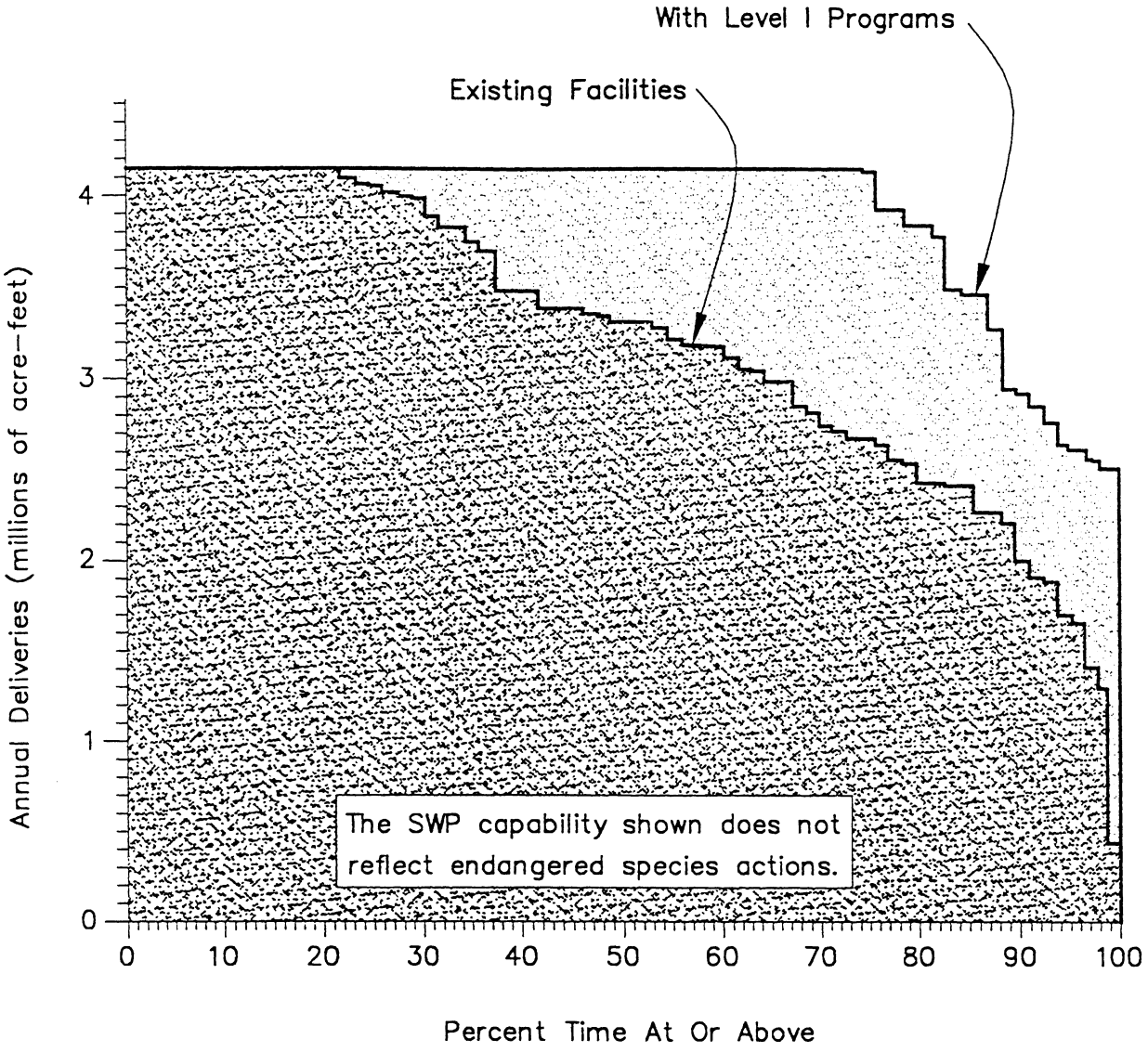
Figure 4–8

significantly impact future SWP water supply. Biological opinions have been issued under the Endangered Species Act which will affect operation of the Delta. In February 1993, the National Marine Fisheries Service (NMFS) issued a biological opinion concerning the operation of the Central Valley Project (CVP) and SWP for winter-run chinook salmon. In February 1994, the United States Fish and Wildlife Services (FWS) issued their biological opinion concerning operation of the CVP and SWP for the Delta smelt. Both species have been listed under the State and Federal Endangered Species Acts. These opinions are intended to restrict pumping at the SWP and CVP export pumps in the Delta. In addition to the Delta pumping restrictions, the Environmental Protection Agency (EPA) issued a draft proposal for additional flow requirements in December 1993 under the Clean Water Act. The EPA is considering establishing stricter Bay/Delta water quality standards.

Figure 4-9 shows the SWP delivery capability for year 2020 with existing and Level 1 water supply management programs. Level 1 Water Management Programs include the South Delta Water Management Program (interim), Kern Water Bank (underground storage), Los Banos Grandes Facilities (open storage south of the Delta) and Long Term Delta program. The curves do not include pending federal requirements discussed above. As shown on Figure 4-9, with existing facilities, the SWP will be able to meet its requirements of 4.2 million acre-feet about 20 percent of the time. Level 1 Water Management Programs will enable the SWP to meet its requirements about 75 percent of the time.

Figure 4-10 shows the SWP delivery capability for year 2000 with existing facilities and Federal requirements. With these requirements, it is anticipated that the SWP will not be capable of ever delivering the full entitlement of all of the contractors. Based on Figure 4-10, the percentage of time that SWP delivery request anticipated to be met is summarized in Table 4-6. The DWR notes that "due to significant uncertainties regarding how Delta impacts will be allocated among all water users," several key factors related to implementation of the Federal Delta standards have not been considered in Figure 4-10. Not all of the criteria required by the NMFS and FWS in their biological opinions are included in Figure 4-10. The most significant criterion not modeled is the "take" limit at the SWP and CVP export pumps in the Delta. "Take" is defined as the maximum number of fish that can be killed by Delta pumping during certain periods. If "take" limits are exceeded for winter-run chinook salmon and Delta smelt, pumping can be restricted. The DWRSIM model does not account for pumping restrictions that might occur if "take" limits are exceeded.

Additionally, the Coordinated Operation Agreement (COA) between the CVP and the SWP is also not accounted for on Figure 4-10. The COA is an agreement between the United States Bureau of Reclamation and the DWR that establishes the basis for how the CVP and the SWP will be operated. The COA ensures that each project receives an equitable share or negotiated amounts of water supplies from the Central Valley's supply. If Federal requirements are enacted, the sharing responsibility assumptions used in the program will change due to changes in the operating criteria of the system. As the new regulations are developed, the DWR will attempt to analyze the potential impacts in its model. It is anticipated that new



Based on D 1485 and 4.2 Million Acre Feet Maximum Delivery
SWP Level I Water Management Programs
South Delta Water Management Program
Kern Water Bank – First Stage
Kern Water Bank – Second Stage
Kern Water Bank – Local Elements
Los Banos Grandes Facilities
Long Term Delta Program

Source: Department of Water Resources, Draft, November 1993, "California Water Plan Update"

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Delivery Capability of SWP (w/o Federal Requirements)

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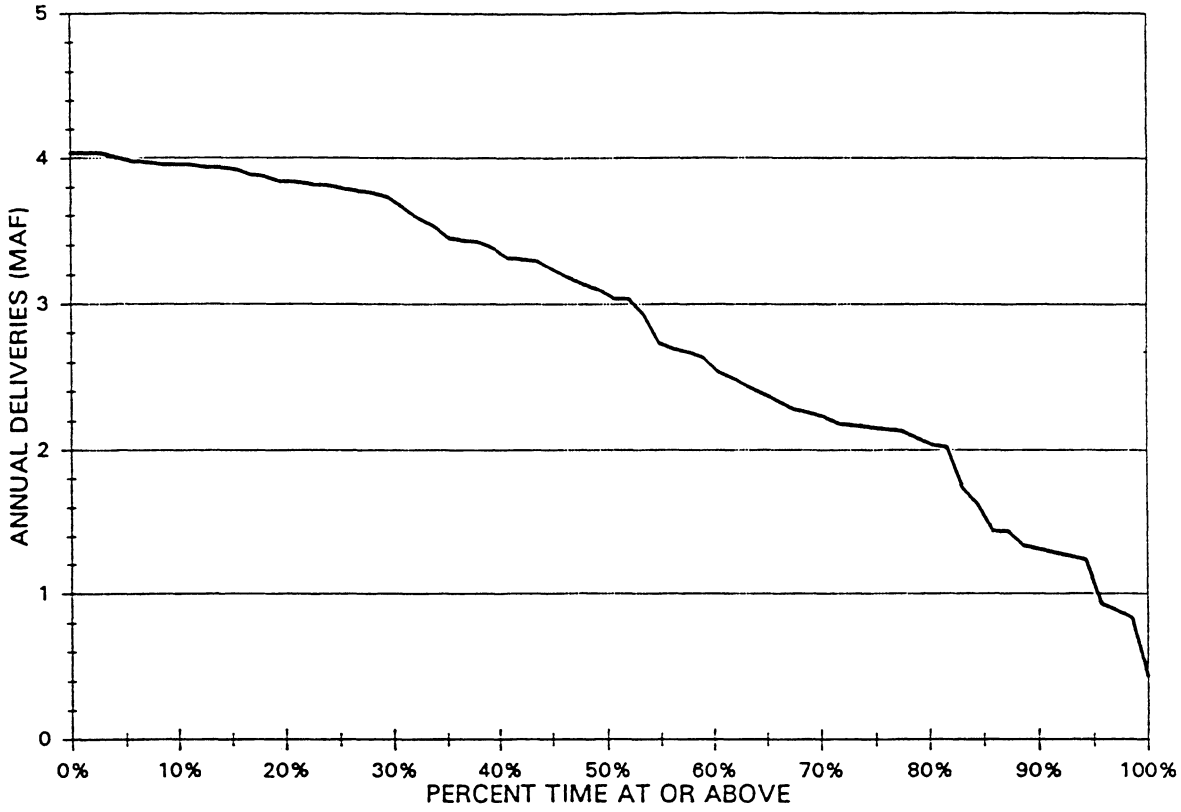
Figure 4–9



Assumptions:

- D 1485
- 4.1 MAF Maximum Delivery
- Existing Facilities
- Federal Requirements for
- Salmon, Smelt and Delta Water Quality

Source: Department of Water Resources

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Delivery Capability of SWP (with Federal Requirements)

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Figure 4–10

Delta environmental requirements will decrease the estimated SWP supply from that shown in Figure 4-10.

Figure 4-10 assumes existing SWP facilities. According to the DWR, additional future SWP facilities is anticipated to increase the estimated SWP supply, however, until the various Delta issues are resolved, the feasibility of constructing additional SWP facilities and accurately estimating the increased water supply from such facilities is difficult to determine. It is anticipated that new facilities will increase the reliability and delivery capability of the SWP supply.

TABLE 4-6

PROBABILITY OF WATER SUPPLIES

Probability	Current Estimated Supply (acre-feet)	2020 Estimated Supply (acre-feet)
Groundwater		
100% probability of getting 100% of potential supply	59,100	59,100
State Water Project		
50% probability of getting at least 76% of potential supply	116,800	116,800
80% probability of getting at least 50% of potential supply	77,000	77,000
90% probability of getting at least 36% of potential supply	46,200	46,200
Littlerock Reservoir		
50% probability of getting at least 100% of potential supply	7,000	7,000
80% probability of getting at least 64% of potential supply	4,500	4,500
90% probability of getting at least 30% of potential supply	2,100	2,100
Reclaimed Water		
100% probability of getting 100% of potential supply (current)	6,500	6,500

Reliability of Littlerock Reservoir Supply

Figure 4-11 shows the yield capability of Littlerock Reservoir. The reliability analysis for the Littlerock Reservoir water supply was based on the maximum yield from the reservoir using actual hydrology from 1954 to 1993. To obtain the annual yield from the Reservoir, estimates for beginning storage, inflows, evaporation, diversions, overflows and ending storage volume were calculated on a monthly basis. The total annual diversions was the sum of the monthly diversions.

PWD provided information on operational constraints for the model. One constraint is a limitation on diversions to the maximum channel capacity between Littlerock Reservoir and Lake Palmdale. The second constraint is a minimum pool of 500 acre-feet of storage for recreational purposes from January through Labor Day. Starting with the beginning storage volume, inflow from Littlerock Creek and Santiago Creek was added. Streamgage data from Littlerock Creek (No L1-R) and Santiago Creek

(No. F125-R) was obtained from the Los Angeles County Department of Public Works. Evaporation was deducted using DWR's evapotranspiration curves and PWD's data for storage volume and surface area. If the amount left in the reservoir was greater than the overflow volume of the Reservoir, the difference was assumed to overflow. The amount left in storage (minus the minimum 500 acre-feet recreational storage) was assumed to be diverted.

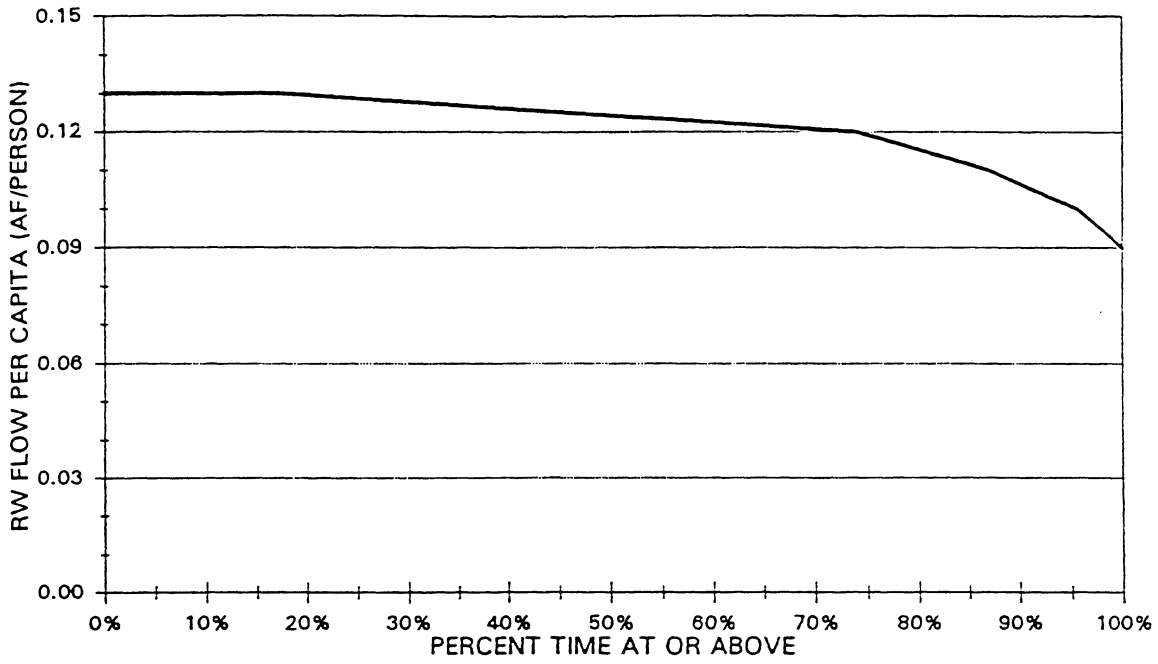
Assuming 1954 to 1993 hydrology, the analysis projects annual diversions ranging between 1170 to 25,300 acre-feet per year. PWD estimates an annual average yield of 7,000 acre-feet from the Reservoir. Therefore, although the analysis indicated potential diversions greater than 7,000 acre-feet, this report assumes 7,000 acre-feet as the maximum annual yield. The result of the analyses is shown on Figure 4-11 and summarized in Table 4-6. Based on the analysis, Littlerock Reservoir can yield at least 7000 acre-feet or 100 percent of the supply at least 50 percent of the time.

Reliability of Reclaimed Water Supply

The reliability analysis for reclaimed water is based on wastewater influent from 1970 to 1992. Historical wastewater production from the Palmdale and Lancaster WRPs divided by historical population for the two cities provided wastewater production per capita. This unit production of wastewater from 1970 to 1992 ranged from 0.9 to 1.3 acre-feet per person per year. Figure 4-12 represents the frequency that the unit production of reclaimed water exceeded a given value. Figures 4-13 and 4-14 are based on Figure 4-12 and the 1993 and 2020 population estimates for the Valley. Based on this analysis, the wastewater treatment plants in the Valley could reliably produce 20,900 acre-feet per year in 1993 and 60,000 acre-feet per year in the year 2020. However, because the potential reclaimed water supply for both 1993 and 2020 is taken as the current reclaimed water use (approximately 6,500 acre-feet), the reclaimed water supply is considered 100 percent reliable. This is summarized in Table 4-6.

Reliability of Available Water Supplies

Figure 4-15 depicts the yield capabilities of the combined water supplies for the Antelope Valley. The graphs are based on the combined probability of available water supplies. However, because groundwater and reclaimed water have a 100 percent reliability, weighted averages were used to compute the reliability of the aggregate water supply. As mentioned previously, the potential water supply is 225,900 acre-feet per year (assuming a high estimate for the groundwater supply). From Figure 4-15, the probability of receiving 100 percent of the supply is approximately 29 percent. As the probability increases, the yield capability decreases. Therefore, it is expected that only 83,000 acre-feet would be available 100 percent of the time. This amount is equivalent to approximately 37 percent of the potential water supplies being available 100 percent of the time.



Assumptions:

- Reclaimed Water Flow based on combined flow from Palmdale and Lancaster WRP's (1970 to 1992).
- Population based on combined City of Palmdale and City of Lancaster populations from 1970 to 1992.

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Unit Production of Reclaimed Water

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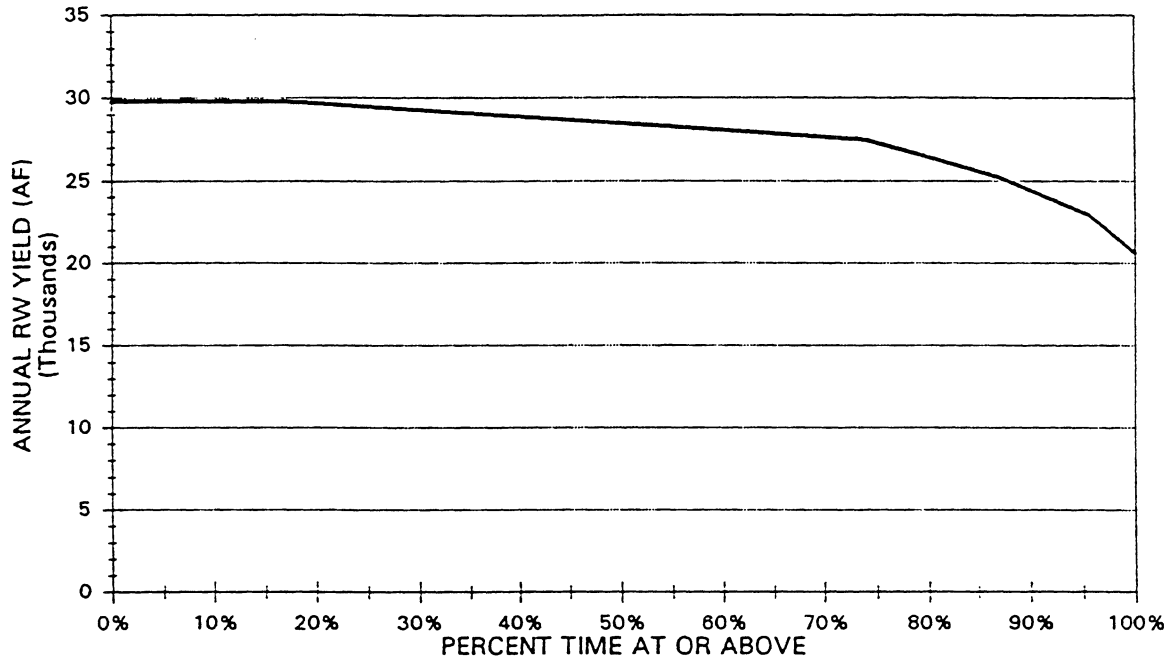
Figure 4–12



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1993 Production Capability of Reclaimed Water

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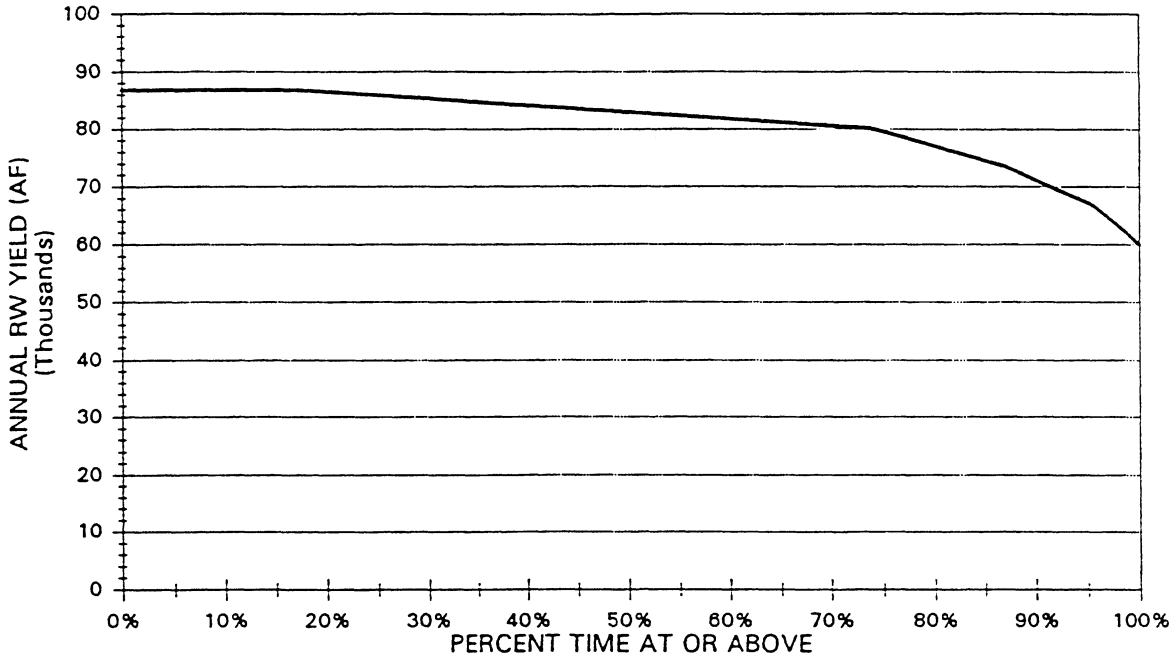
Figure 4–13



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2020 Production Capability of Reclaimed Water

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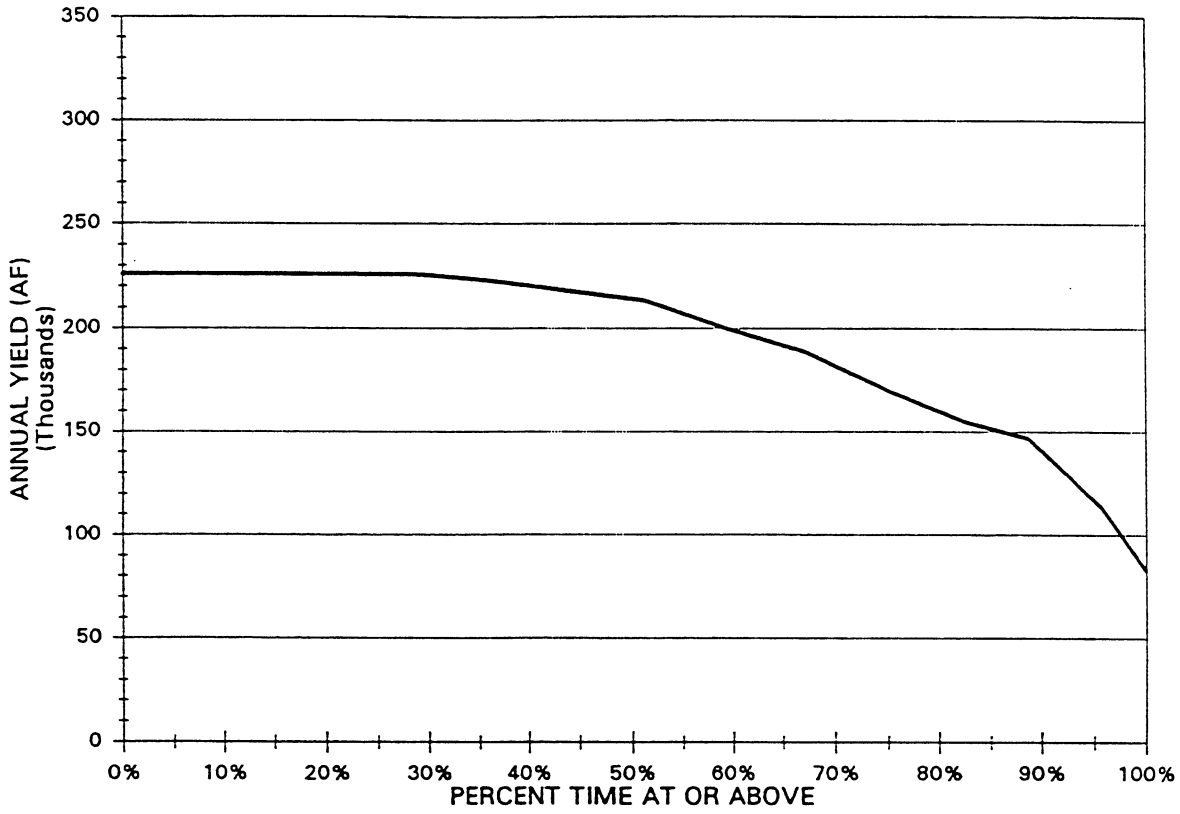
Figure 4–14



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Yield Capability of Available Water Supplies

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Figure 4–15

Table 4-7 summarizes the available water supplies from Figure 4-15 at 50, 80, and 90 percent probability levels. As shown on Figure 4-15, approximately 214,300, 160,200 and 141,900 acre-feet of water is available at 50, 80 and 90 percent probability. A breakdown of estimated supply from individual water sources is also presented.

The medium demand and projected supply estimates at the 50, 80 and 90 percent probability levels is shown on Figure 4-16. The 50, 80 and 90 percent probabilities are based on the total estimated supplies presented in Table 4-7. The most optimistic supply assumption (i.e. delivery of 100 percent of available water supplies) is also shown. As shown on Figure 4-16, the estimated 1993 water demand is met approximately 73 percent of the time. For comparison, the Metropolitan Water District of Southern California (MWD) has established the following levels of service objectives:

Percentage of Demand	Percentage of the Time
80%	100%
90%	92%
100%	90%

Based on the result of Figure 4-16, the purveyors in the Antelope Valley currently provide a water supply reliability that is currently below MWD's objectives. By the year 1998, 100 percent of the water demand is estimated to be met only 50 percent of the time. In the year 2000, without overdrafting the groundwater basin, 100 percent of the potential water supplies would be required to meet the water demand.

Figure 4-17 is based upon Figure 4-16 and shows the probable operating level of available water supplies. As shown in Figure 4-17, the water supply reliability is expected to decrease. By the year 2000, assuming that overdrafting of the groundwater basin does not occur, it is anticipated that the water demands will exceed the available supplies. This means that the probability of meeting 100 percent of the water demands is zero.

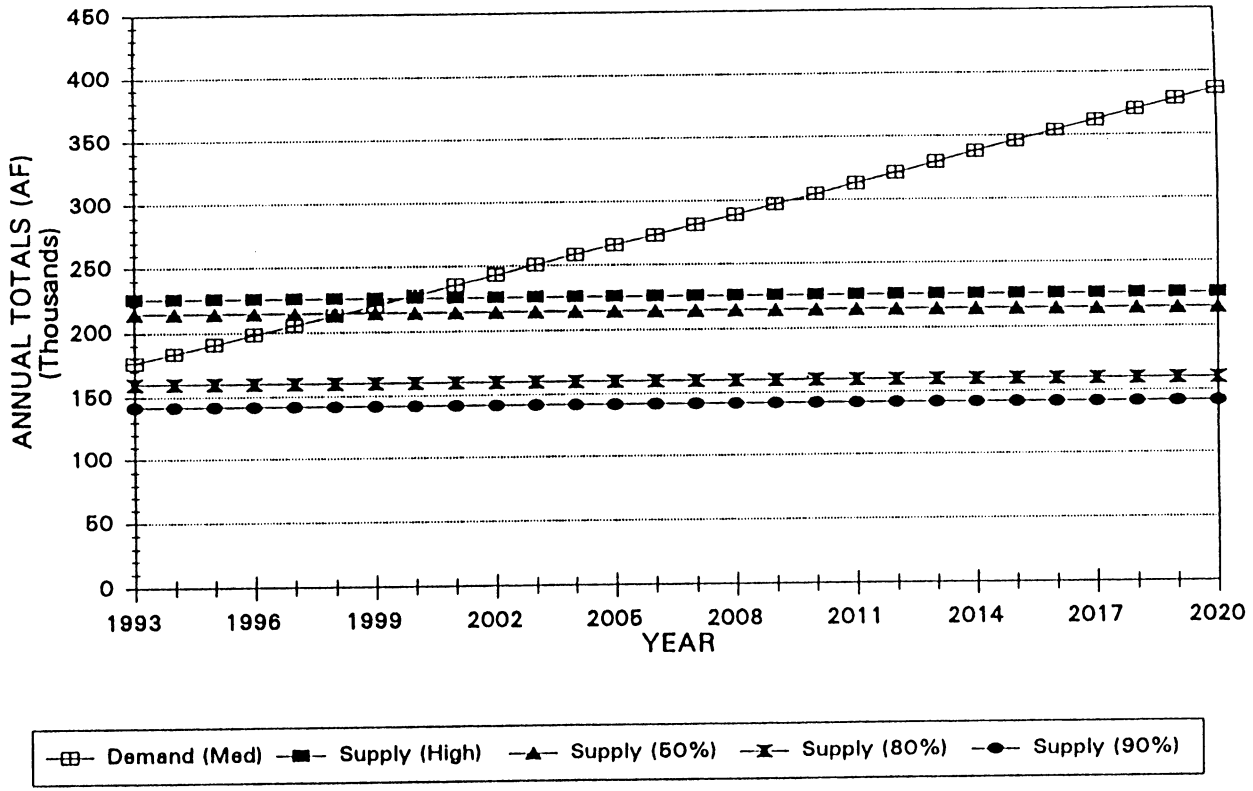
EFFECT OF SWP DELIVERIES ON GROUNDWATER LEVELS

To assess the effects of SWP deliveries on groundwater levels, areas that receive SWP deliveries were compared with areas that did not. Hydrographs in areas that receive SWP water and areas that do not were provided by AVEK. By comparing the hydrographs from areas that remained in similar land uses, the effect on groundwater levels would be from SWP deliveries and not by other causes (i.e. land use transitions). Because SWP deliveries occurred prior to urbanization, hydrographs in urban areas should exhibit the effects from SWP deliveries. As shown on Figure 4-19, hydrographs in areas that do not receive SWP water indicate groundwater levels are generally remaining level, whereas as shown in Figure 4-20, hydrographs in areas that do receive SWP water generally indicate a rising of groundwater levels. Figure 4-18 show locations of the wells.

TABLE 4-7

ANNUAL WATER SUPPLY FOR THE ANTELOPE VALLEY
(INCLUDES PROBABILITY)

Probability Level	Source	Estimated Supply (acre-feet)
50 %	Groundwater	59,100
	State Project Water	
	AVEK	124,100
	LCID	2,100
	PWD	16,000
	Subtotal	142,200
	Littlerock Reservoir	7,000
	Reclaimed Water	6,500
	Total	**214,800**
80 %	Groundwater	59,100
	State Project Water	
	AVEK	78,400
	LCID	1,300
	PWD	10,100
	Subtotal	89,800
	Littlerock Reservoir	5,300
	Reclaimed Water	6,500
	Total	**160,700**
90 %	Groundwater	59,100
	State Project Water	
	AVEK	63,300
	LCID	1,100
	PWD	8,200
	Subtotal	72,600
	Littlerock Reservoir	4,200
	Reclaimed Water	6,500
	Total	**142,400**



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Supply and Projected Demand
(Includes Delivery Reductions)

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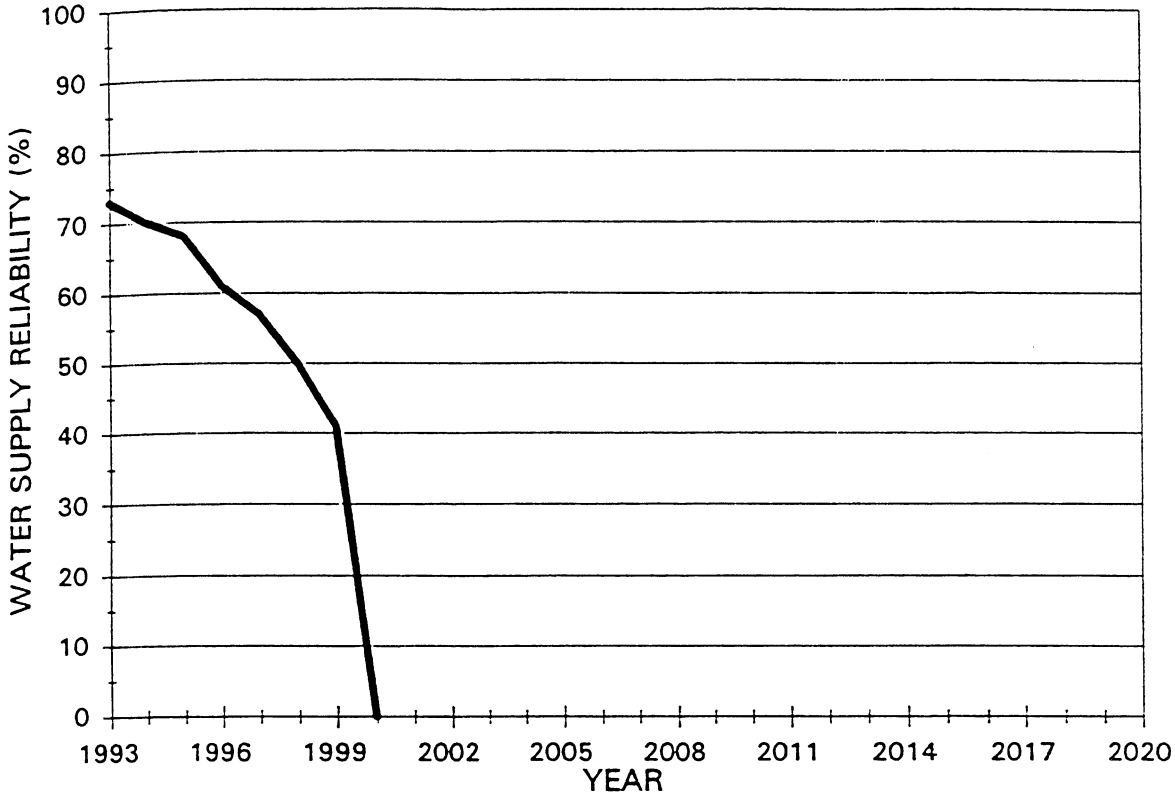
Figure 4–16

Figure 4–16



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Reliability of Available Water Supplies

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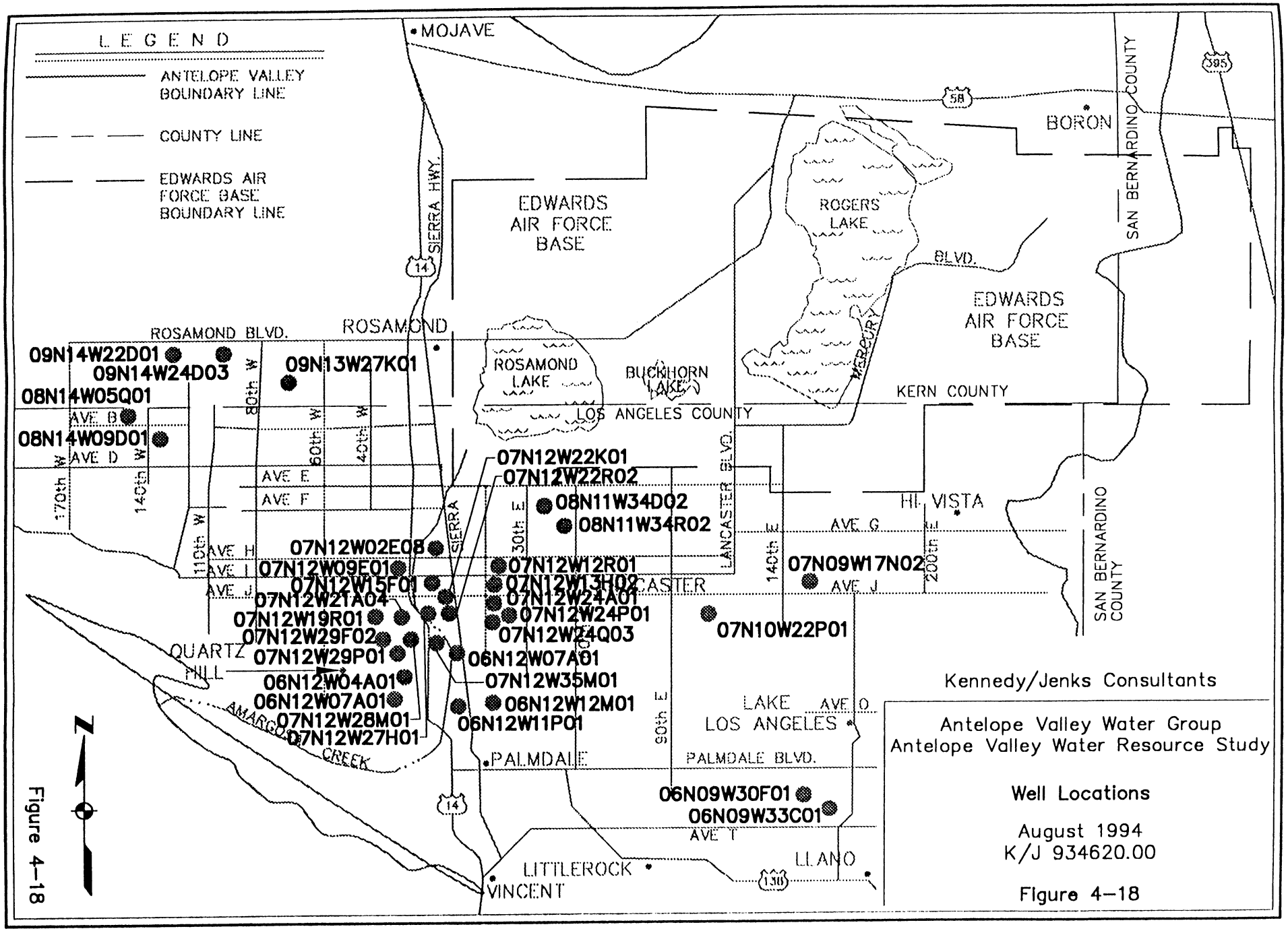
Figure 4–17


LEGEND
ANTELOPE VALLEY BOUNDARY LINE
COUNTY LINE
EDWARDS AIR FORCE BASE BOUNDARY LINE
MOJAVE
BORON
SAN BERNARDINO COUNTY
395
58
SIERRA HWY.
14
EDWARDS AIR FORCE BASE
ROGERS LAKE
BLVD.
MERCURY
ROSAMOND BLVD.
ROSAMOND
ROSAMOND LAKE
BUCKHORN LAKE
LOS ANGELES COUNTY
KERN COUNTY
09N14W22D01
09N14W24D03
09N13W27K01
08N14W05Q01
08N14W09D01
AVE B
AVE D
AVE E
AVE F
AVE G
AVE H
AVE I
AVE J
80th W
90th W
40th W
170th W
140th W
110th W
07N12W22K01
07N12W22R02
08N11W34D02
08N11W34R02
07N12W02E08
07N12W09E01
07N12W15F01
07N12W21A04
07N12W19R01
07N12W29F02
07N12W29P01
06N12W04A01
06N12W07A01
07N12W28M01
07N12W27H01
07N12W12R01
07N12W13H02
07N12W24A01
07N12W24P01
07N12W24Q03
06N12W07A01
07N12W35M01
06N12W12M01
06N12W11P01
LANCASTER BLVD.
30th E
90th E
140th E
200th E
LANCASTER
HI VISTA
07N09W17N02
07N10W22P01
QUARTZ HILL
AMARGOSA CREEK
PALMDALE
PALMDALE BLVD.
LAKE LOS ANGELES
AVE O
06N09W30F01
06N09W33C01
AVE T
LITTLEROCK
VINCENT
LLANO
130
N
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Well Locations
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Figure 4-18

Figure 4-18

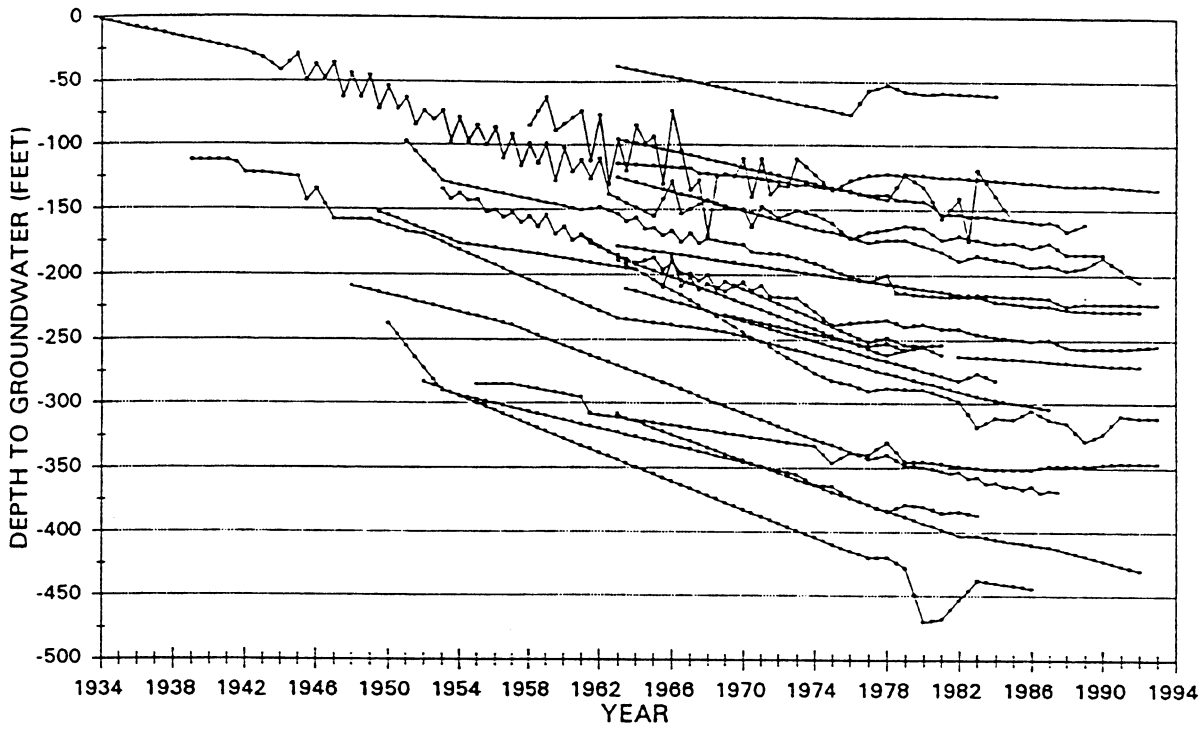
EFFECT OF TRANSITION FROM AGRICULTURAL TO URBAN ON GROUNDWATER LEVELS

To assess the effects on groundwater levels due to transition from agricultural to urban land uses, areas of agriculture that had transitioned to urban were compared with areas of agriculture that had not transitioned. A limitation of this approach is the fact that hydrographs in urban areas may also show effects of both SWP deliveries and the transition.

Figure 4-21 shows hydrographs obtained from AVEK for the areas of Lancaster and Palmdale. These two areas transitioned from predominantly agricultural areas to urban areas in the 1980s. The well numbers are listed below:

- 06N12W07A01
- 06N12W11P01
- 06N12W12M01
- 06N12W04A01
- 07N12W35MO1
- 07N12W27H01
- 07N12W28M01
- 07N12W29F02
- 07N12W29P01
- 07N12W19R01
- 07N12W21A04
- 07N12W22K01
- 07N12W22R02
- 07N12W24A01
- 07N12W24P01
- 07N12W24Q03
- 07N12W13H02
- 07N12W15F01
- 07N12W09E01
- 07N12W12R01
- 07N12W02E08

The rate of decline in water levels prior to 1977-1978 was noticeably more than the rate of decline after 1977-1978 when SWP deliveries started to significantly contribute to the Valley's water supply. As shown on Figure 4-19, hydrographs in agricultural areas that have maintained agricultural land use status, are generally level. If the agricultural area receives SWP water, the groundwater levels may rise as shown in Figure 4-20. These comparisons indicate that the importation of SWP water generally has a beneficial effect on groundwater levels and that urbanization generally has an adverse effect on groundwater levels. However, it is likely that the increased use of SWP water could mitigate these adverse effects. Figure 4-18 shows the locations of the wells used for this evaluation.



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Hydrographs in Areas that have Transitioned from Agricultural to Urban

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Figure 4–21

CHAPTER 5

WATER CONSERVATION

Although not truly a water resource, water conservation can stretch available resources by decreasing demands. The importance of long-term conservation has been emphasized by the recent prolonged drought and the fact that water demands are projected to exceed available supplies in the near future. This chapter develops and evaluates water conservation alternatives for the Antelope Valley. Elements of the chapter include a description of the service area, discussion of current water conservation regulations, summary of existing water conservation programs in the Valley, description of existing and projected water demands, and discussion on available water conservation measures as well as case studies on the effectiveness of the most viable measures. Finally, a water conservation program for the Antelope Valley is presented, followed by a discussion of the effects that conservation may have on the reliability of water supplies.

SERVICE AREA

As previously described in Chapter 2 and Chapter 3, the Antelope Valley encompasses approximately 2,400 square miles in northern Los Angeles County, southern Kern County and western San Bernardino County. The water demands within the Antelope Valley are serviced by a variety of water purveyors, including large wholesale agencies, irrigation districts, special districts providing primarily municipal and industrial water, investor-owned water companies, mutual water companies, and private well-owners. Land uses within the Valley have primarily focused on agriculture, however the Valley is in transition from predominantly agricultural uses to predominantly residential and industrial uses. An estimated 332,000 people currently reside within the Valley. As shown in Table 3-1, it is projected that the population will reach nearly 1,000,000 people by the year 2020. Mean daily summer temperatures range from 63° Fahrenheit (F) to 93° F, and mean daily winter temperatures range from 34° F to 57° F. Major communities within the Valley include Boron, Edwards Air Force Base, Lancaster, Mojave, Palmdale and Rosamond.

As shown in Table 3-1, it is anticipated that the City of Palmdale (Palmdale), the City of Lancaster (Lancaster) and the Community of Rosamond (Rosamond) will serve the largest number of people in the Antelope Valley. By the year 2020, the populations are estimated to be 326,815, 269,558 and 52,696, respectively. Therefore, this chapter focuses primarily on these three urban areas as well as agricultural water uses.

WATER CONSERVATION REGULATIONS

A number of federal and state regulations currently encourage water conservation. The regulations include plumbing efficiency standards, urban water management,

agricultural water management, and other issues such as graywater and landscape irrigation. A brief description of these regulation is presented below.

Plumbing Efficiency Standards

The Energy and Policy Act of 1992 establishes efficiency standards for toilets, urinals, faucets, and showerheads manufactured in the United States after January 1994. The Act provides some exceptions for facilities such as prisons and commercial buildings.

The Health and Safety Code (Section 17921.3) establishes efficiency standards for toilets sold or installed in California after January 1994. Section 17921.3 establishes a 1.6 gallon per flush requirement for all toilets, urinals and associated flushometer valves sold or installed in California.

Urban Water Management Plans

The Urban Water Management Planning Act requires that urban water retailers supplying more than 3,000 acre-feet of water per year or serving more than 3,000 customers prepare an Urban Water Management Plan (UWMP) by the end of 1985. In 1991, the Act was amended to require that 1) the plans be updated at least every five years, 2) the plans include additional elements, and 3) urban water suppliers, whether serving customers directly or indirectly, prepare a plan. In addition, the Act requires that UWMPs 1) describe and evaluate water reclamation activities, 2) provide estimates of projected reclaimed water use, and 3) describe findings, actions and planning relating to the use of internal and external water audits, and incentive programs. In 1993, the Act was amended to require that the UWMP include a Water Shortage Contingency Plan.

Agricultural Water Management

The California Agricultural Water Management Planning Act requires all water suppliers providing more than 50,000 acre-feet per year to agricultural growers in California to prepare and submit informational reports identifying potential agricultural water conservation programs. In addition, if water conservation programs identified are applicable, the Act requires the suppliers to prepare and submit a water management plan. In 1991, the Act was amended to require a description of water recycling activities to be included in the informational reports and water management plans.

The Agricultural Water Suppliers Efficient Water Management Practices Act requires the California Department of Water Resources (DWR) to establish an advisory committee to evaluate efficient water management practices for agricultural water suppliers. The Act establishes the mechanism for implementation of the practices. The implementation of the practices is on a cooperative basis similar to that for the urban best management practices.

The Agricultural Water Management regulation authorizes an agricultural water supplier to institute a water conservation or efficient water management program. The program may include making improvements to the supplier's facilities and providing assistance or consultation to its customers on conservation methods.

Other Regulations

Section 14875 of the Water Code legalizes installation and retrofitting of graywater systems in single family residences. Section 14875 authorizes cities and counties to adopt state standards for installation of graywater systems in residential buildings and allows the cities and counties to adopt more stringent standards for graywater systems, or prohibit graywater systems within their jurisdiction.

The Water Conservation in Landscaping Act establishes provisions of a model conservation landscaping ordinance for adoption on the local level. The Act requires cities and counties to adopt the state's DWR model ordinance for the development of water efficient landscapes if the cities and counties have not adopted their own ordinances.

EXISTING CONSERVATION PROGRAMS IN THE ANTELOPE VALLEY

Water conservation programs existing in the Antelope Valley are primarily directed at urban areas. These programs are provided through agencies like the City of Lancaster, the Los Angeles County Waterworks (LACWW), Palmdale Water District (PWD) and Rosamond Community Services District (RCSD). The Agricultural Stabilization and Conservation Service (ASCS) office provides agricultural conservation programs for farmers and ranchers. The following section describes both urban and agricultural conservation programs existing in the Antelope Valley.

Urban Conservation Programs

Urban water conservation programs in the Antelope Valley include ordinances, literature and advertising, and phased water conservation plans as described below.

Conservation Ordinances. The City of Lancaster adopted Ordinance No. 629 in December 1992. This ordinance details landscape development specifications to minimize use of water. The ordinance specifies acceptable water saving irrigation systems and low water-use plant materials. The specifications apply to all new and rehabilitating (including developer installed) landscape development projects, both public and private. Cemeteries, registered historical sites, and projects with a landscaped area of less than 1,000 square feet are exempt from the ordinance. The owner or consultant for any project requiring landscape development as part of the project development is required to submit a Landscape Documentation Package to the City for review. The Landscape Documentation Package will typically include landscape and irrigation drawings, maximum water allowance calculations, irrigation schedules, maintenance schedules, soils analysis report, an approved or tentative grading plan, and a copy of the approved tract or parcel map.

In addition to the ordinance for landscape development specifications, the City of Lancaster also has provisions for graywater use in its municipal plumbing code, Ordinance No. 604. The provisions apply to the construction, alteration and repair of existing graywater systems and to the installation of new systems (allowed in residential occupancies only). The graywater systems supply underground irrigation to trees and other deep-rooted plants using household water which has not come into contact with toilet waste or wastewater from kitchen sinks, dishwaters, or laundry tubs. Permits must first be obtained in order to construct a new graywater system.

Similarly with the City of Lancaster, the County of Los Angeles (LA County) also adopted landscaping and graywater ordinances. On 17 December 1992, LA County adopted Ordinance No. 92-0135 in compliance with the Water Conservation in Landscaping Act. The ordinance establishes a procedure for designing, installing, and maintaining water efficient landscapes in new and rehabilitated projects. Effective 26 September 1991, LA County's ordinance for Graywater Systems for Residential Occupancies provides for construction, alteration and repair of graywater systems for on-site underground irrigation of trees and other deep-rooted plants. Both ordinances apply to the unincorporated areas of the county.

On 21 March 1991, LA County adopted a water wasting ordinance that applied to only unincorporated areas of the county. The ordinance placed limitations on water usage (i.e., washing down paved surfaces, excessive landscape watering, etc.). Water purveyors serving the unincorporated area of the county and all LACWW customers were notified of the ordinance and the $500 fine for noncompliance. This ordinance was terminated on 1 January 1991.

As of February 1991, the PWD adopted water conservation regulations prohibiting the use of water for hose washing of sidewalks, walkways, buildings, and driveways. The regulations also establishes limits on a variety of water uses such as washing motor vehicles, filling decorative fountains, serving drinking water at restaurants, and watering landscaped areas. The prompt repair of leaks from indoor and outdoor plumbing fixtures by all residents is also required under these regulations. In addition, the owner and manager of every short-term commercial lodging facility must post a notice of a water shortage and associated compliance measures.

Conservation Literature and Advertising. Produced by LACWW for the Antelope Valley is a booklet titled "Antelope Valley Colorful Landscapes for Water Conservation." The booklet describes how residents can develop beautiful, water conserving landscapes through low water-use plants, efficient irrigation systems and improved watering techniques.

The LA County has been involved in various activities to raise public awareness on the subject of water conservation. A number of public meetings were held by the LA County in conjunction with the ordinances regarding the need to conserve water. Water conservation literature and water conservation kits were distributed at the

meetings. In addition, arrangements were made with the Lancaster Unified School District to promote water awareness month by providing them with conservation kits, book covers, brochures, posters, and other materials. The County also participated in and helped sponsor the Landscaping for Water Conservation Conference put on by the Antelope Valley College.

RCSD sends informational brochures to its customers during periods of drought requesting its users to practice water conservation.

Phased Water Conservation Plan. LACWW has developed a set of rules intended "to minimize the effect of a shortage of water supplies on the customers of any or all of the Districts during a water shortage emergency." The Phased Water Conservation Plan characterizes the percentage of water supply shortages based on nine phases and involves the issuance of conservation surcharges to users for quantities of water used above the set target water use for a given phase once the supply shortage percentage has been determined. For example, if the LACWW determines that a 20% water shortage will be suffered for a given year, then users will be charged normal rates for up to 80% use and will be surcharged for any use above 80%. Calculation of the surcharges is based upon whether the user's meter size is less than or greater than a specified size. In addition to conservation surcharges, water users are also required to comply with additional water conserving measures related to landscape watering as the percentage of supply shortage increases.

Agricultural Conservation Programs

The Agricultural Conservation Program provided through the ASCS is currently the only available conservation program for agricultural areas in the Antelope Valley. A description of the program as well as a summary of current practices by the Soil Conservation Service is provided below.

Agricultural Conservation Program. The ASCS of the U.S. Department of Agriculture (USDA) provides an Agricultural Conservation Program (ACP) which offers cost sharing to farmers and ranchers to encourage conservation practices on agricultural land that will result in long-term benefits. The ACP is intended to 1) help prevent soil erosion and water pollution, 2) protect and improve productive farm and ranch land, 3) conserve water used for agriculture, 4) preserve and develop wildlife habitat and 5) encourage energy conservation measures. Water conservation programs eligible for cost-sharing are listed as follows:

- Permanently installed systems
- Lining irrigation ditches
- Land leveling
- Tailwater recovery systems or other installations where the installation is an integral part of the irrigation system being reorganized for the conservation of soil or water.

City of Palmdale. Water demand projections for Palmdale are based on a per capita demand of 0.32 acre-feet/person/year derived from 1993 population and water use data from PWD and applied to the medium population projection presented in Chapter 3. The breakdown of water use for each user class (residential, commercial, industrial and other) by percentage of the total water use was obtained from information supplied by LACWW and PWD. It is estimated that of the total water used in Palmdale, approximately 87 percent is used by the residential class, 8 percent is used by the commercial class, 4 percent is used by the industrial class, and 1 percent is used by the others. The percentages of water use for each user class are assumed to remain the same over the evaluation period (1994 to 2020).

City of Lancaster. Water demand projections for Lancaster are based on a per capita demand of 0.35 acre-feet/person/year derived from information provided in the City of Lancaster 1992 State of the City (SOC) report and applied to the medium population projection presented in Chapter 3. The SOC report provides estimates of current (1991) and projected water use for each user class. It is estimated that of the total water used in Lancaster in 1991, approximately 51 percent was used by the residential class, 14 percent was used by the commercial class, 19 percent was used by the industrial class and 16 percent was used by the others. The SOC report projects proportionally higher growth in the industrial class, thereby decreasing the proportion of water use for the residential, commercial and other classes. It is estimated that total water use in the year 2020 will comprise of approximately 50 percent residential, 8 percent commercial, 33 percent industrial and 9 percent other uses.

Community of Rosamond. Water demand projections for Rosamond are based on a per capita demand of 0.17 acre-feet/ person/year derived from 1993 population and water use data from RCSD and applied to the medium population projection presented in Chapter 3. It is estimated that of the total water used in Rosamond in 1993, approximately 86 percent was used by the residential class, 7 percent was used by the commercial class, 0.02 percent was used by the industrial class, and 7 percent was used by the others (Note that the industrial water demand is not shown on Figures 5-3 or 5-6 due to the small percentage of total water use). The percentages of water use for each user class is assumed to remain the same over the evaluation period (1994 to 2020).

Agricultural Water Demands

As shown in Table 5-1, current and projected 2020 agricultural water uses in the Antelope Valley are approximately 58,700 acre-feet and 39,100 acre-feet, respectively. These water demands include agricultural farmlands identified as high potential reclaimed water users in Chapter 6. Because the reclaimed water supply is projected to significantly exceed the reclaimed water demands, and the disposal of treated wastewater (i.e. reclaimed water) is highly dependent on maintaining agricultural farmlands, water conservation opportunities do not include the farmlands that have been identified as high potential reclaimed water users. Therefore, current and projected agricultural water demands shown in Table 5-1 and

on Figure 5-7 do not include farmlands identified as high potential users of reclaimed water.

WATER CONSERVATION MEASURES

The role of water conservation in water resources management has steadily increased in recent years. According to DWR, many water purveyors began incorporating water conservation into their planning in the early 1970s by distributing water-saving devices to their customers, providing public information and education programs, and implementing leak detection and repair programs. During the 1976-77 drought, more severe water conservation measures such as rationing and revised rate structures became commonplace. Because of its practical and economic values, many California water purveyors now regard water conservation as an integral part of their water supply planning. In addition to increased practice by water purveyors, a considerable amount of literature on water conservation has been published. Due to this increased attention, there is now a wide variety of effective water conservation measures available.

Urban Water Conservation Measures

Urban water conservation measures are identified in the September 1991 Memorandum of Understanding Regarding Urban Water Conservation in California and the Urban Water Management Planning Act.

Memorandum of Understanding. The Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California was entered into in 1991 by urban water suppliers, public advocacy organizations and other interested groups who recognized the need for conservation due to increasing water demands for urban, agricultural and environmental uses (currently, none of the members of the Antelope Valley Water Group are signatories to the MOU). Urban water conservation practices or Best Management Practices (BMPs) identified in the MOU are intended to reduce long-term urban water demands and is defined as a policy, program, practice, rule, regulation or ordinance or the use of devices, equipment or facilities which meets either of the following criteria:

- An established and generally accepted practice among water suppliers that results in more efficient or use or conservation of water.

- A practice for which sufficient data are available from existing water conservation projects to indicate that significant conservation or conservation related benefits can be achieved; that the practice is technically and economically reasonable and not environmentally or socially unacceptable; and that the practice is not otherwise unreasonable for most water suppliers to carry out.

The following is a list of the BMPs identified in the MOU. A description of each BMP is included in Appendix A.

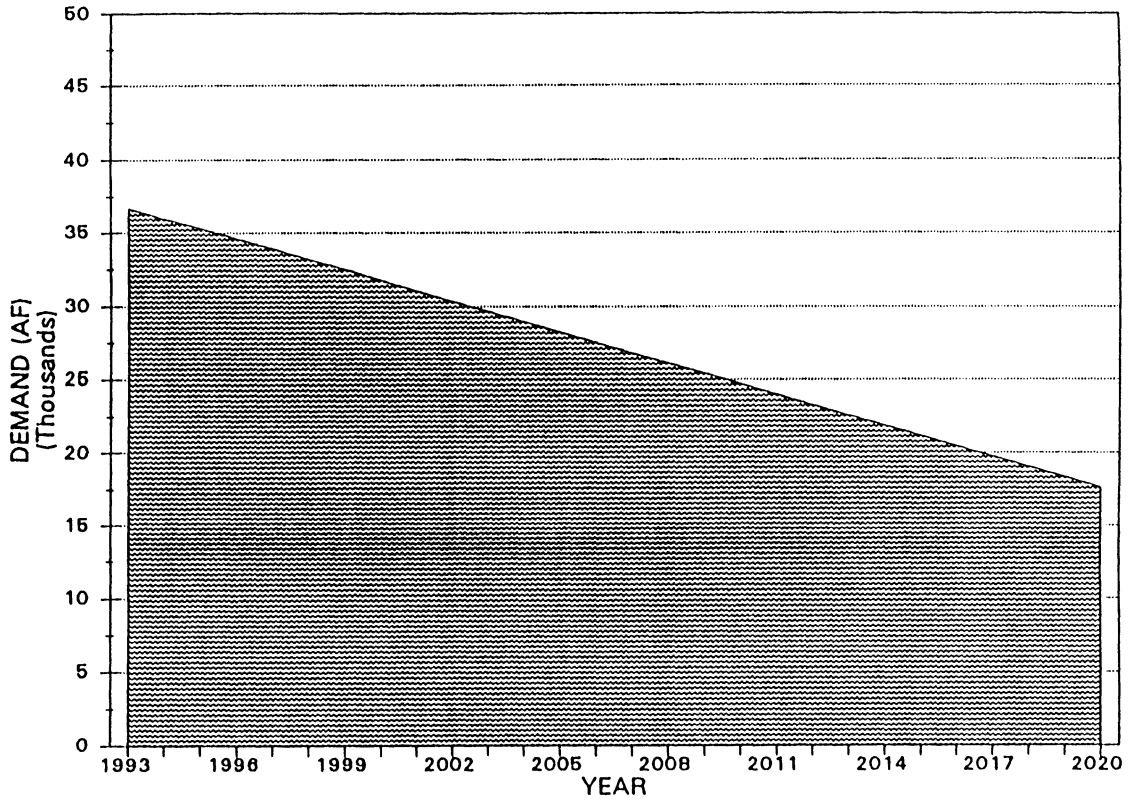

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Figure 5–7

Figure 5–7

- Interior and exterior water audits and incentive programs for single family residential, multi-family residential, and governmental/institutional customers.
- Plumbing, new and retrofit.
- Distribution system water audits, leak detection and repair.
- Metering with commodity rates for all new connections and retrofit of existing connections.
- Large landscape water audits and incentives.
- Landscape water conservation requirements for new and existing commercial, industrial, institutional, governmental, and multi-family developments.
- Public information.
- School education.
- Commercial and industrial water conservation.
- New commercial and industrial water use review.
- Conservation pricing.
- Landscape water conservation for new and existing single family homes.
- Water waste prohibition.
- Water conservation coordinator.
- Financial incentives.
- Ultra low flush toilet replacement.

In addition to identifying BMPs, the MOU also included Potential Best Management Practices (PBMPs). The intent of the MOU was to study and then determine whether or not the PBMP's met the criteria designated as BMPs. The following is a list of the PBMPs under study identified in the MOU.

- Rate structures and other economic incentives and disincentives to encourage water conservation.
- Efficiency standards for water using appliances and irrigation devices.

- Replacement of existing water using appliances (except toilets and showerheads whose replacements are incorporated as BMPs) and irrigation devices.

- Retrofit of existing car washes.

- Graywater use.

- Distribution system pressure regulation.

- Water supplier billing records broken down by customer class (e.g., residential, commercial, industrial).

- Swimming pool and spa conservation including covers to reduce evaporation.

- Restrictions or prohibitions on devices that use evaporation to cool exterior spaces.

- Point-of-Use water heaters, recirculating hot water systems and hot water pipe insulation.

- Efficiency standards for new industrial and commercial processes.

Urban Water Management Planning Act. As previously discussed, the Urban Water Management Planning Act requires urban water retailers supplying more than 3,000 acre-feet of water per year or serving more than 3,000 customers to prepare an UWMP to achieve conservation and efficient use of water. The Act requires the UWMP to evaluate water management practices identified below:

- Consumer education.

- Metering.

- Water saving fixtures and appliances.

- Pool covers.

- Lawn and garden irrigation techniques.

- Low water use landscaping.

- Internal and external water audits for single-family residential, multifamily residential, institutional, commercial, industrial, and governmental customers.

- Incentive programs to encourage customer audits and program participation.

- Distribution system water audits.

- Leak detection and repair.
- Large landscape water audits and incentives for conversion to water reuse.
- Financial incentives to encourage use of reclaimed water.
- Incentive programs to facilitate development of dual water systems for use of reclaimed water in new construction, for flushing toilets and urinals, landscaping, golf courses, cemeteries, irrigation, and other appropriate purposes.
- Plans to eliminate use of once-through cooling systems, non-recirculating water systems, and non-recycling decorative water fountains and to encourage recirculation of water if proper public health and safety standards are maintained.
- Wastewater reclamation.
- Exchanges or transfer of water on a short-term or long-term basis.
- Management of water system pressure and peak demands.
- Issues relevant to meter retrofitting for all uses
- Incentives to alter water use practices, including fixture and appliance retrofit programs.
- Changes in pricing, rate structure, and regulations.

A copy of the Urban Water Management Planning Act and subsequent amendments is included in Appendix B.

Agricultural Water Conservation Measures

Agricultural water conservation measures are identified in the DWR November 1993 draft "California Water Plan Update" (Bulletin 160) and are described below. A description of the Mobile Agricultural Water Conservation Laboratory program is also presented.

Bulletin 160. Bulletin 160 reports that programs offered through the University of California, California State Universities, local Resource Conservation Districts and the USDA have resulted in constant improvement in use of resources for agricultural productions in California. Through the collective efforts of these groups, DWR reports that irrigation efficiencies have increased and water requirements have decreased. As discussed previously, enactment of the Agricultural Water Suppliers Efficient Water Management Act in 1990 requires the DWR to establish an advisory

and ranchers have used the Mobile Lab to troubleshoot system problems and make scheduling recommendations, and over 400 evaluations on 10,000 acres have been completed by the RCRDC Mobile Lab. Over 2,300 evaluations have been completed by Mobile Labs throughout California.

Pond-Shafter-Wasco Resource Conservation District

Estimates provided by the Pond-Shafter-Wasco Resource Conservation District indicate that approximately 1,500 acre-feet of water could be saved on 6,642 acres of farmland if the irrigation systems were operating more efficiently. The water savings is based on averages over a six year period and is regarded as potential savings from implementation of the recommendations and adjustments provided by the Mobile Lab Program.

A.A. Naumann, Inc

The Regional Water Quality Control Board, Resource Conservation District, United Water Conservation District, Pleasant Valley County Water District, City of Oxnard, Casitas Municipal Water District and the Association of Water Agencies of Ventura County are participating agencies in a pilot project involving testing of underground reusable drip irrigation tape for row crops on the A.A. Naumann Ranch in Ventura County. Most row crops grown in Ventura County are furrow or furrow/sprinkler irrigated, which is reported to be less efficient than buried drip irrigation for the application of water, fertilizers and pesticides. The drip irrigation resulted in a 66 percent savings in water per acre compared to furrow irrigation (2.3 acre-feet versus 7 acre-feet), while product yield increased by almost 10 percent. Pesticide use declined by 33 percent. Savings in reduction of fertilizer, pesticide and water use, accompanied by increases in production yield resulted in a good initial return on the investment of the underground drip irrigation system.

RECOMMENDED WATER CONSERVATION PROGRAMS

This section briefly describes the measures recommended for inclusion in the water conservation plan for the Antelope Valley. Because agricultural water use is expected to decline significantly during the planning period (1994-2020), the plan consists primarily of urban conservation programs developed for the City of Palmdale, City of Lancaster and Community of Rosamond. A brief discussion on the agricultural water conservation program is included in the overall plan for the Antelope Valley. Evaluation of urban water conservation measures was performed utilizing the DWR's WaterPlan computer software. Benefit to cost (B/C) analyses were performed for each recommended urban water conservation measure to determine cost effectiveness. A discussion on the B/C analyses as well as an implementation plan for each water conservation measure is also included.

City of Palmdale

Table 5-2 identifies the conservation measures recommended for the City of Palmdale. The water conservation program for Palmdale consists of 6 measures;

TABLE 5-2

SELECTED URBAN WATER CONSERVATION MEASURES

Area	Measure
City of Palmdale	• Ultra Low-Flush Toilet Ordinance, New Residential • Standards for New Large Landscapes • Retrofit Kit Program • Information and Education, Residential • Seasonal Rates, Residential • Uniform or Increasing Block Rates, Residential
City of Lancaster	• Ultra Low-Flush Toilet Ordinance, New Residential • Standards for New Large Landscapes • Information and Education, Residential • Residential Water Audit and Retrofit Kit • Seasonal Rates, Residential • Seasonal Rates, Commercial • Seasonal Rates, Industrial • Uniform or Increasing Block Rates, Residential • Uniform or Increasing Block Rates, Commercial • Uniform or Increasing Block Rates, Industrial • Large Turf Irrigation Audits
Community of Rosamond	• Ultra Low-Flush Toilet Ordinance, New Residential • Standards for New Large Landscapes • Seasonal Rates, Residential • Uniform or Increasing Block Rates, Residential • System Water Audit, Leak Detection, and Repair • Residential Retrofit Kit

2 existing and 4 potential. The two existing measures: Ultra Low-Flush Toilet Ordinance for New Residential and Standards for New Large Landscapes are measures established in regulations previously described. The 4 potential conservation measures recommended for consideration by the City of Palmdale are described below.

Fixture Retrofit Kit for Pre-1980, Residential. This program involves the provision of fixture retrofit kits to 5,900 housing units built prior to 1980. The measure is intended to reduce residential water consumption by eliminating some of the high water using fixtures typically found in older housing units (pre-1980). The kits include the following:

- Two toilet tank displacement dams to reduce the volume of water used by non-conserving toilets.

- Two leak detection tablet packets to identify equipment-related leakage in residential toilets.

- One ultra-low flow showerhead to achieve water savings through replacement of one non-conserving showerhead.

Information and Education, Residential. This program is designed to increase customer "water" awareness and promote understanding of local community water conservation projects. The program may involve in-school education by providing educators with a water conservation curriculum, a teacher training workshop and/or through water conservation assemblies. Information may be disseminated to the public through bill stuffers, brochures, print media, television, etc. The information packages may include the following:

- Information on water-wise versus water-wasteful practices designed to increase customer awareness of indoor and outdoor water use.

- Lawn watering guides to provide customers with easy to follow instructions on how to determine the appropriate watering time required to adequately irrigate their own turfgrass.

- Information on "Xeriscape principles" to increase customer awareness of water-saving techniques that may be implemented in residential landscapes.

Seasonal Rates, Residential. This program involves implementation of higher water rates during peak water use periods and is intended to encourage customers to conserve water during summer months when consumption is high due to landscape irrigation requirements.

Uniform or Increasing Block Rates, Residential. This program involves implementation of a modified rate schedule to charge the same amount for each unit of water sold (uniform) or more per unit of water as consumption rises (increasing

block). The program is intended to encourage customers to use water conserving practices and devices in order to avoid higher per unit water charges associated with increased water use.

Implementation of the Ultra-Low-Flow Toilet Ordinance and the Standards for New Large Landscapes will be the responsibility of the City of Palmdale. Implementation of the Seasonal and Block Rates will be the responsibility of the individual water purveyors. The Retrofit Kits and Information and Education measure can be implemented by both the City and the individual water purveyors.

Total water savings during the planning period (1994-2020) are estimated to be 225,800 acre-feet. The B/C ratio of the plan is 4.7. Figure 5-8 depicts projected water demand with and without the water conservation program recommended for the City of Palmdale.

City of Lancaster

Table 5-2 identifies the conservation measures recommended for the City of Lancaster. The water conservation program for Lancaster consists of 11 measures; 2 existing and 9 potential. The two existing measures are the Ultra Low-Flush Toilet Ordinance for New Residential and Standards for New Large Landscapes, established in regulations described previously. Because commercial and industrial users comprise a large percentage of water demand in Lancaster as shown on Figure 5-5, commercial and industrial conservation programs are recommended for the City. The 9 potential conservation measures recommended for consideration by the City of Lancaster are described below.

Information and Education, Residential. Discussed under "City of Palmdale."

Residential Water Audit and Retrofit Kit. This program is conducted at the request of the homeowner and usually involves the following:

- Identification and discussion of water uses with the homeowner.
- Offer to install low-flow showerheads, tank displacement dams, and faucet aerators, and check for toilet leaks using leak detection tablets.
- Repair of toilet leaks if detected.
- Provision of guides and information on additional water conserving actions and lawn watering.

Availability of free water audits is promoted through the public information program as an incentive for homeowners to request them.

Seasonal Rates, Residential, Commercial, Industrial. Discussed under "City of Palmdale."

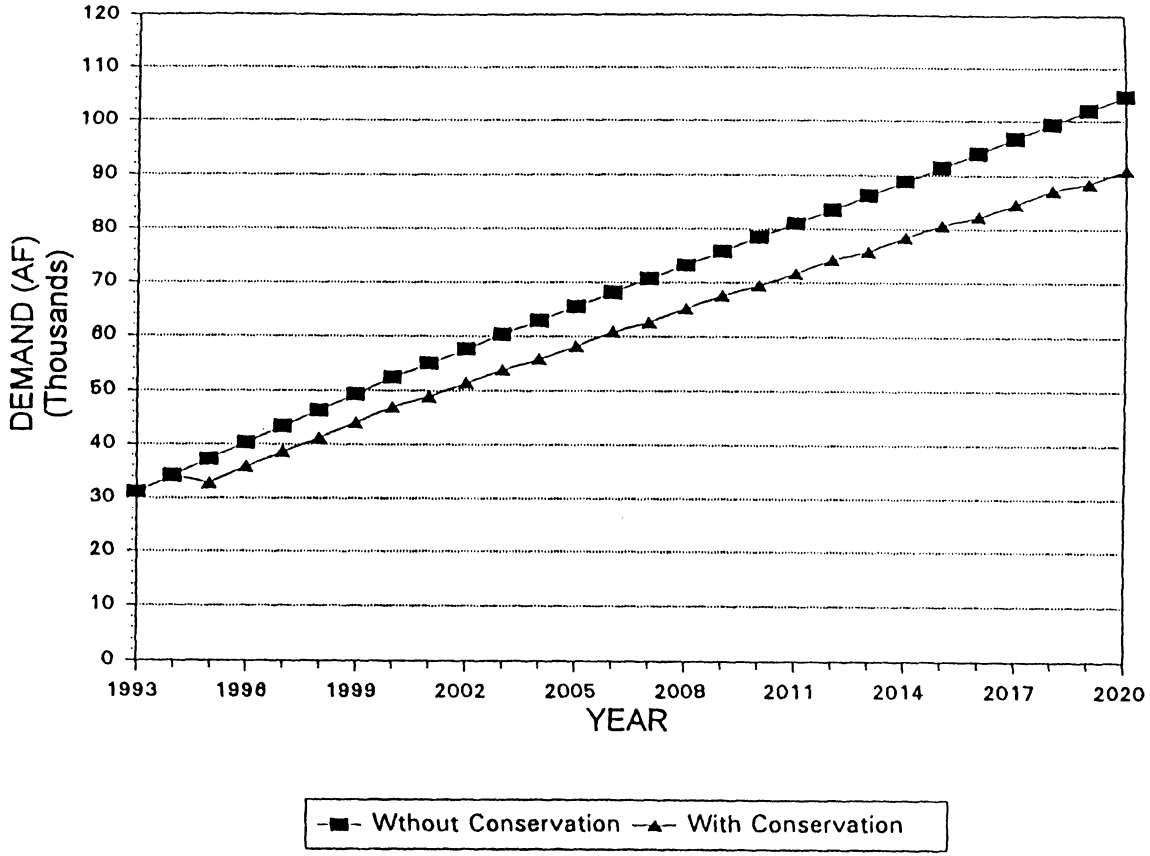

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Figure 5-8

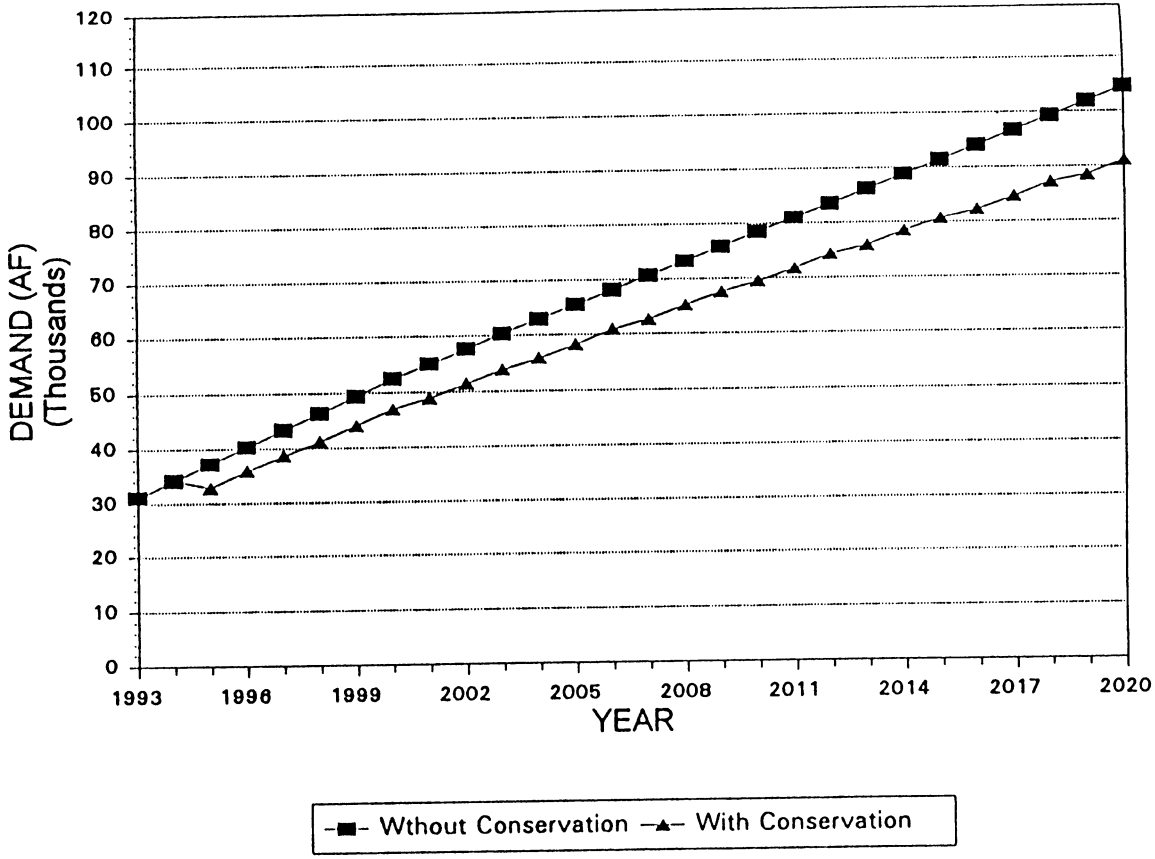

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Figure 5-8

Figure 5-8

Residential Retrofit Kit. This program involves the provision of fixture retrofit kits to 3,000 housing units. The measure is intended to reduce residential water consumption by eliminating some of the high water using fixtures. The kits include the following:

- Lawn watering guides to provide customers with easy to follow instructions on how to determine the appropriate watering time required to adequately irrigate his or her own turfgrass.

- Two toilet tank displacement dams to reduce the volume of water used by non-conserving toilets.

- Two leak detection tablet packets to identify equipment-related leakage in residential toilets.

- One ultra-low flow showerhead to achieve water savings through replacement of one non-conserving showerhead.

- One faucet aerator to reduce water use.

Implementation of the Ultra-Low-Flow Toilet Ordinance and the Standards for New Large Landscapes will be the responsibility of the County of Kern. Implementation of the Seasonal and Block Rates and the System Water Audit will be the responsibility of the individual water purveyors. The Retrofit Kits can be implemented by both the County and the individual water purveyor.

Total water savings during the planning period (1994 to 2020) are estimated to be 21,700 acre-feet. The B/C ratio of the plan is 4.5. Figure 5-10 depicts projected water demand with and without the water conservation program recommended for the Community of Rosamond.

Benefit to Cost Analyses

Water conservation programs described above were evaluated utilizing the DWR WaterPlan software. The WaterPlan software allows the user to input specific information applicable to each service area. This information includes:

- water consumption
- water rates
- marginal cost of water
- electric rates and marginal cost
- natural gas rates and marginal cost
- sewer rates and marginal cost

The software then allows the user to select or design water conservation programs for analysis.

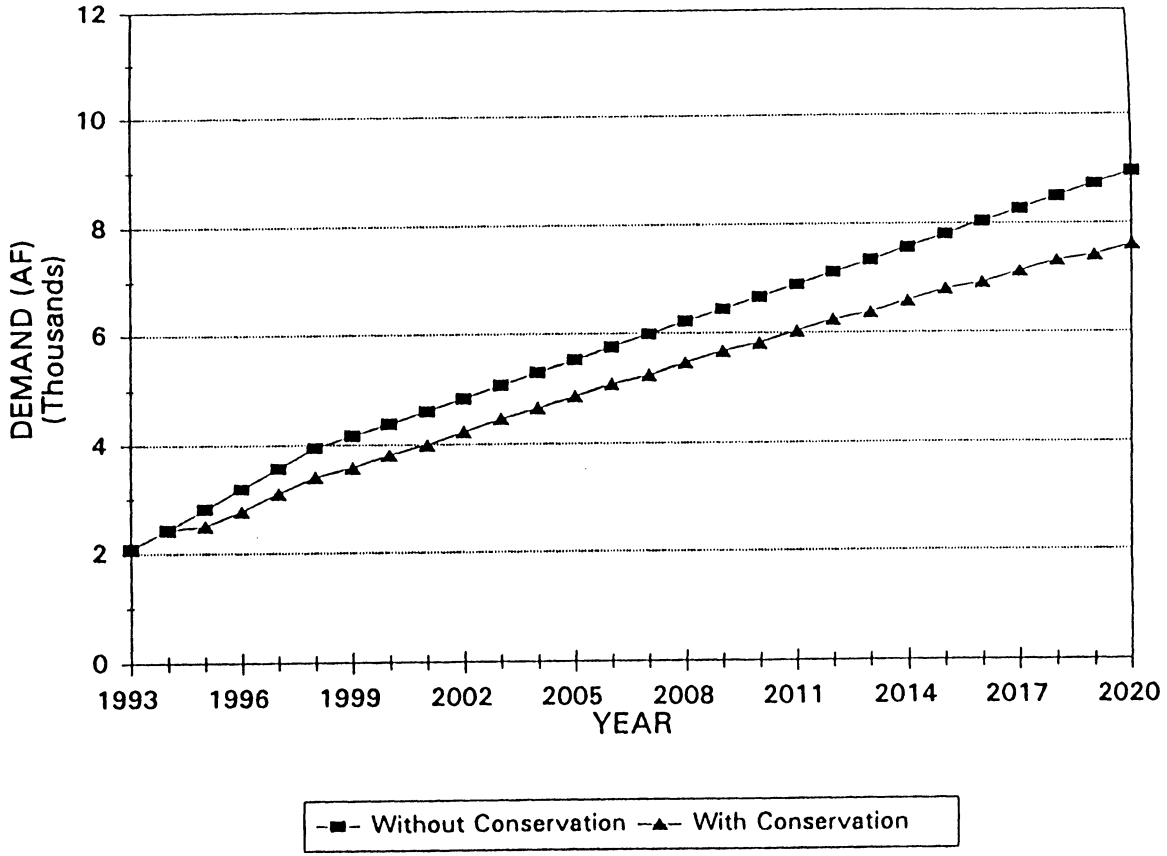

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Figure 5–10

Figure 5–10

After a program is selected, information pertaining to each measure within the program is input. This information includes:

- Number of items delivered by year over the study period.
- Responsible party for the capital, installation, and operation and maintenance costs.
- Percentage of people expected to participate.

Once the service area and measure information are input, the B/C analysis can be run. The B/C ratio is the ratio of the present value of benefits to the present value of costs resulting from water conservation measures. An investment is cost-effective when the present value of benefits to the present value of costs (or B/C) exceeds 1.0. Benefits of water conservation are calculated by estimating water savings from each program which are multiplied by the value of water; yielding the estimated benefits from water conservation in dollars. Costs of water conservation include device and administrative costs associated with each conservation measure. Device costs include capital, installation, and operation and maintenance. Administrative costs include salaries of personnel associated with conservation, delivery, incentive payments, and advertising.

Results of the B/C analyses for the conservation measures analyzed for each area are summarized in Table 5-3. The overall B/C ratios for the City of Palmdale, City of Lancaster, and Community of Rosamond were calculated to be 4.7, 3.0, and 4.5 respectively.

Agricultural Water Conservation Program

As discussed previously, the Agricultural Water Suppliers Efficient Water Management Practices Act requires the DWR to establish an advisory committee to evaluate EWMPs aimed at agricultural water suppliers concerning conservation of irrigation water. Because the evaluation of the EWWPs will require detailed planning by each water agency and will include analysis of technical feasibility, social and district economic criteria and legal feasibility of each practice, an assessment of the impact of implementation of EWWps (i.e., costs and water savings) is not currently available through the DWR.

In addition, due to all the variables associated with agriculture (i.e., crop type, soil type, acreage, irrigation system, management, etc.), it may be difficult to produce a software program that will provide B/C ratios for agricultural measures similar to DWR's WaterPlan for urban conservation measures which uses typical values for costs and water savings obtained from historical information. Therefore, until DWR's assessment of the EWMPs is complete, analyses of potential agricultural conservation measures for the Valley cannot be provided. However, based on the available case studies, an agricultural water conservation program can be recommended on a preliminary basis. It is recommended that a Mobile Lab program

TABLE 5-3

BENEFIT TO COST RATIO SUMMARY

PROGRAM	AGENCY
City of Palmdale	
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	0.1
• Standards for New Large Landscapes [1]	1.4
• Retrofit Kit Program	1.9
• Information and Education, Residential	1.8
• Seasonal Rates, Residential	327.4
• Uniform or Increasing Block Rates, Residential	545.6
Total	4.7
City of Lancaster	
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	2.5
• Standards for New Large Landscapes [1]	2.7
• Information and Education, Residential	2.6
• Residential Water Audit and Retrofit Kit	2.6
• Seasonal Rates, Residential	3.1
• Seasonal Rates, Commercial	3.0
• Seasonal Rates, Industrial	3.0
• Uniform or Increasing Block Rates, Residential	3.1
• Uniform or Increasing Block Rates, Commercial	3.0
• Uniform or Increasing Block Rates, Industrial	3.1
• Large Turf Irrigation Audits	2.9
Total	3.0
Community of Rosamond	
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	2.1
• Standards for New Large Landscapes [1]	1.1
• Seasonal Rates, Residential	3.3
• Uniform or Increasing Block Rates, Residential	3.3
• System Water Audit, Leak Detection, and Repair	21.0
• Residential Retrofit Kit	2.1
Total	4.5

(1) Existing regulations

be established to serve agricultural areas in the Antelope Valley. Although the RCRCD 1993 report reported a potential 20 to 50 percent water savings through the Mobile Lab program, for purposes of this report, a conservative estimate of 10 percent is used. This estimate results in total water savings during the planning period (1995-2020) of 68,800 acre-feet. Figure 5-11 depicts the projected agricultural water demands with and without the Mobile Lab program.

Implementation Schedule

An implementation schedule as well as the estimated water savings for each conservation measure described above is shown on Table 5-4. Implementation of the urban conservation measures is assumed to begin in 1994 and continue through the year 2020. Estimated water savings from the urban measures range from 0.67 to 87,356 acre-feet for the City of Palmdale, 0.34 to 43,775 acre-feet for the City of Lancaster, and 0.34 to 7,821 acre-feet for the Community of Rosamond. The estimated water savings is shown as the total amount of water saved over the entire implementation period (1994 to 2020). Implementation of the agricultural conservation measure is assumed to begin in 1995 and continue through the year 2020. Estimated water savings for the agricultural measure is 68,800 acre-feet over the entire implementation period (1995 to 2020).

It is important to note that a cooperative attitude from all agencies involved may help to contribute to the success of implementation of the conservation program.

RELIABILITY

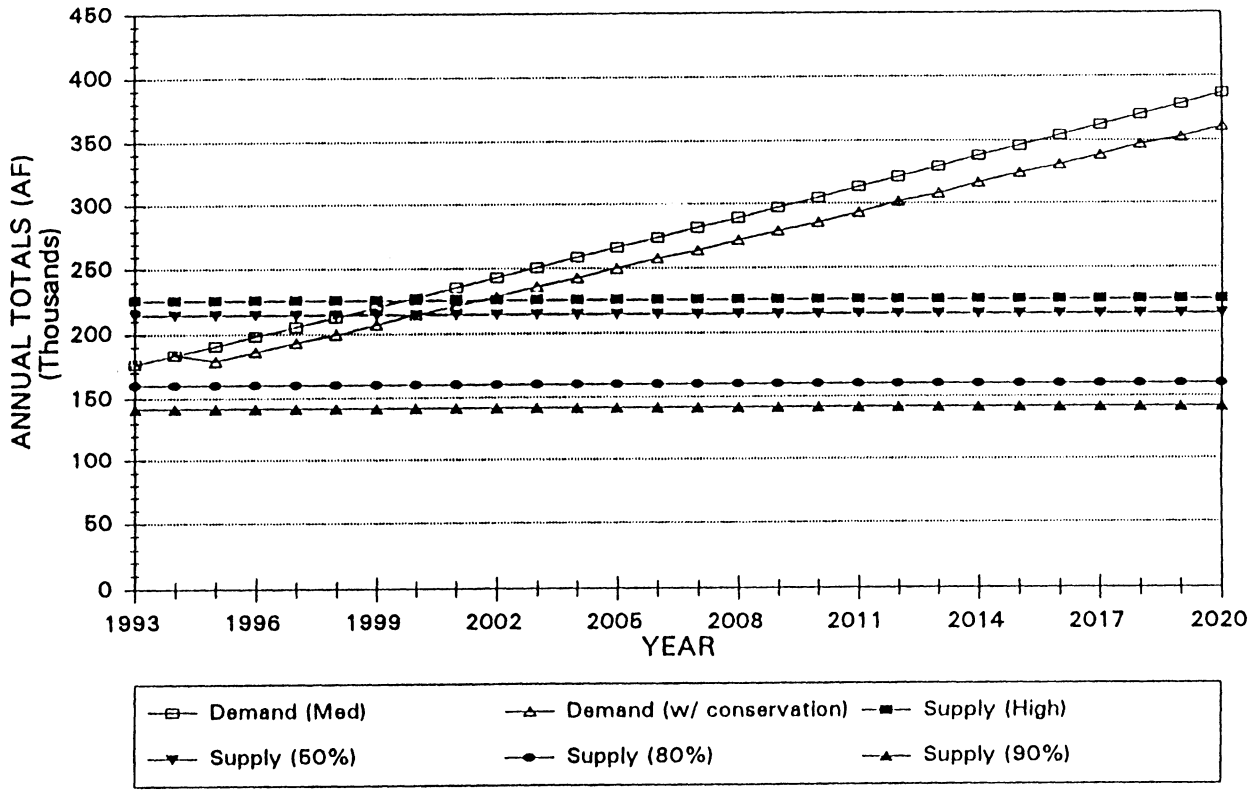
Figure 5-12 depicts the medium demand with and without implementation of conservation measures and projected supply estimates at the 50, 80, and 90 percent probability levels. The most optimistic supply assumption (i.e., delivery of 100 percent of available water supplies) is also shown. Figure 5-12 is identical to Figure 4-16 with one exception, a second demand curve is provided to show the affect on the projected water demands from implementation of the conservation program discussed in this chapter. As shown on Figure 5-12, the estimated 1993 water demand is met approximately 73 percent of the time. Without a conservation program, by the year 1998, 100 percent water demand is estimated to be met only 50 percent of the time and by the year 2000, 100 percent of the potential water supplies would be required to meet the water demand. With a conservation program, by the year 2000, 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2002, 100 percent of the potential water supplies would be required to meet the water demand.

TABLE 5-4

IMPLEMENTATION SCHEDULE
AND ESTIMATED WATER SAVINGS

Conservation Measure	Implementation Years	Estimated Water Savings (acre-feet)
City of Palmdale		
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	1994-2020	0.67
• Standards for New Large Landscapes [1]	1994-2020	40
• Retrofit Kit Program	1994-2020	7,357
• Information and Education, Residential	1994-2020	78,642
• Seasonal Rates, Residential	1994-2020	52,415
• Uniform or Increasing Block Rates, Residential	1994-2020	87,356
Total		225,811
City of Lancaster		
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	1994-2020	0.34
• Standards for New Large Landscapes [1]	1994-2020	80
• Information and Education, Residential	1994-2020	25,233
• Residential Water Audit and Retrofit Kit	1994-2020	1,245
• Seasonal Rates, Residential	1994-2020	43,775
• Seasonal Rates, Commercial	1994-2020	6,575
• Seasonal Rates, Industrial	1994-2020	10,927
• Uniform or Increasing Block Rates, Residential	1994-2020	43,775
• Uniform or Increasing Block Rates, Commercial	1994-2020	10,961
• Uniform or Increasing Block Rates, Industrial	1994-2020	18,210
• Large Turf Irrigation Audits	1994-2020	9,325
Total		170,106
Community of Rosamond		
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	1994-2020	0.34
• Standards for New Large Landscapes [1]	1994-2020	40
• Seasonal Rates, Residential	1994-2020	5,694
• Uniform or Increasing Block Rates, Residential	1994-2020	5,694
• System Water Audit, Leak Detection, and Repair	1994-2020	7,821
• Residential Retrofit Kit - Minimal	1994-2020	2496
Total		21,745
Agricultural		
• Mobile Lab Program	1995-2020	68,800

(1) Existing regulations



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Supply and Projected Demand
(Includes Conservation)

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Figure 5–12

Figure 5–12

CHAPTER 6

USE OF RECLAIMED WATER

This chapter evaluates the feasibility of reclaimed water use within the Antelope Valley. Elements of the chapter include reclaimed water characteristics and facilities, regulatory requirements and market assessment for reclaimed water. A conceptual plan as well as discussions on excess reclaimed water supply, permit requirements, other institutional issues, and financing alternatives are also presented.

WASTEWATER CHARACTERISTICS AND FACILITIES

Because the extent of the reclaimed water system is dependent on the amount of wastewater available, as well as the quality of the treated wastewater, the following section presents an overview of wastewater facilities, flow, and quality in the Antelope Valley.

Wastewater Facilities

Existing wastewater facilities in the Antelope Valley are listed in Table 6-1. Flow, capacity and treatment levels for current and planned plant conditions are provided in the table. Discussion in this chapter focuses primarily on the Palmdale Water Reclamation Plant (WRP), Lancaster WRP, and Rosamond WRP, with some discussion on Edwards Air Force Base (Edwards AFB) WRP. Locations of these facilities are shown on Figure 6-1. These plants were selected as having the greatest potential for expansion, as well as the highest projected flows in the year 2020. Edwards AFB WRP is discussed to a lesser extent than the other three plants because design of water reclamation facilities are already underway.

Palmdale WRP. The County Sanitation Districts of Los Angeles County (CSDLAC) District 20 operates the Palmdale WRP located on 30th Street East, southeast of the Palmdale Airport. The Palmdale WRP is an undisinfected secondary treatment facility with a capacity of 8.0 million gallons per day (mgd). A schematic of the plant's process is presented on Figure 6-2. A portion of the effluent from Palmdale WRP is currently used for irrigating farmland at the Department of Airports (DOA). The DOA has a contract for up to 12 mgd of effluent (CSDLAC, 1994). The remaining effluent is spread over 2,600 acres of land owned by the DOA (approximately 0.3 percent of reclaimed water was used by local farmers on DOA property in 1991-1992 (CSDLAC, 1992-1993)). To accommodate anticipated growth in the Antelope Valley, CSDLAC is planning to expand the plant to a capacity of 15.0 mgd in 1994.

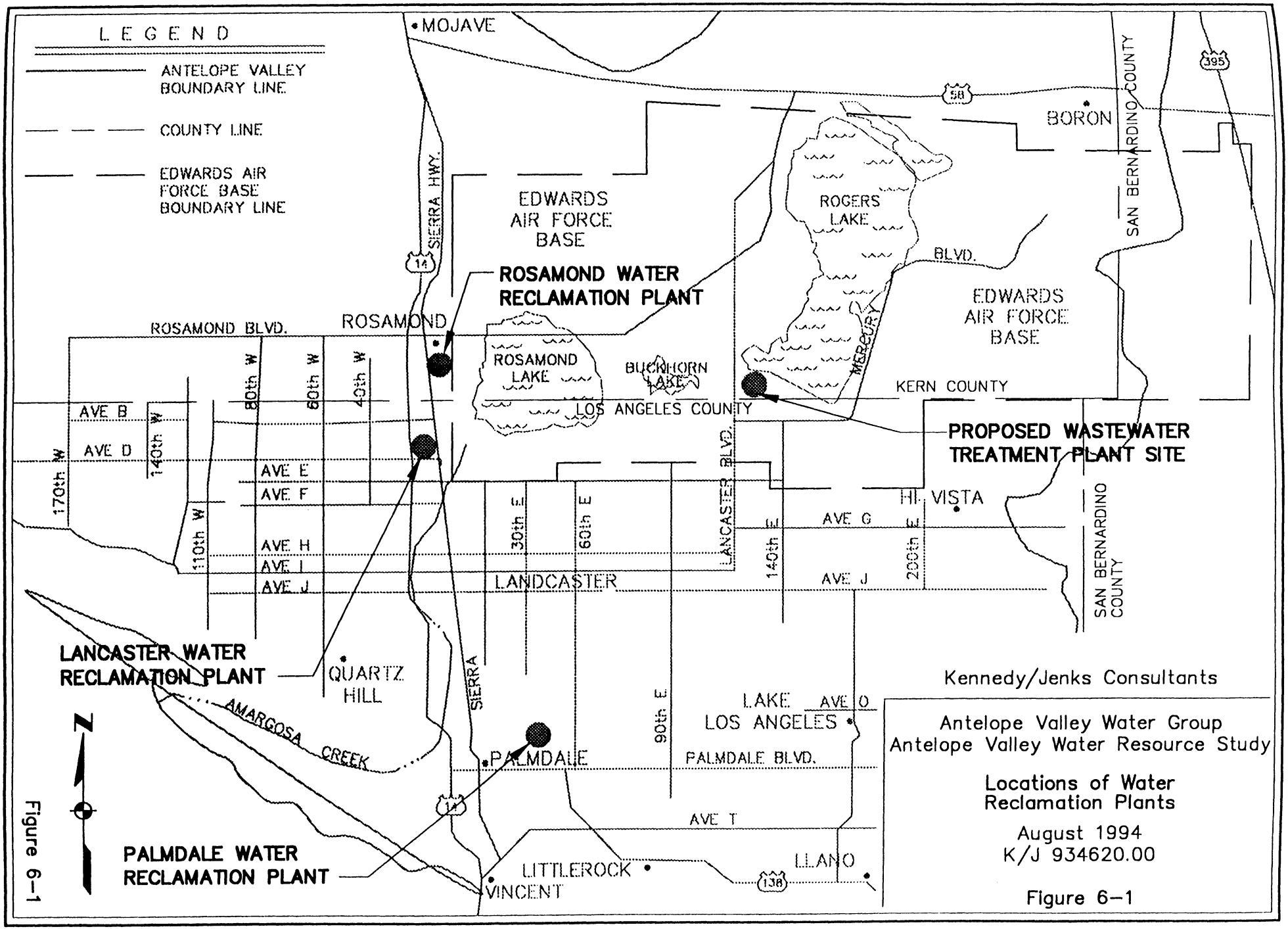
Lancaster WRP. The CSDLAC District 14 operates the Lancaster WRP located southeast of the intersection of Antelope Valley Freeway (I-14) and Avenue C, near Edwards AFB. The Lancaster WRP is currently the only facility in Antelope Valley

TABLE 6-1

EXISTING WASTEWATER FACILITIES IN THE ANTELOPE VALLEY

Facility Name	Areas Served	Current Plant Conditions			Planned Plant Conditions			
		Flow (mgd)	Capacity (mgd)	Treatment Level	Flow (mgd)	Capacity (mgd)	Expected Year	Treatment Level
Palmdale WRP	Palmdale	7.4	8.0	Secondary	9.5	15.0	1994	Secondary
Lancaster WRP	Lancaster Quartz Hill	8.4	10.0	Secondary Tertiary	12.9	16.0	1995	Secondary Tertiary
Rosamond WRP	Rosamond	0.8	2.0	Primary	1.0	2.0	1996	Tertiary
Edwards AFB WRP	Edwards AFB	1.7	1.5	Primary	1.8	2.5	1995	Tertiary
Mojave WRP	Mojave	0.4	0.6	Secondary	No current plans for expansions			
Plant 42 WRP	U.S. Air Force	0.25	1.0	Primary	No current plans for expansions			
Desert Lake WRP	Desert Lake	0.08	0.14	Primary	No current plans for expansions			
Boron WRP	Boron	0.12	0.21	Primary	No current plans for expansions			
Edwards AFB Missile Test Site WWTF	Edwards AFB	0.05	0.06	Primary	No current plans for expansions			
Edwards AFB N. Base Research WWTF	Edwards AFB	0.075	0.125	Primary	No current plans for expansions			
Boron Federal Prison WWTF	Boron Federal Prison	0.01	0.017	Primary	No current plans for expansions			

mgd = million gallons per day
WRP = water reclamation facility
WWTF = wastewater treatment facility



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Locations of Water Reclamation Plants

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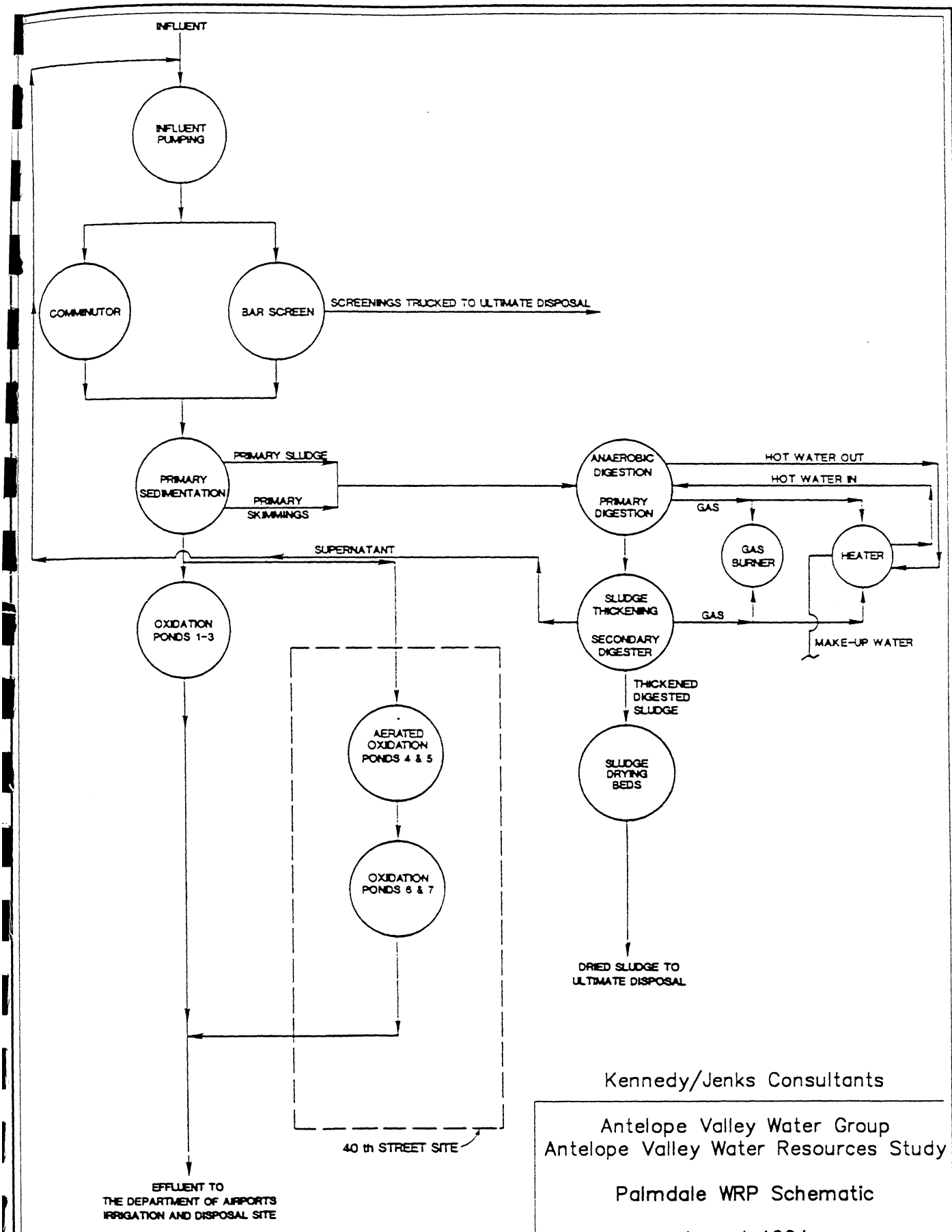
Figure 6–1

Figure 6–1



Source: County Sanitation Districts of Los Angeles County

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Palmdale WRP Schematic

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Figure 6-2

supplying tertiary treated water (0.6 mgd design capacity). A majority of the plant's flow is treated to a secondary treatment level. Total capacity of the plant is 10.0 mgd. A schematic of the plant's process is presented on Figure 6-3. Undisinfected secondary effluent from the WRP is used for irrigating farmland at Nebeker Ranch. Tertiary quality effluent is used at Apollo Lakes County Parks for lake and irrigation use. The remaining effluent is disinfected before discharging to Paiute Ponds. To accommodate anticipated growth in the Antelope Valley, CSDLAC is planning to expand the plant to a capacity of 16.0 mgd in 1995.

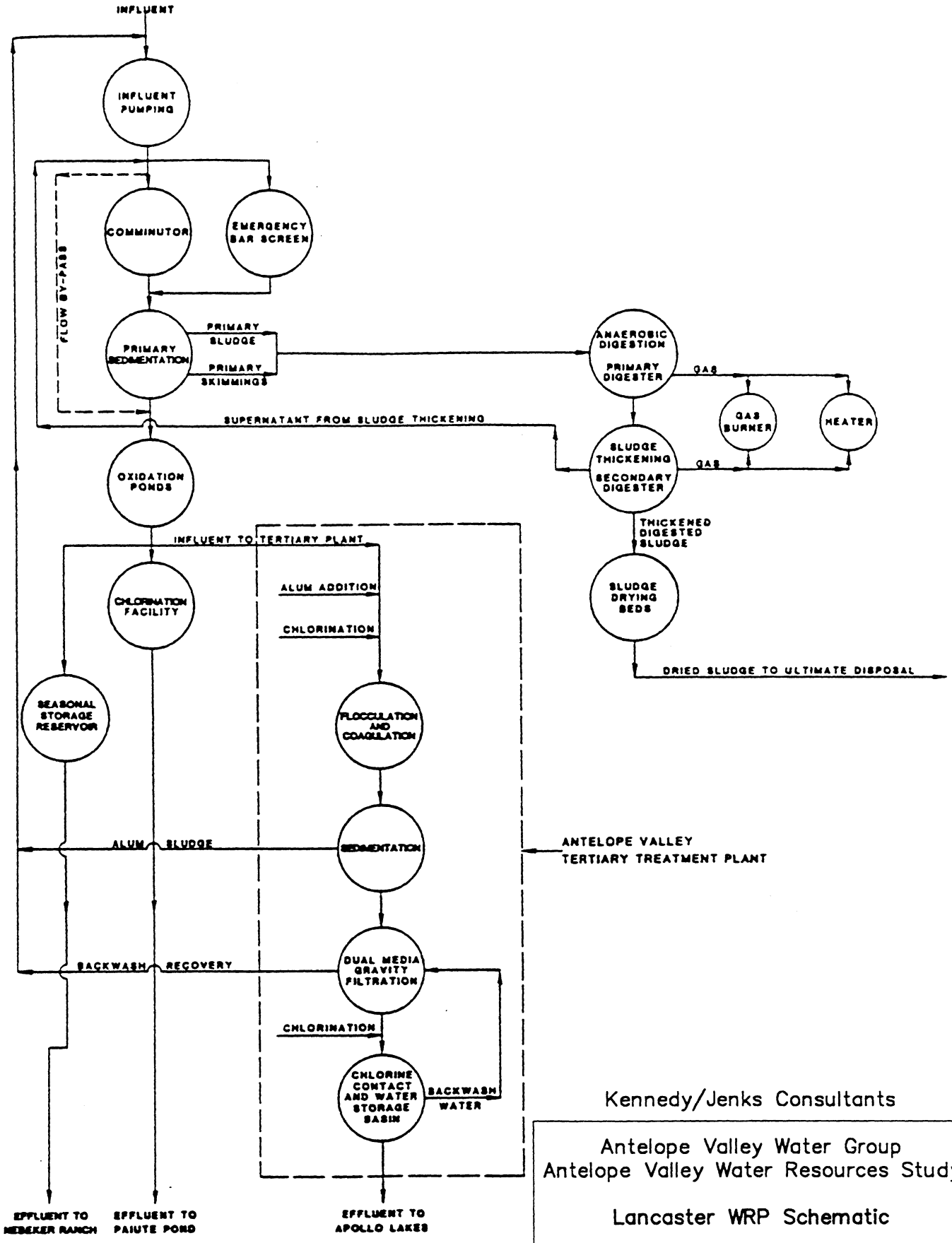
Rosamond WRP. Rosamond Community Services District (RCSD) operates a wastewater treatment plant located approximately 0.5 miles east of the Southern Pacific Railroad and approximately 1 mile north of the Kern County/Los Angeles County border. The Rosamond WRP is a 2.0 mgd primary treatment facility. Effluent from the Rosamond WRP is currently discharged to evaporation ponds. RCSD is planning to convert the existing system to a 2.0 mgd tertiary treatment facility in 1996.

Edwards AFB WRP. Edwards AFB operates a wastewater treatment plant located approximately 2 miles east of Lancaster Boulevard and approximately 1/4 mile north of the South Base well fields. The Edwards AFB WRP is a 1.5 mgd primary treatment facility. Effluent from the plant is currently discharged to evaporation ponds. Edwards AFB is designing a 2.5 mgd tertiary treatment facility scheduled to be constructed in 1995.

Wastewater Flow

Historic Flows. Average daily flow rates for the WRPs during the period from 1970 through 1992 are summarized in Table 6-2 and depicted on Figures 6-4 through 6-7. Average daily flow rates at all four plants have been steadily increasing over the past several years. Palmdale WRP's average flow of 7.9 mgd in 1991 approached the average daily flow design capacity of 8.0 mgd. Average daily flow rates of 1.7 mgd at the Edwards WRP were slightly above the design capacity of 1.5 mgd from 1988 through 1992.

Projected Flows. The projected flows for the WRPs to the year 2020 are also depicted on Figures 6-4 to 6-7. Two projections are shown for the Palmdale and Lancaster WRPs. (See Figures 6-4 and 6-5.) The low projection for the Palmdale WRP and the high projection for the Lancaster WRP were provided by CSDLAC and are based on the adopted 1989 Growth Management Plan in the Air Quality Management Plan (AQMP/GMP) by the Southern California Association of Governments (SCAG). The other projections on Figures 6-4 and 6-5 were developed based on the medium population projections for the cities of Palmdale and Lancaster presented in Chapter 3 and the wastewater flow per capita in the AQMP/GMP. The SCAG projections are shown for comparison purposes only. Based on the medium projections developed for this study, the average daily wastewater flow in the year 2020 is estimated to be 37.2 mgd for the Palmdale WRP and 29.8 mgd for the Lancaster WRP. Similar to the Palmdale and Lancaster WRPs, projected wastewater



Source: County Sanitation Districts of Los Angeles County

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Lancaster WRP Schematic

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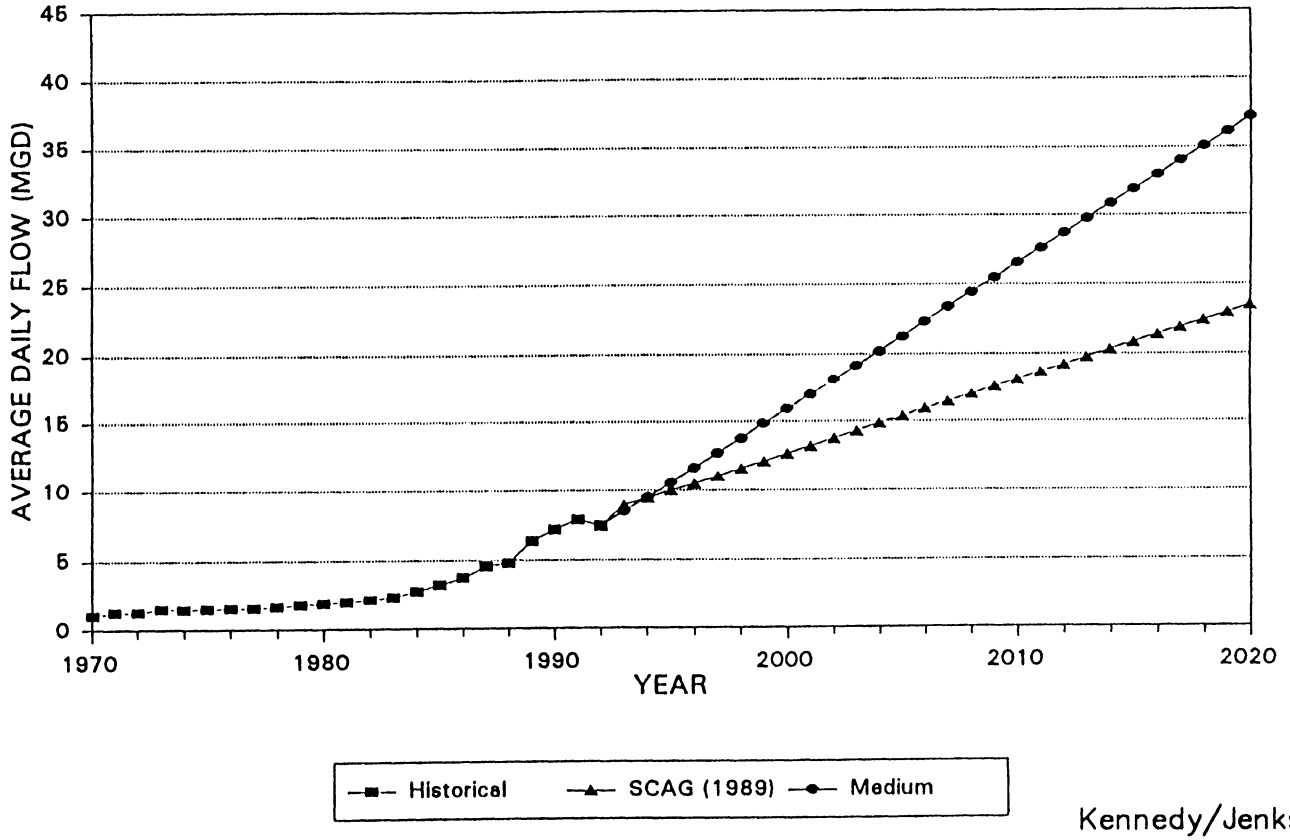
Figure 6–3

TABLE 6-2

HISTORICAL AVERAGE DAILY FLOWS

Year	Palmdale WRP (mgd)	Lancaster WRP (mgd)	Rosamond WRP (mgd)	Edwards AFB WRP (mgd)
1970	1.1	3.2	NA	NA
1971	1.3	3.6	NA	NA
1972	1.3	3.7	NA	NA
1973	1.6	4.0	NA	NA
1974	1.6	3.9	NA	NA
1975	1.6	4.0	NA	NA
1976	1.6	4.0	NA	NA
1977	1.6	3.8	NA	NA
1978	1.7	3.8	NA	NA
1979	1.8	4.3	NA	NA
1980	1.9	4.7	NA	NA
1981	2.1	4.8	NA	NA
1982	2.2	4.9	NA	NA
1983	2.4	5.3	NA	NA
1984	2.8	5.7	NA	NA
1985	3.3	5.5	0.3	1.3
1986	3.8	5.8	0.3	1.3
1987	4.6	6.2	0.4	1.3
1988	4.8	6.5	0.4	1.7
1989	6.4	7.7	0.6	1.7
1990	7.2	8.3	0.7	1.7
1991	7.9	8.1	0.7	1.7
1992	7.4	8.4	0.7	1.7

NA: Not Available



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Historical and Projected Flows
Palmdale WRP

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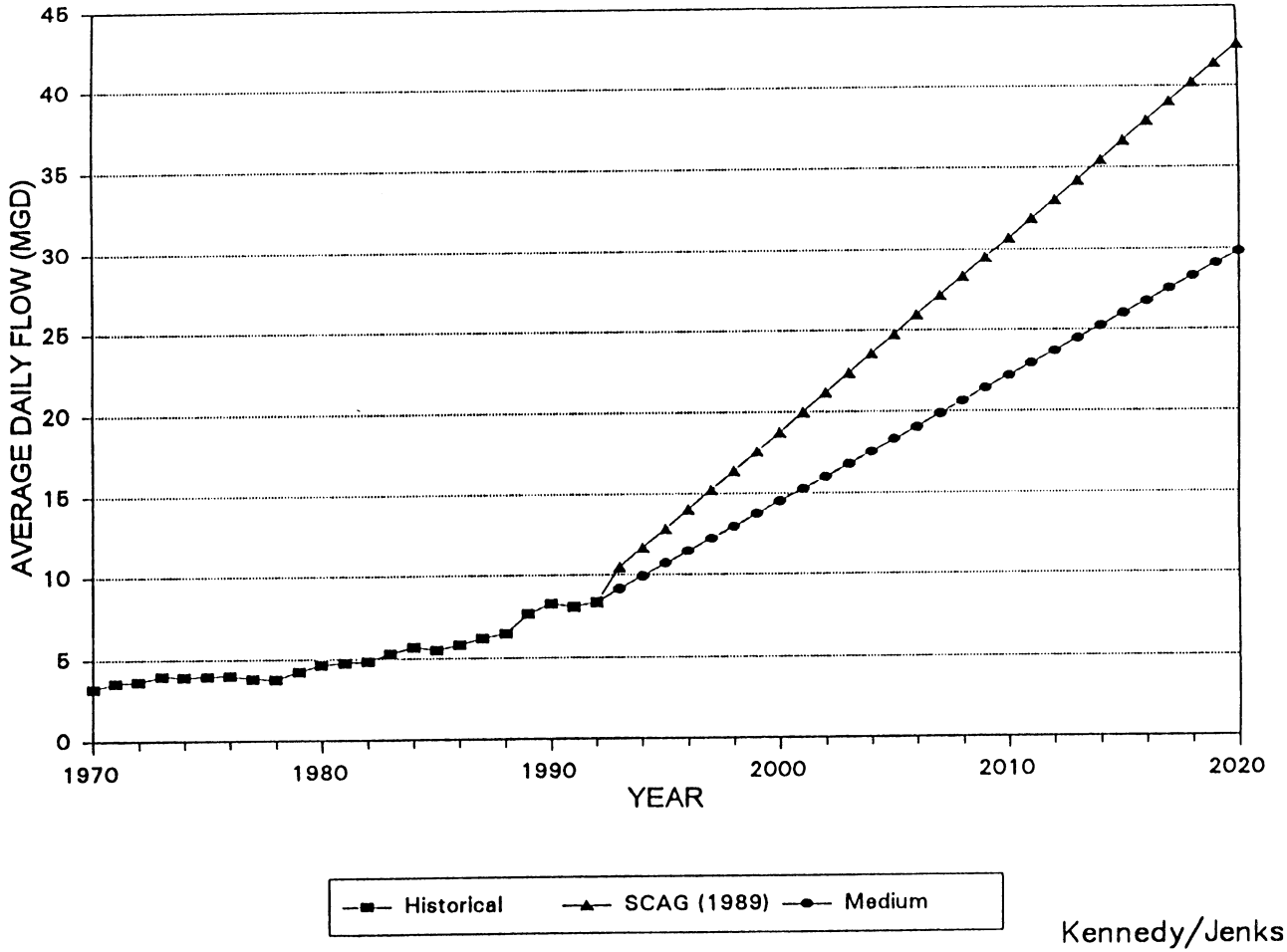
Figure 6–4

Figure 6–4



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Historical and Projected Flows
Lancaster WRP

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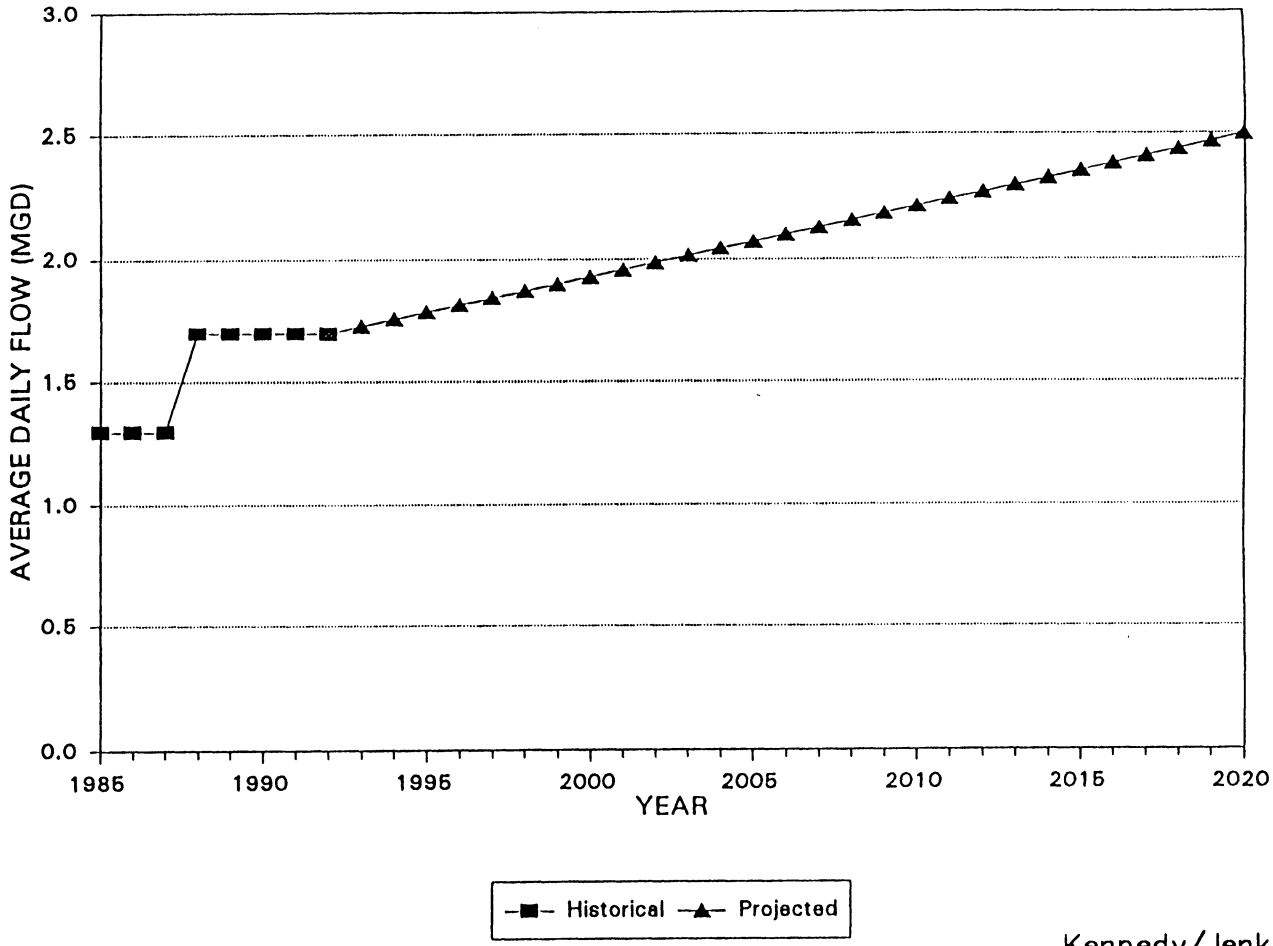
Figure 6–5

Figure 6–5



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Historical and Projected Flows
Edwards AFB WRP

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Figure 6-7

Figure 6-7

flows for the Rosamond WRP were developed based on the medium population projection presented in Chapter 3 and the average historical wastewater flow per capita. Projected flow for the Edwards AFB WRP was obtained from a report entitled "Projected Definition for U.S. Air Force Wastewater Treatment Facilities at Edwards Air Force Base" (CH2M Hill 1991). The average daily wastewater flow in the year 2020 for the Rosamond WRP and the Edwards AFB WRP is estimated to be 3.0 and 2.5 mgd respectively.

It is important to consider seasonal wastewater flows rather than average daily flows when developing a reclaimed water system, because reclaimed water demands typically peak in the summer months and are minimal in the winter months. Figures 6-8 through 6-10 present the projected 2020 seasonal flow patterns for the Palmdale, Lancaster and Rosamond WRPs. The 2020 patterns were developed based on the current seasonal flow patterns.

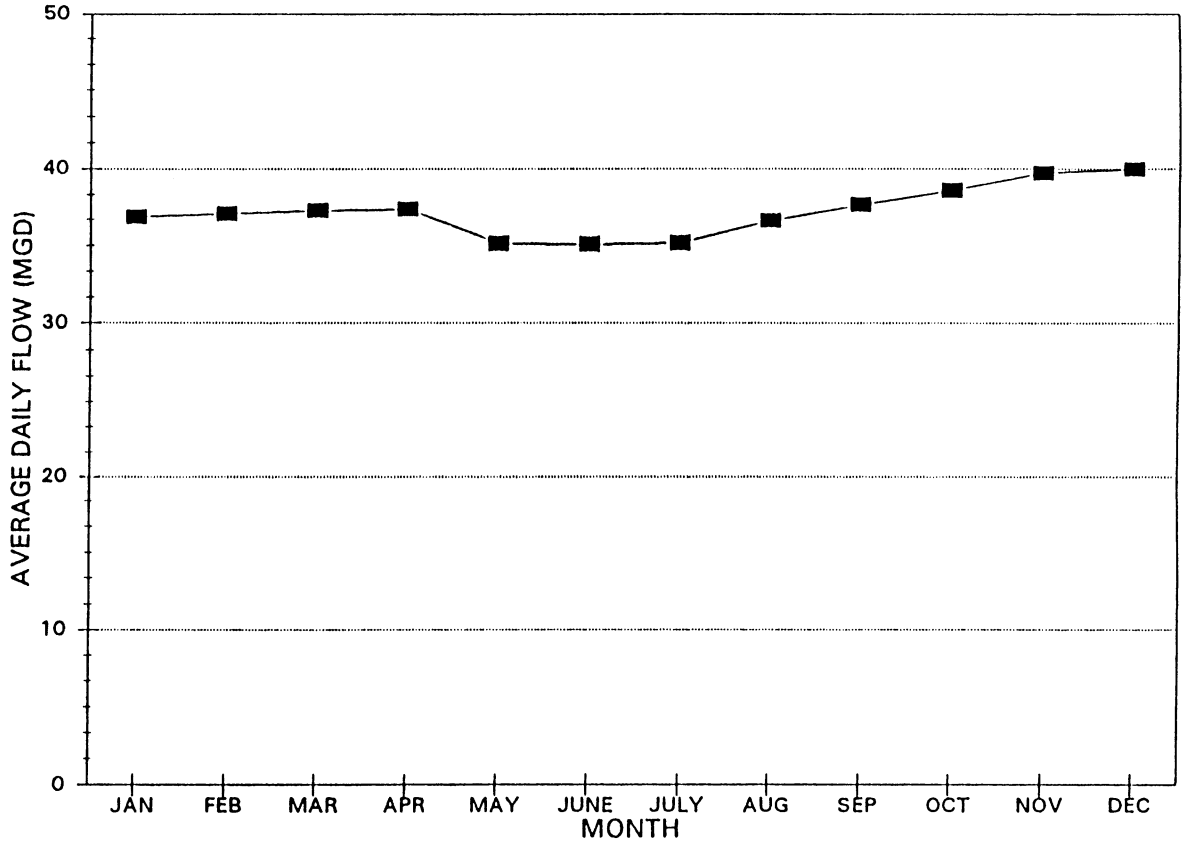
Wastewater Quality

Reclaimed Water Quality Requirements. Effluent quality from the Palmdale and Lancaster WRPs is regulated by the California Regional Water Quality Control Board - Lahontan Region (RWQCB-LH). Waste discharge requirements specifying the wastewater quality requirements for effluent discharged have been issued for these two plants (Board Order Nos. 6-93-18 and 6-93-75, respectively). The Palmdale and Lancaster WRPs also have reclamation requirements issued by the RWQCB-LH specifying wastewater quality requirements for reclamation of effluent at the Department of Airports (Board Order No. 6-90-64) and Nebeker Ranch (Board Order No. 6-86-58), respectively.

Depending on the place and purpose of reclaimed water use, the necessary treatment processes and the maximum allowable concentration of constituents vary. These variations are addressed in the reclamation permits. Reclaimed water uses are limited to the uses identified in the permits.

Effluent Quality. Average concentrations of effluent constituents measured in 1992 for the Palmdale and Lancaster WRPs are listed in Table 6-3. The tertiary-treated wastewater from Lancaster WRP is "adequately disinfected, oxidized, coagulated, clarified, filtered wastewater" as specified for use of reclaimed water in nonrestricted recreational impoundments, the use subject to the most stringent requirements under current state regulations.

Potential Irrigation Water Use. Table 6-4 lists guidelines for irrigation water quality standards and compares the effluent water quality from the Palmdale and Lancaster WRPs to the standards. From the guidelines, it can be seen that sodium and chloride contents in the effluent are relatively high and may prove toxic to some plants after repeated irrigations. If sensitive plants are to be irrigated with the effluent, application of the water by a drip system or surface system should be considered. In addition, ammonia and nitrate concentrations and boron concentrations fall in the "increasing problems" range and could prove toxic to



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Projected 2020 Seasonal Flows
Palmdale WRP

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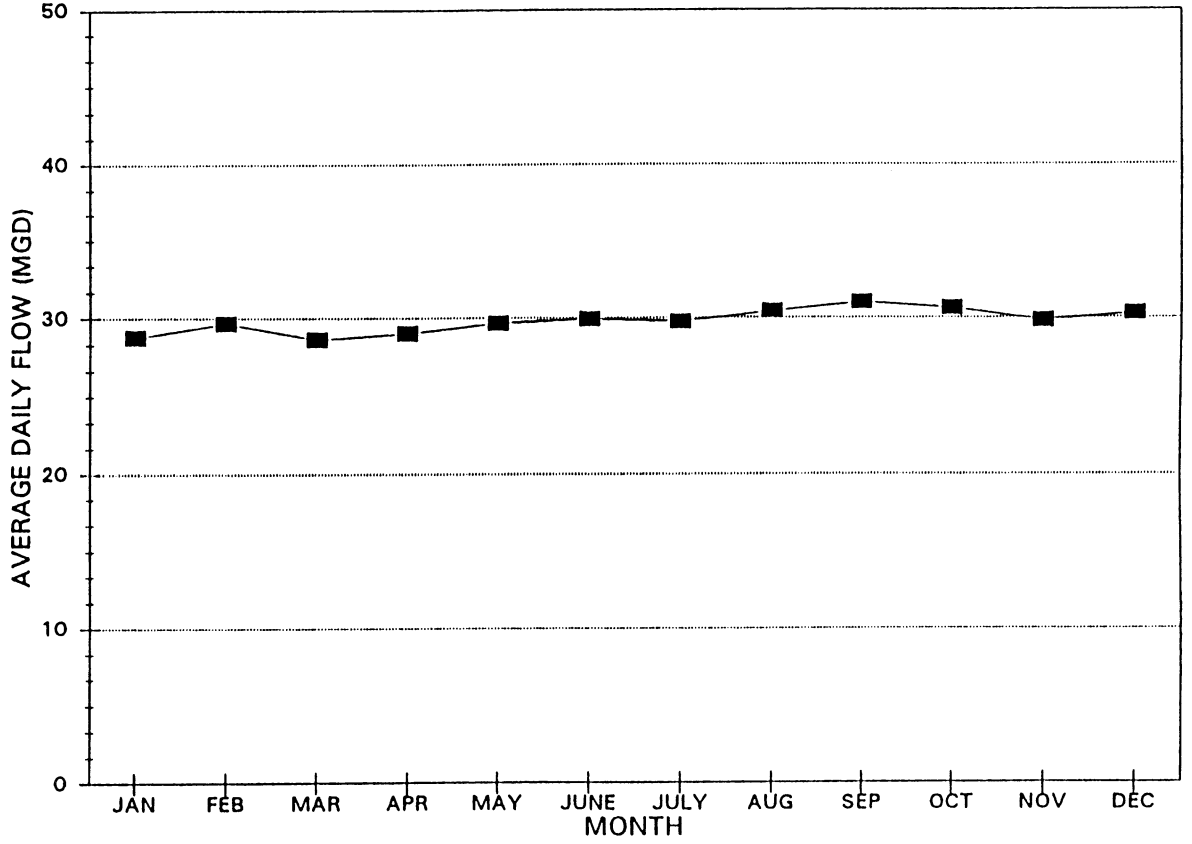
Figure 6–8

Figure 6–8



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Projected 2020 Seasonal Flows
Lancaster WRP

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Figure 6-9

Figure 6-9

TABLE 6-3

EFFLUENT QUALITY AND WATER RECLAMATION REQUIREMENTS
PALMDALE AND LANCASTER WRPs

Constituent (units)	Average Effluent Quality [1] For 1992			Maximum Limit [2]
	Palmdale WRP Secondary	Lancaster WRP Secondary	Lancaster WRP Tertiary	
Total Dissolved Solids (mg/L)	600	561	1076 [3]	1,000
Chloride (mg/L)	112	126	232 [3]	300
Sulfate (mg/L)	79	105	299 [3]	450
Coliform Group (MPN/100 ml)	NM	<2	<2	2.2
Nitrate + Nitrate (mg/L)	3.53	1.8	NM	10
Turbidity (NTU)	NM	NM	0.8	2
pH (pH units)	8.1	8.1	NM	6.0 - 9.0
Arsenic (mg/L)	<0.001	0.004	NM	0.05
Barium	0.03	0.02	NM	1.0
Cadmium (mg/L)	<0.01	<0.005	NM	0.010
Total Chromium (mg/L)	<0.02	<0.02	NM	0.05
Copper (mg/L)	<0.02	<0.02	NM	1.0
Lead (mg/L)	<0.04	<0.04	NM	0.05
Mercury (mg/L)	<0.0001	<0.0001	NM	0.002
Selenium (mg/L)	<0.001	<0.001	NM	0.01
Silver (mg/L)	<0.005	<0.005	NM	0.05
Zinc (mg/L)	0.22	0.07	NM	5.0
Fluoride (mg/L)	0.28	0.44	NM	1.6
Total Identifiable Chlorinated Hydrocarbons (µg/L)	0.03	0.02	NM	NS
Phenols (mg/L)	<0.01	0.006	NM	1.0

(1) Arithmetic mean of effluent analytical data (CSDLAC, Annual Monitoring Report for 1992, 15 March 1993). Frequency of analyses varies among constituents; frequency specified in the Monitoring and Reporting Programs outlined in RWQCB-LH Order Nos. 93-18 and 93-75.

(2) Reclaimed water limitations specified in RWQCB-LH Order No. 89-31 (Palmdale WRP) and RWQCB-LH Order No. 89-32 (Lancaster WRP). Trace constituent concentration limits obtained from California Department of Health Services, California Administrative Code, Title 22, Division 4, Chapter 15, "Domestic Water Quality and Monitoring" (1989)

(3) Monitored at the Apollo Park Recreational Lakes.

NS: Not Specified.
mg/L: milligrams per liter.
MPN/100 ml: Most probable number per 100 milliliters.
NTU: Nephelometric turbidity units.
pCi/L: picocuries per liter.
µg/L: micrograms per liter.
NM: Not monitored.

TABLE 6-4

COMPARISON OF EFFLUENT WATER QUALITY TO
IRRIGATION WATER QUALITY STANDARD GUIDELINES [1]

Problem	Related Constituents	Units	Water Quality Guidelines			Effluent Quality [6]	
			No Problems	Increasing Problems	Severe Problems	Palmdale WRP	Lancaster WRP
alinity[2]	Electroconductivity	umho/cm	750	750-3,000	3,000	1003	1038
ermeability	Electroconductivity Adjusted SAR [3]	umho/cm Ratio	500 6.0	500-200 6.0-9.0	200 9.0	1003 (5)	1038 (5)
pecific Ion Toxicity	Sodium (by adj. SAR) Chloride Boron	Ratio mg/l mg/l	3 142 0.5	3.0-9.0 142-355 0.5-2.0	9.0 355 2.0-10	(5) 112 0.47	(5) 126 0.65
pecific Ion Toxicity om Foliar Absorption	Sodium Chloride	mg/l mg/l	69 106	69 106	-- --	137 112	139 126
liscellaneous	Ammonia & Nitrate N. [4] Bicarbonate, HCO_3 pH	mg/l mg/l pH	5 90 6.5-8.4	5-30 90-520 low or high	30 520 --	11.2 (5) 8.1	7.6 (5) 8.1

Adapted from R.S. Ayres and D.W. Westcott, "Water Quality for Agriculture, Irrigation and Drainage Paper 29", FAO, Rome, 1976.
Plants vary in tolerance to salinity.
Adjusted Sodium Absorption Ration (SAR) is calculated to include the added effects of precipitation or dissolution of calcium and magnesium in soil and is related to CO_3 and HCO_3 concentrations.
For sensitive crops.
Not available.
Secondary treated water.

sensitive plants over a period of time. Salinity of the WRPs effluent also falls in the "increasing problems" range, however, plants vary widely in tolerance to salinity (Nebeker Ranch has experienced no salinity problems in 6 years of reclaimed water use for irrigation of alfalfa (CSDLAC, 1994)). Provision of adequate soil drainage will help to alleviate any potential problems due to salinity.

The nutrient composition (nitrogen and phosphorus) of the effluent is actually beneficial for irrigation and may result in a reduction in fertilizer use.

REGULATORY REQUIREMENTS

Production, discharge, distribution, and use of reclaimed water are subject to federal, state, and local regulations, the primary objectives of which are to protect public health. A synopsis of the regulatory requirements and the methods of administration are included in Appendix C.

MARKET ASSESSMENT FOR RECLAIMED WATER

Potential reclaimed water users within the WRP areas are identified in the following section. For each potential user, estimates are provided for annual demand, peak monthly demand, peak daily demand, and the hourly distribution of water demand during peak months. Seasonal demand patterns for the users are also presented. Finally, the requirements for potential users to convert their existing water systems to reclaimed water are discussed.

Potential Users

Examination of city and area maps for the Antelope Valley, Restricted Materials Use Permits from the Office of Agricultural Commissioner - County of Los Angeles, Development Summary Reports from the Cities of Palmdale and Lancaster Planning Departments, Tentative Tract Activity Reports from the Kern County Planning Department, and discussions with CSDLAC, City, County and water purveyor staff, as well as land developers, led to identification of existing and future potential users of reclaimed water from the Palmdale, Lancaster and Rosamond WRPs. Potential users of reclaimed water from the Edwards AFB WRP were identified in Boyle Engineering Corporation's November 1992 draft report titled "Effluent/Sludge Disposal Study - Edwards Air Force Base Wastewater Treatment Plant Project, Corps of Engineers, Sacramento District."

The criteria for placement on the initial list of potential reclaimed water users (for Palmdale, Lancaster and Rosamond) were as follows:

- proximity to the WRPs
- acreage greater than 100 acres for developments

The initial list of potential users and their reclaimed water demands is included in Appendix D, and the geographical location of the potential users is shown on

Plate 2. The user numbers on Plate 2 correspond with the user numbers in Appendix D.

The initial list was reduced by defining a service area and eliminating potential users outside the service area. Identification of a service area was based on the location of concentrated demand and the relative cost of constructing facilities to serve users outside the area of concentrated demand. Four service areas were defined:

- Palmdale/Lancaster - Tertiary System
- Palmdale/Lancaster - Secondary System
- Rosamond System
- Edwards AFB System

Table 6-5 presents a list of high potential reclaimed water users. The locations of the users are shown on Plate 2. The user numbers on Plate 2 correspond with the user numbers in Table 6-5. Status of the users (existing or future) and the required treatment level are included in Table 6-5. It should be noted that some users listed under the Palmdale/Lancaster - Secondary System service area require disinfected reclaimed water while others can use nondisinfected water, according to RWQCB-LH requirements.

Potential Reclaimed Water Demand

Potential annual demands for reclaimed water were estimated from historical water use records or from applying a water demand per acre factor to the proposed irrigated area. Demands for reclaimed water are seasonal, with the highest demands occurring during the hot, dry summer months when irrigation requirements are greatest. To approximate peak month demand for users, typical water use patterns for various crops were obtained from the United States Department of Agriculture Soil Conservation Service (SCS). A peaking factor of approximately 2.2 was calculated for turfgrass and was used to obtain peak month demands for all landscape irrigation users. Likewise, peaking factors for agricultural crops were calculated based on SCS data and used to obtain peak month demands for agricultural irrigation users.

Peak day demands and peak hour demands for potential users were estimated based on the number of irrigation days per month and the irrigation hours per day. The estimated annual, peak month, peak day and peak hour demands for the high potential reclaimed water users are shown in Table 6-5. The total annual reclaimed water demand is approximately 35,600 acre-feet per year. Total peak month demand is estimated to be approximately 6,300 acre-feet, and total peak day demand is estimated to be 74 million gallons or 216 acre-feet.

Reclaimed water users already receiving reclaimed water are indicated with an "*" in Table 6-5. Total annual demand, peak month demand and peak day demand for these current users of reclaimed water are 6,460, 1,192 and 41 acre-feet, respectively. Actual demand data were used when available.

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
	Palmdale/Lancaster Tertiary System										
	2840 ZONE										
101	Palmdale High School	Existing	Tertiary	138	25.3	0.82	265.9	7	12 am - 6 am	6	739
102	Desert Aire Golf Course	Existing	Secondary-D	120	22.0	0.71	231.2	7	10 pm - 8 am	10	385
104	McAdam Park	Existing	Tertiary	72	13.2	0.43	138.7	7	10 pm - 8 am	10	231
105	Courson Park	Existing	Tertiary	23	4.1	0.13	43.4	7	10 pm - 8 am	10	72
118	Desert Rose Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
120	Tumbleweed Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
122	Cactus K-8 School	Existing	Tertiary	36	6.7	0.22	70.1	7	12 am - 6 am	6	195
124	Mesa Intermediate School	Existing	Tertiary	52	9.5	0.31	100.2	7	12 am - 6 am	6	278
	2840 ZONE TOTAL			493	90.4	2.92	949.7				2,179
	2920 ZONE										
65A	Palmdale Business Park	Future	Tertiary	118	16.6	0.54	174.6	7	12 am - 6 am	6	485
65B	Palmdale Business Park Golf Course	Future	Secondary-D	453	50.9	1.64	535.3	7	12 am - 6 am	6	1,487
100	Antelope Valley Country Club	Existing	Secondary-D	375	68.8	2.22	722.5	7	10 pm - 6 am	8	1,505
107	Desert Sands Park	Existing	Tertiary	68	12.5	0.40	131.0	7	10 pm - 8 am	10	218
121	Yucca Elementary School	Existing	Tertiary	23	4.3	0.14	45.1	7	12 am - 6 am	6	125
128	Highlands High School	Existing	Tertiary	100	18.3	0.59	192.7	7	12 am - 6 am	6	535
134	Summerwind Elementary School	Future	Tertiary	42	7.6	0.25	80.2	7	12 am - 6 am	6	223
	2920 ZONE TOTAL			1,179	179.0	5.77	1,881.4				4,579
	2620 ZONE										
52	Lancaster Business Park	Existing	Tertiary	55	10.0	0.32	105.6	7	12 am - 6 am	6	293
53A	Serrano Ranch	Future	Tertiary	329	60.3	1.95	633.9	7	12 am - 6 am	6	1,761
53B	Serrano Ranch Golf Course	Future	Secondary-D	633	116.1	3.74	1,219.7	7	12 am - 6 am	6	3,388
54	K&B Development (Tract 49864)	Future	Tertiary	47	8.6	0.28	90.2	7	12 am - 6 am	6	250
64	Fox Airfield Commercial Development	Future	Tertiary	1,920	352.0	11.35	3,699.5	7	12 am - 6 am	6	10,276
152A	Lancaster City Park	Existing	Tertiary	150	23.5	0.91	295.0	6	10 pm - 6 am	8	615

TABLE 6-5

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
152B	Lancaster City Park	Future	Tertiary	32	5.9	0.23	73.5	6	10 pm - 6 am	8	153
153	Jane Reynolds Park	Existing	Tertiary	30	5.2	0.20	64.6	6	10 pm - 6 am	8	135
154	Mariposa Park	Existing	Tertiary	28	6.2	0.24	78.3	6	10 pm - 6 am	8	163
155	Eastside Park	Existing	Tertiary	71	10.3	0.40	129.5	6	10 pm - 6 am	8	270
156	El Dorado Park	Existing	Tertiary	40	6.5	0.25	81.0	6	10 pm - 6 am	8	169
158	Skytower Park	Existing	Tertiary	48	8.8	0.34	110.3	6	10 pm - 6 am	8	230
159	Apollo Lakes County Park *	Existing	Tertiary	129	30.4	1.44	470.0	7	12 am - 6 am	6	1,306
160	Antelope Valley High School	Existing	Tertiary	130	23.8	0.77	250.5	7	12 am - 6 am	6	696
161	Desert Winds High School	Existing	Tertiary	8	1.4	0.05	14.8	7	12 am - 6 am	6	41
163	Parkview Intermediate High School	Existing	Tertiary	65	11.9	0.38	124.9	7	12 am - 6 am	6	347
169	Mariposa Elementary School	Existing	Tertiary	38	7.0	0.22	73.1	7	12 am - 6 am	6	203
170	Joshua Elementary School	Existing	Tertiary	56	10.3	0.33	108.7	7	12 am - 6 am	6	302
171	El Dorado Elementary School	Existing	Tertiary	25	4.6	0.15	48.6	7	12 am - 6 am	6	135
172	Linda Verde Elementary School	Existing	Tertiary	28	5.1	0.16	53.6	7	12 am - 6 am	6	149
175A	Joshua Memorial Park	Existing	Secondary-D	90	16.5	0.53	173.4	7	12 am - 6 am	6	482
175B	Joshua Memorial Park	Future	Secondary-D	21	3.9	0.12	40.5	7	12 am - 6 am	6	112
186	New Vista Elementary School	Future	Tertiary	43	7.9	0.26	83.2	7	12 am - 6 am	6	231
	2620 ZONE TOTAL			4,016	736	25	8,022				21,706
	Tertiary System Total			5,688	1,006	33	10,853				28,463
	Palmdale/Lancaster Secondary System										
2	Alfalfa Farm	Existing	Secondary-U	1,151	214.6	7.40	2,627.4	7	12 am - 12 am	24	1,825
2A	Alfalfa Farm	Existing	Secondary-U	1,306	243.6	8.40	2,982.4	7	12 am - 12 am	24	2,071
4	Grain & Alfalfa Farm	Existing	Secondary-U	2,895	540.6	18.90	6,553.8	7	12 am - 12 am	24	4,551
5	Alfalfa Farm	Existing	Secondary-U	2,706	504.6	17.40	6,177.9	7	12 am - 12 am	24	4,290
6A	Alfalfa Farm	Existing	Secondary-U	1,866	348.0	12.00	4,260.6	7	12 am - 12 am	24	2,959
6B	Alfalfa Farm	Existing	Secondary-U	1,120	208.8	7.20	2,556.4	7	12 am - 12 am	24	1,775
8	Nebeker Ranch *	Existing	Secondary-U	4,229	788.8	27.20	9,657.3	7	12 am - 12 am	24	6,706
9	Alfalfa Farm	Existing	Secondary-U	1,617	301.6	10.40	3,692.5	7	12 am - 12 am	24	2,564
9A	Alfalfa Farm	Existing	Secondary-U	746	139.2	4.80	1,704.2	7	12 am - 12 am	24	1,184
11	Alfalfa Farm	Existing	Secondary-U	1,244	232.0	8.00	2,840.4	7	12 am - 12 am	24	1,973
12A	Christmas Tree & Landscape Farm *	Existing	Secondary-U	81	18.8	0.80	233.9	7	12 am - 12 am	24	162

TABLE 6-5

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
13	Alfalfa Farm	Existing	Secondary-U	995	185.6	6.40	2,272.3	7	12 am - 12 am	24	1,578
13A	Alfalfa Farm	Existing	Secondary-U	622	116.0	4.00	1,420.2	7	12 am - 12 am	24	986
13B	Alfalfa Farm	Existing	Secondary-U	995	185.6	6.40	2,272.3	7	12 am - 12 am	24	1,578
13C	Alfalfa Farm	Existing	Secondary-U	373	69.6	2.40	852.1	7	12 am - 12 am	24	592
15A	DOA Test Farm	Existing	Secondary-U	32	7.5	0.32	93.6	7	12 am - 12 am	24	65
15B	DOA Pistachio Farm *	Existing	Secondary-U	112	29.4	0.90	338.3	7	12 am - 12 am	24	235
15C	DOA Chestnut Farm *	Existing	Secondary-U	149	39.2	1.20	451.1	7	12 am - 12 am	24	313
15D	DOA Barley Farm *	Existing	Secondary-U	304	57.2	2.20	643.3	7	12 am - 12 am	24	447
18A	Sod Farm	Existing	Secondary-D	684	126.1	5.20	1,683.4	7	12 am - 12 am	24	1,169
173	Paiute Ponds *	Existing	Secondary-D	1,456	228.4	7.37	2,400.0	7	12 am - 12 am	24	1,667
174A	Wagas Land Duck Ponds	Existing	Secondary-D	1,558	186.0	6.00	1,954.8	7	12 am - 12 am	24	1,358
176	Young Ranch	Existing	Secondary-D	253	43.1	1.39	453.0	7	12 am - 12 am	24	315
	Secondary System Total			26,493	4,814	166	58,121				40,362
	Rosamond System										
200	Rosamond Elementary School	Existing	Tertiary	17	3.1	0.10	32.6	7	10 pm - 8 am	10	54
201	Hamilton Elementary School	Existing	Tertiary	65	11.9	0.38	125.2	7	10 pm - 8 am	10	209
202	Rosamond High School	Existing	Tertiary	66	12.1	0.39	127.2	7	10 pm - 8 am	10	212
203	Tropico Middle School	Existing	Tertiary	26	4.8	0.15	50.1	7	10 pm - 8 am	10	83
204	Rare Earth Continuation School	Existing	Tertiary	17	3.1	0.10	32.6	7	10 pm - 8 am	10	54
205	Rosamond Park	Existing	Tertiary	30	5.5	0.18	57.8	7	12 am - 6 am	6	161
206	West Park	Existing	Tertiary	15	2.8	0.09	28.9	7	12 am - 6 am	6	80
207	Desert Highlands Development	Future	Tertiary	209	29.8	1.15	373.3	6	12 am - 6 am	6	1,037
208	Desert Highlands Golf Course	Future	Secondary-D	90	16.5	0.63	206.8	6	12 am - 6 am	6	574
209	Tract 5052	Future	Tertiary	15	2.8	0.09	29.4	7	12 am - 6 am	6	82
210	Tract 5172	Future	Tertiary	58	10.7	0.35	112.6	7	12 am - 6 am	6	313
211	Tract 5188	Future	Tertiary	12	2.2	0.07	23.1	7	12 am - 6 am	6	64
212	Tract 5195	Future	Tertiary	20	3.6	0.12	38.2	7	12 am - 6 am	6	106
213	Tract 5196	Future	Tertiary	19	3.5	0.11	37.0	7	12 am - 6 am	6	103
214	Tract 5198	Future	Tertiary	19	3.5	0.11	37.0	7	12 am - 6 am	6	103
215	Tract 5204	Future	Tertiary	19	3.6	0.11	37.5	7	12 am - 6 am	6	104
216	Tract 5313	Future	Tertiary	4	0.7	0.02	7.8	7	12 am - 6 am	6	22

Seasonal water demand patterns were developed for Palmdale/Lancaster tertiary and secondary systems and the Rosamond system service areas based on irrigation requirements provided by SCS and conversations with existing growers of crops in the Antelope Valley. Figures 6-11, 6-12 and 6-13 present the developed seasonal water demand patterns versus the projected 2020 seasonal WRP effluent flows for the tertiary, secondary and Rosamond systems, respectively. It was assumed that partial conversion to tertiary treatment of the Palmdale and Lancaster WRPs would occur to meet peak day demands of the high potential users within the tertiary system service area. The remaining flows at the plants would be allocated to the secondary system service area. Figure 6-12 indicates that the secondary supply from the Palmdale and Lancaster WRPs cannot meet the peak day demand by approximately 4.0 mgd.

Onsite Conversion Requirements

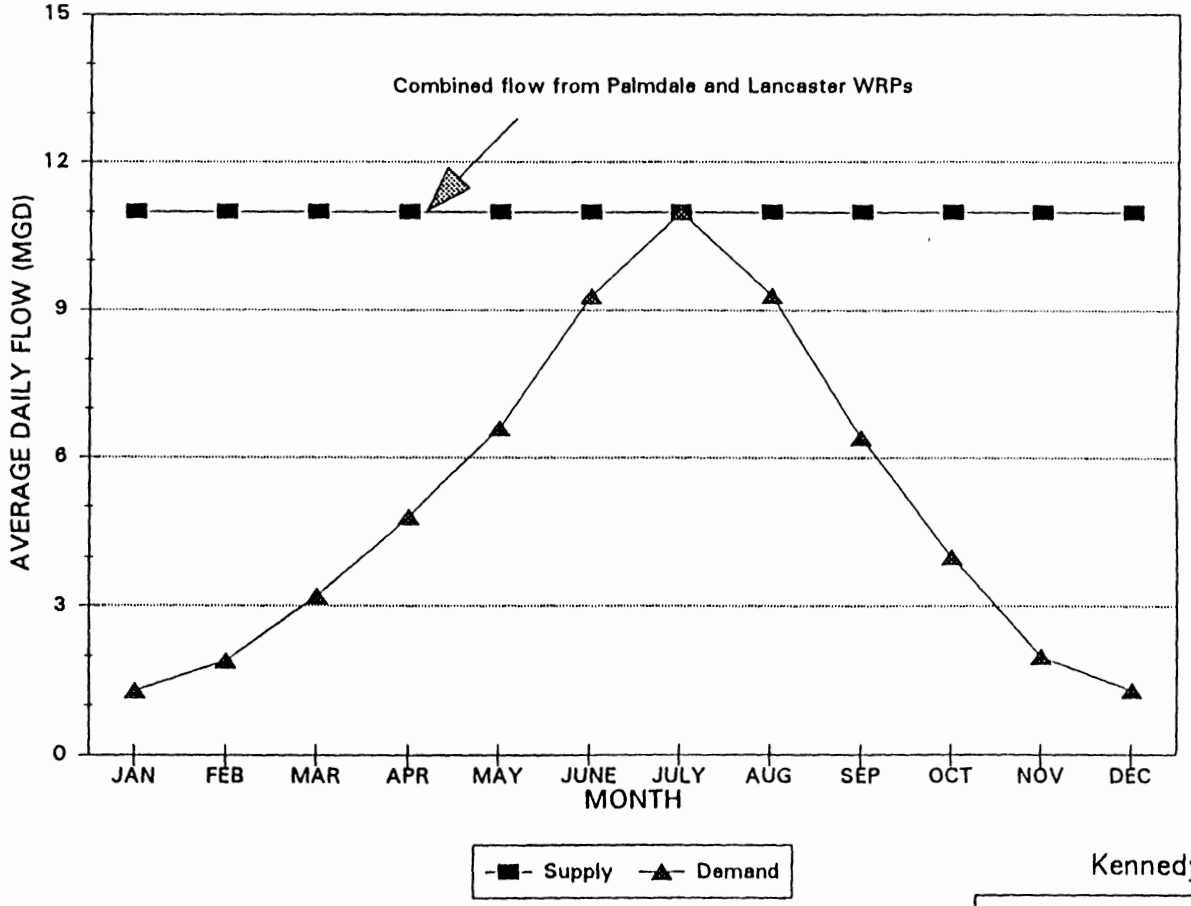
The California Department of Health Services has prepared guidelines for use of reclaimed water which are based on the reclamation criteria set forth in Title 22. The guidelines address what steps should be taken in converting water systems to reclaimed water systems. Two primary goals of the guidelines are to prevent potable water systems from being contaminated by reclaimed water and to make the public aware that reclaimed water is being used.

For users with separate irrigation and potable water systems, the primary requirement will be to disconnect the irrigation system from the potable water service and connect it to the reclaimed water service. Reduced pressure principal backflow prevention devices will need to be installed on the potable service immediately downstream of the meter. For those users with irrigation systems that tie to their potable water systems at several locations, the systems will have to be separated. Additionally, all hose bibs on the user's reclaimed water systems will need to be replaced by quick coupling connections. Public areas, such as golf courses, parks, and schools, will need to post signs notifying the public that reclaimed water is being used for irrigation. Parks, schools, and other users with exposed drinking fountains near landscaped areas will have to provide shields to prevent reclaimed water from coming into contact with the drinking fountains.

The costs of these conversion requirements will be incurred by the users. In general, the costs are anticipated to be relatively low; however, because the cost will depend on meter size and complexity of the irrigation system, costs will vary from user to user.

CONCEPTUAL PLAN

The development of the reclaimed water systems was based on established planning criteria. These criteria are the concepts and assumptions that ultimately form the service criteria of the system. The following section presents the criteria for and development of the systems, as well as the details of the conceptual plan for the



Kennedy/Jenks Consultants

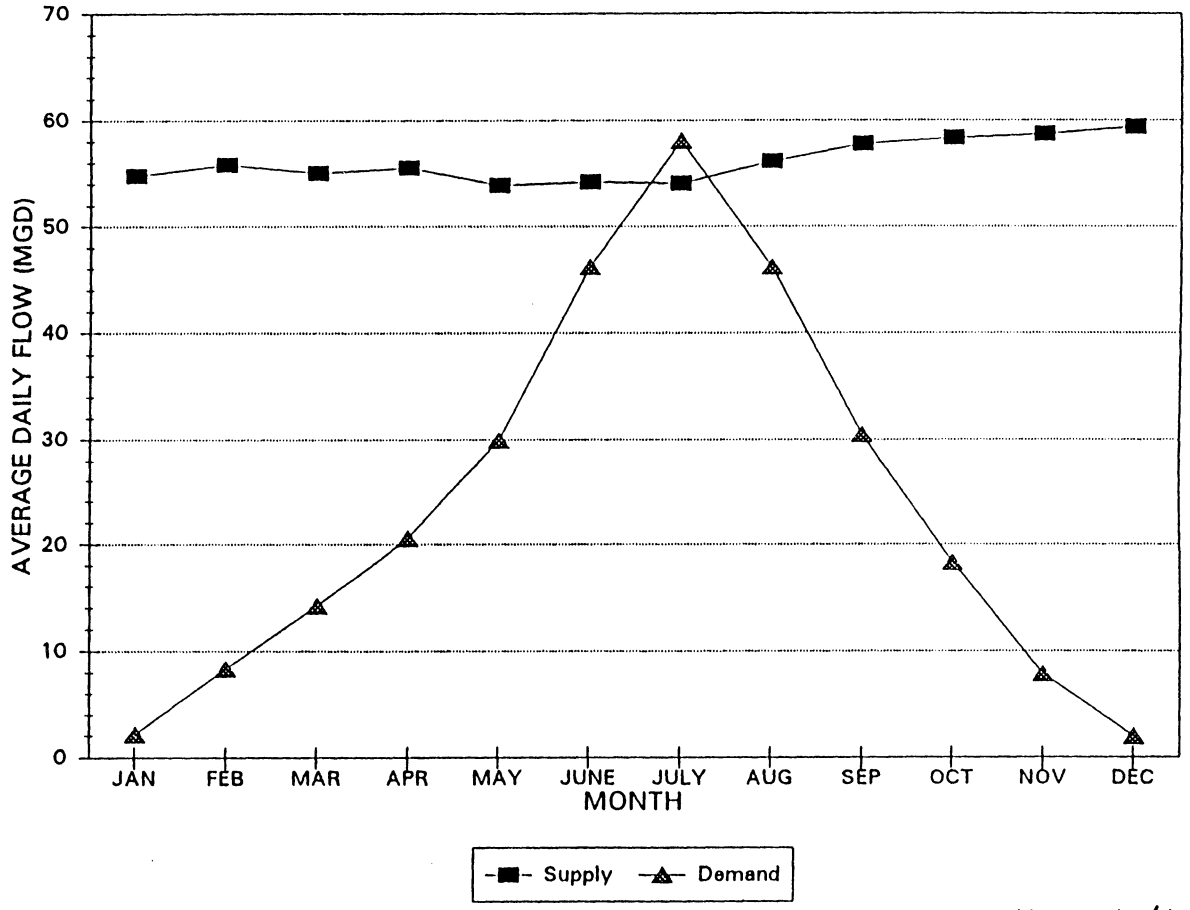
Water Quality Improvement Program
for the Port Hueneme Subregion

Seasonal Demand Pattern Versus
WRP Flow – Tertiary System

August 1994
K/J 934629.10

Figure 6–11

Figure 6–11



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Seasonal Demand Pattern Versus
WRP Flow – Secondary System

August 1994
K/J 934620.00

Figure 6–12

Figure 6–12

reclaimed water systems. Because Edwards AFB is currently designing a tertiary treatment facility and reclaimed water system, discussion in the following section focuses on the Palmdale, Lancaster and Rosamond WRPs, followed by a brief description of the proposed facilities at Edwards AFB.

Criteria and Assumptions

Criteria and assumptions were established for each component of the Palmdale, Lancaster and Rosamond reclaimed water systems, including the reclaimed water supply, the main pump stations, the booster pump stations, the storage reservoirs, and the distribution system. These criteria and assumptions, summarized in Table 6-6, are discussed in the following sections.

Reclaimed Water Supply. Reclaimed water will be supplied to the reclaimed water systems by the four WRPs. Initially, plant production may not be adequate to meet the total demands of the systems; however, as potable water demands increase and, consequently, reclaimed water production increases, the water available to meet system demands will also increase. Projected production of the WRPs versus projected demands is depicted on Figures 6-11 to 6-13. It appears that production of the Lancaster and Palmdale WRPs cannot meet peak day demands in the year 2020. Design of the systems is based on projected plant production for the year 2020 and an assumption of equalized effluent flow.

Main Pump Stations. A main pump station will be located at each WRP to provide reclaimed water to the distribution systems. The pump station capacity is dependent upon plant production, as well as reclaimed water demands, and will be designed to meet peak day demands. Proposed storage reservoirs will provide for reductions in the required main pump station reservoirs by allowing peak hour demands to be met with a combination of pumped water and water from storage reservoirs. It is assumed that the pump stations will operate 24 hours per day. The main pump stations will be controlled by water level sensors in the storage reservoirs.

Booster Pump Stations. The functions of the booster pump stations are to boost the system pressure from low service zones to high service zones or, due to the relatively flat terrain, to boost delivery pressures from reservoirs to users. In order to minimize pump station and pipeline capacities, booster pump stations designed to boost system pressures from low zones to high zones will operate 24 hours per day and, therefore, will be designed to meet peak day of the high zone. Booster pump stations designed to boost delivery pressures from reservoirs will operate only during the users' operating hours and, therefore, will be designed to meet peak hour demands of the user served.

Storage Reservoirs. The recommended operating storage capacity to be provided for the reclaimed water systems is equivalent to the peak day demand. Reservoir elevations will be dictated by the required system and delivery pressures as discussed below. Reservoirs provide supplemental supply during peak demand

TABLE 6-6

SUMMARY OF RECLAIMED WATER SYSTEM CRITERIA

System Components	Criteria
Reclaimed Water Supply	• Assume projected plant production for year 2020. • Assume equalized effluent flow.
Main Pump Stations	• Pumps will operate 24 hours during peak day demands. • Size for peak day demands.
Booster Pump Stations	• To serve high zones, size for peak day demands. • To serve users from reservoirs, size for peak hour demands.
Storage Reservoirs	• Provide storage for peak demand. • Reservoir elevations should be adequate to provide optimum delivery pressures to most users. • Provide surface storage adequate to meet peak season demands.
Distribution System	• Size to meet the peak hour demands. • Maximum design velocity is 6 feet per second. • Maximum system pressure: 185 psi. • Optimum delivery pressure range: 55 to 150 psi. • All buried piping is "purple" high-pressure PVC (currently 24-inch diameter is maximum available) or ductile iron pipe.

days. Capacity should be based on the supplemental supply necessary to meet all demands during the peak season.

Distribution System. Distribution system design is dependent upon flow, velocity, and pressure criteria. The distribution systems will be sized to handle the peak hour demands. High velocities, which may impair pipeline useful life and increase energy requirements to deliver water, are not desirable. Maximum design flow velocity in the system will be 6 feet per second.

Two pressure criteria were considered in the planning of the system. Defined as the pressure at any point within the distribution system, system pressure is dependent upon reservoir levels, reclaimed water demands and pumping conditions. The maximum system pressure will be 185 pounds per square inch (psi). Delivery pressure refers to the pressure at which reclaimed water is delivered to the users. Optimum delivery pressure ranges from 55 psi to 150 psi.

Components of the Plan

The development of the recommended reclaimed water system was based on the above criteria and assumptions. The recommended conceptual plan is divided into 4 main reclaimed water systems:

- Palmdale and Lancaster Tertiary System (Tertiary System)
- Palmdale and Lancaster Secondary System (Secondary System)
- Rosamond System
- Edwards AFB System

Plate 2 shows the conceptual plans (except for Edwards AFB), the location of the reclaimed water users and the service zones. Because a conceptual plan already exists for Edwards AFB System, it is discussed separately. The tertiary system would serve tertiary treated reclaimed water to approximately 34 users in three service zones. Service zone maximum water surface elevations are 2,620, 2,840 and 2,920 feet above sea level. The secondary system would serve secondary treated reclaimed water to approximately 23 users in one service zone (maximum water surface elevation of 2,680 feet). The Rosamond system would serve tertiary treated water to approximately 20 users in one service zone (maximum water surface elevation of 2,620 feet).

Main pump stations would be located at the reclaimed water supply. Each of the service zones would contain storage reservoirs, distribution system piping, and booster pump stations.

Reclaimed Water Supply. Reclaimed water would be supplied to the tertiary and secondary systems from the Palmdale and Lancaster WRPs. Similarly, reclaimed water would be supplied to the Rosamond system from the Rosamond WRP. The total system demand for reclaimed water is approximately 5,688 acre-feet per year for the tertiary system, 26,493 acre-feet per year for the secondary system, and

758 acre-feet per year for the Rosamond system. It is anticipated that reclaimed water would be constantly available from the WRPs.

Under normal operating conditions for the tertiary system, reclaimed water from the Lancaster WRP would serve service zone 2620, and reclaimed water from the Palmdale WRP would serve zones 2840 and 2920. An 8.0 mgd and a 3.0 mgd tertiary treatment plant would be constructed at the Lancaster WRP and the Palmdale WRP, respectively. A 2.0 mgd tertiary plant would be constructed at the Rosamond WRP. The tertiary treatment process at the plants would include oxidation, flocculation, clarification, filtration and disinfections.

Without a storage supply, the secondary supply remaining from the Palmdale and Lancaster WRPs after partial conversion to tertiary appears inadequate to meet the peak day demand of the secondary system users by approximately 3,000 gpm. (See Figure 6-12.) The secondary system facilities have been planned accordingly.

Main Pump Stations. Reclaimed water pump stations would be located at the WRPs and would be used to transport the reclaimed water to the storage reservoirs and to the users in each zone. With the exception of the Secondary system main pump station, the main pump stations are designed to operate at a constant flow rate (24-hour operation) and to provide total daily flow equivalent to the peak day demand. Without a storage supply, projected secondary flows at the Lancaster and Palmdale WRPs appear inadequate to meet projected secondary peak day demands, therefore, the secondary system main pump stations are designed to provide maximum secondary flow available from the WRPs. The recommended capacities of the main pump stations are shown in Table 6-7.

Booster Pump Stations. Included in the recommended plan are seven booster pump stations (BPS) located throughout the distribution system. BPS 1 through BPS 5 are a part of the tertiary system; BPS 6 is a part of the secondary system; and BPS 7 is a part of the Rosamond system. BPS 1 is at the head of service zone 2920 to increase system and delivery pressures from the 2840 zone. Due to the relatively flat terrain in Lancaster, BPS 2 through BPS 4 are located at the reservoirs within service zone 2620 to increase delivery pressures to users in the zone. BPS 5 serves as a backup supply source for service zones 2920 and 2840 allowing reclaimed water from the Lancaster WRP to flow to these zones. BPS 6 would be located at the open reservoir (described in the next section) within service zone 2680 to provide supplemental water for peak days when WRP supply is inadequate to meet demands. BPS 7 would be required to increase delivery pressures for the Desert Highlands Development in the Rosamond system. BPS capacities range from 1,320 to 8,935 gpm. Booster pump station locations are shown on Plate 2 and capacities and operating hours are listed in Table 6-8.

TABLE 6-7

MAIN PUMP STATION CAPACITIES

System	Capacity (gpm)
Tertiary System	
Palmdale WRP	2,000
Lancaster WRP	5,600
Secondary System	
Palmdale WRP	25,800
Lancaster WRP	15,700
Rosamond System	
Rosamond WRP	1,050

Storage Reservoirs. The conceptual plan includes construction of eight reclaimed water storage reservoirs. Each service zone would have one reservoir with the exception of the 2620 zone (tertiary system) which would have three and the 2680 zone (secondary system) which would have three reservoirs (one existing). The storage capacity in each zone would be equal to peak day demand with the exception of the 2680 zone (secondary system) which would be sized large enough to provide supply supplemental to WRP supply as required to meet peak day demands. Six of the eight reservoirs are assumed to be above-ground steel tanks and would range in size from 1.0 million gallons (MG) to 4.6 MG. Reservoir No. 6 in the 2680 zone is assumed to be open and lined and would be capable of holding a minimum of approximately 400 acre-feet of water.

Additionally, storage would be provided for the Lancaster and Palmdale WRPs to hold secondary treated water for periods when irrigation water is not required due to precipitation. In addition, storage would provide the added benefit of reducing wastewater effluent discharged to Paiute ponds during the winter. The capacity of the reservoir would allow for storage of 14 days or approximately 2500 acre-feet of total secondary reclaimed water flow. This storage capacity is sufficient to provide the 400 acre-feet of water required to meet peak day demands.

Currently, the Lancaster WRP has storage ponds capable of holding approximately 1535 acre-feet of water. Therefore, an additional 965 acre-feet of storage is required. Because only 400 acre-feet of water is required from storage to meet peak day demands in the 2680 zone, it is recommended that two separate reservoirs be constructed; one 400 acre-feet open, lined reservoir and one 565 acre-feet open, unlined reservoir. This would reduce capital costs. Storage reservoir locations are shown on Plate 2 and reservoir volumes are listed in Table 6-9. The

TABLE 6-8

BOOSTER PUMP STATION CAPACITIES

Booster Pump Station	Zones Served	Operating Hours (hrs./day)	Capacity (gpm)
Tertiary System			
1	2920	24	1,320
2	2620	8	1,520
3	2620	8	5,660
4	2620	8	8,935
5	2920	As required	5,600
Secondary System			
6	2680	24	3000
Rosamond System			
7	Desert Highlands	6	1,611

maximum water surface elevations are determined by the system and delivery pressure criteria and are also listed in Table 6-9.

Distribution System. The recommended pipeline routes for the reclaimed water systems are shown on Plate 2. The distribution systems consist of approximately 486,000 lineal feet of pipe ranging from 6 to 42 inches in diameter. The lengths and diameters of the pipeline segments for each system are presented in Table 6-10. Purple, high-pressure, polyvinyl chloride (PVC) pipe is the primary pipe type used in the tertiary and Rosamond systems. Because 24 inches is the maximum diameter currently available for purple PVC pipe, and the majority of pipeline in the secondary system is greater than 24 inches in diameter, ductile iron pipe is used in the secondary system.

Cost Estimates

Table 6-11 presents criteria used in estimating costs. Cost estimates presented in this report are order-of-magnitude type estimates expected to be accurate within ± 25 percent. The cost estimates were developed from general cost curves, information from suppliers, other studies and Kennedy/Jenks Consultants' previous experience. The main pump station costs include costs for all materials, equipment, construction and testing. Incorporated into the reservoir construction costs are the costs for grading, materials, and construction. Pipeline construction costs assume in-street construction with a moderate degree of utility crossings and include items such as valves, traffic control and road resurfacing. Booster pump station costs consist of costs for all materials, equipment, construction and testing. System

flushing and testing costs assume that approximately 1,000 feet of pipe would be tested per day. Not included in the cost estimate are pipeline easements and pump station/reservoir property costs.

TABLE 6-9

RESERVOIR VOLUMES AND ELEVATIONS

Reservoir Number	Service Zone	Volume (MG)	Maximum Water Surface Elevation (feet)
Tertiary System			
1	2840	1.0	2840
2	2920	2.0	2920
3	2620	1.0	2620
4	2620	2.4	2620
5	2620	4.6	2620
Secondary System			
6	2680	400 AF	2680
7	2680	565 AF	2350
8	2680	1535 AF (E)	2300
Rosamond System			
9	2620	1.5	2620

(E) Existing

The estimated construction cost of the reclaimed water system is shown in Table 6-12. As shown in the table, the treatment facilities for the tertiary and the Rosamond systems are $24,417,000 and $7,731,000 respectively. The distribution facilities for the tertiary, secondary, and Rosamond systems are $36,456,000, $67,486,000, and $8,296,000 respectively. The total cost for construction of the entire regional system is approximately $144,386,000 (1994 dollars). Construction costs include 15 percent for contractor overhead and profit, 20 percent for engineering/administration and 25 percent for contingencies.

The cost estimates were developed to provide a reference for financial planning. The actual construction cost and project cost would depend on the final project scope, the schedule for construction, and market conditions at the time of construction. Feasibility of the project and funding needs must be considered and reviewed thoroughly in order to select the proper option and to provide adequate funding.

TABLE 6-10

PIPELINE DIAMETERS AND LENGTHS

	Material	Diameter (In.)	Length (Ft).
Tertiary System	Ductile Iron	30	100
	PVC	24	1,600
	PVC	18	93,800
	PVC	16	9,500
	PVC	14	43,700
	PVC	12	27,600
	PVC	10	24,900
	PVC	8	7,500
	PVC	6	12,800
		Subtotal -	221,500
Secondary System	Ductile Iron	42	43,100
	Ductile Iron	36	48,800
	Ductile Iron	24	15,840
	Ductile Iron	20	14,700
	Ductile Iron	16	5,400
	Ductile Iron	14	18,700
	Ductile Iron	12	5,500
	Ductile Iron	10	20,500
	Ductile Iron	6	1,300
		Subtotal -	173,840
Rosamond System	PVC	16	2,000
	PVC	12	39,200
	PVC	10	19,400
	PVC	8	21,800
	PVC	6	8,600
		Subtotal -	91,000
Total			486,340

TABLE 6-11

COST CRITERIA

Component	Cost Criteria
Tertiary Treatment Plant	Based on Dave Richard's "A Summary of Wastewater Reclamation Costs in California"
Main Pump Stations	Cost curve based on historical data
Booster Pump Stations	Cost curve based on historical data
Reservoirs [2]	50¢/gal.
Open Reservoir (unlined)	2¢/gal.
Open Reservoir (lined)	7¢/gal.
Pipelines [3]	
42-inch D.I.	$210/ft.
36-inch D.I.	$180/ft.
30-inch D.I.	$150/ft.
24-inch D.I.	$120/ft.
20-inch D.I.	$100/ft.
16-inch D.I.	$80/ft.
14-inch D.I.	$70/ft.
12-inch D.I.	$60/ft.
10-inch D.I.	$50/ft.
6-inch D.I.	$30/ft.
24-inch PVC	$96/ft.
20-inch PVC	$80/ft.
18-inch PVC	$72/ft.
16-inch PVC	$64/ft.
14-inch PVC	$56/ft.
12-inch PVC	$48/ft.
10-inch PVC	$40/ft.
8-inch PVC	$32/ft.
6-inch PVC	$24/ft.
System Flushing and Testing [4]	$1/ft.

(1) All figures represent installed costs.
(2) Includes tank, foundation, appurtenances, excavation, paving, fencing, landscaping and telemetry.
(3) Assume $4.00/diameter-inch for PVC - and $5.00/diameter-inch for ductile iron.
(4) Assumes 1,000 ft./day at $1,000/day.

TABLE 6-12

PRELIMINARY COST ESTIMATE

COMPONENT	ESTIMATED COST (1994 Dollars)	COMPONENT	ESTIMATED COST (1994 Dollars)
I. Treatment Facilities			
A. Tertiary System		B. Secondary System	
Palmdale - 3.0 mgd	$ 6,200,000	1. Main Pump Stations	
Lancaster - 8.0 mgd	9,061,000	Palmdale - 25,800 gpm	$ 2,591,000
		Lancaster - 15,700 gpm	1,846,000
SUBTOTAL	$ 15,261,000		
Contractor's OH & Profit (15%)	2,289,000	2. Booster Pump Stations	
Engineering/Admin (20%)	3,052,000	No. 6 - 3,000 gpm	$ 421,000
Contingency (25%)	3,815,000		
TOTAL (Tertiary System)	$ 24,417,000	3. Open Reservoir	
		No. 6 - 400 AF	$ 9,123,000
B. Rosamond System		No. 7 - 565 AF	3,682,000
Rosamond - 2.0 mgd	$ 4,832,000		
		4. Distribution Pipelines	
SUBTOTAL	4,832,000	42-inch D.I. (43,100 LF)	$9,051,000
Contractor's OH & Profit (15%)	725,000	36-inch D.I. (48,800 LF)	8,784,000
Engineering/Admin (20%)	966,000	24-inch D.I. (15,840 LF)	1,901,000
Contingency (25%)	1,028,000	20-inch D.I. (14,700 LF)	1,470,000
TOTAL (Rosamond System)	$ 7,731,000	16-inch D.I. (5,400 LF)	432,000
		14-inch D.I. (18,700 LF)	1,309,000
TOTAL (Treatment Facilities)	$ 32,148,000	12-inch D.I. (5,500 LF)	330,000
		10-inch D.I. (20,500 LF)	1,025,000
II. Distribution Facilities		6-inch D.I. (1,300 LF)	39,000
A. Tertiary System		5. System Flushing and Testing	$ 174,000
1. Main Pump Stations			
Palmdale - 2,000 gpm	$ 518,000	SUBTOTAL	$ 42,178,000
Lancaster - 5,600 gpm	1,004,000	Contractor's OH & Profit (15%)	6,327,000
		Engineering/Admin (20%)	8,436,000
2. Booster Pump Stations		Contingency (25%)	10,545,000
No. 1 - 1,320 gpm	$ 249,000	TOTAL (Secondary System)	$ 67,486,000
No. 2 - 1,520 gpm	275,000		
No. 3 - 5,660 gpm	648,000	C. Rosamond System	
No. 4 - 8,935 gpm	875,000	1. Main Pump Station	
No, 5 - 5,600 gpm	648,000	Rosamond - 1,050 gpm	$ 324,000
3. Reservoirs		2. Booster Pump Stations	
No. 1. - 1.0 mg	$ 500,000	No. 7 - 1,611 gpm	$ 288,000
No. 2. - 2.0 mg	1,000,000		
No. 3. - 1.0 mg	500,000	3. Reservoirs	
No, 4. - 2.4 mg	1,200,000	No. 9 - 1.5 mg	$ 750,000
No. 5. - 4.6 mg	2,300,000		
		4. Distribution Pipelines	
4. Distribution Pipelines		16-inch PVC (2,200 LF)	$ 128,000
30-inch D.I. (100 LF)	$ 15,000	12-inch PVC (39,200 LF)	1,882,000
24-inch PVC (1,600 LF)	154,000	10-inch PVC (19,400 LF)	776,000
18-inch PVC (93,800 LF)	6,754,000	8-inch PVC (21,800 LF)	698,000
16-inch PVC (9,500 LF)	608,000	6-inch PVC (8,600 LF)	206,000
14-inch PVC (43,700 LF)	2,447,000		
12-inch PVC (27,600 LF)	1,325,000	5. System Flushing and Testing	$ 91,000
10-inch PVC (7,500 LF)	996,000		
8-inch PVC (7,500 LF)	240,000	SUBTOTAL	$ 5,143,000
6-inch PVC (12,800 LF)	307,000	Contractor's OH & Profit (15%)	771,000
		Engineering/Admin (20%)	1,029,000
5. System Flushing and Testing	$ 222,000	Contingency (25%)	1,353,000
		TOTAL (Rosamond System)	$ 8,296,000
SUBTOTAL	$ 22,785,000		
Contractor's OH & Profit (15%)	3,418,000	TOTAL (Distribution Facilities)	$112,238,000
Engineering/Admin (20%)	4,557,000		
Contingency (25%)	5,696,000		
TOTAL	$36,456,000		
CONTINUED ON RIGHT			
		GRAND TOTAL	$ 144,386,000

Edwards AFB System

Edwards AFB is currently designing a 2.5-mgd tertiary wastewater treatment plant, located south of the South Base entry gate and east of Switch Station #4. (See Figure 6-1.) The following is a list of facilities for the planned reclaimed water distribution system identified in Boyle Engineering Corporation's July 1993 "Early Preliminary Design Submittal, Volume 1, Design Narrative:"

- A 3,125-gpm main pump station at the wastewater treatment plant.
- A 3,125-gpm booster pump station.
- A 2.2-mg storage reservoir.
- Approximately 31,740 feet of PVC pipe ranging from 4 to 18 inches in diameter.

The estimated capital cost of the planned distribution facilities is $6,300,000. Operation and Maintenance (O&M) costs were estimated to be $140,000 per year.

EXCESS RECLAIMED WATER SUPPLY

Figures 6-11 through 6-13 depict seasonal demand patterns for the tertiary, secondary and Rosamond systems. As shown in the figures, excess reclaimed water supply would be available from all three systems after demands have been met. It is estimated approximately 6,400 acre-feet from the tertiary system, 37,500 acre-feet from the secondary system (excludes 2,500 acre-feet diverted to open reservoirs in the 2680 Zone) and 2,500 acre-feet from the Rosamond system would be available from the WRPs annually. The excess supplies can be discharged through the following methods:

- Ssurface Spreading
- Groundwater Recharge
- Evaporation

Currently, Rosamond CSD has approximately 80 acres of land near their existing WRP that could be used for spreading. In addition, the Department of Airports (DOA) owns approximately 2600 acres that is currently used to spread wastewater from the Palmdale WRP. However, the DOA has plans to eventually farm most of the land.

Tertiary treated water from the three WRPs could be recharged into the groundwater basin. This approach would depend on factors such as availability of land, location, soil type, and percolation rates. Two potential recharge sites are shown on Plate 2 The first site, identified in Earth Systems Consultants draft February 1994 Summary Report regarding test boring along the Amargosa Creek, is located along the Amargosa Creek between 10th and 25th Street West. The second site is located on DOA's property along Little Rock Creek. Previous studies at this site could not be identified. As shown on Plate 2, both sites are located near reclaimed water

pipelines outlined in the conceptual plan. Groundwater recharge potential is also discussed in Chapter 5 - Aquifer Storage and Recovery Methods.

Pan evaporation data from CSDLAC's March 1993 "Lancaster Water Reclamation Plant Water Balance" indicates that approximately 107 inches or 9 feet of evaporation occurs at the Lancaster WRP on an annual basis. Assuming a depth of 9 feet for evaporation ponds, approximately 8 square miles of land is required to evaporate 46,400 acre-feet of water.

PERMIT REQUIREMENTS

Numerous permits will be required for construction and operation of the conceptual plan. A summary of potential regulatory requirements is shown in Table 6-13.

Federal

A Nationwide 404 Permit from the United States Army Corps of Engineers (Corps) is required for activities impacting the waters of the United States. Because some construction activities may occur within the riverbed (river crossings), it is recommended that the Corps be notified in writing of the proposed activities.

State

The following state agencies may require permits and/or approvals for the reclaimed water systems:

- California Department of Fish & Game
- California Department of Transportation
- California Department of Health Services
- Regional Water Quality Control Board
- tate Water Resources Control Board

The 1601 Agreement from the California Department of Fish & Game (DFG) is required for all crossings or activities which may impact a streamed or natural drainage way. This requirement includes construction of pipelines on bridges if construction activity occurs within the streamed. In addition, crossings of minor streams may require 1601 Agreements.

An encroachment permit from the California Department of Transportation would be required for any work done within the state right-of-way. This includes installation of a pipeline in or across a highway, installation of a pipeline in a roadway crossing under a highway, support of a pipeline on a bridge crossing over a highway, and activities that impact on-ramp and off-ramp traffic.

The California Department of Health Services (DHS) would be involved during implementation of the reclaimed water systems. The DHS is concerned with cross connections, separation of pipelines, and any activity that may result in

TABLE 6-13

POTENTIAL REGULATORY REQUIREMENTS
FOR THE
RECLAIMED WATER SYSTEMS

	Agency	Type of Approval
I. FEDERAL PERMITS	United States Army Corps of Engineers (ACE)	Nationwide 404 Permit
II. STATE PERMITS	California Department of Fish and Game	1601 Permit for impact on or activity in streams
	California Department of Transportation	Encroachment Permit
	California Department of Health Services	Cross connection control
	Regional Water Quality Control Board	NPDES Construction Activity Permit
	Regional Water Quality Control Board	Reclamation Permit
	Regional Water Quality Control Board	Engineering report requirements
	State Water Resources Control Board	Petition for change in place and purpose of use
III. LOCAL PERMITS	Los Angeles County Department of Health Services	Onsite (cross connection control) (user) facilities approval
	Los Angeles County Department of Health Services	Distribution system design & construction approval
	Kern County Environmental Health Department	Onsite (cross connection control) (user) facilities approval
	Kern County Environmental Health Department	Distribution system design & construction approval
	City of Palmdale	Encroachment Permit
	City of Lancaster	Encroachment Permit
	Los Angeles County Department of Public Works	Excavation Permit
	Los Angeles County Flood Control District	Encroachment Permit
	Kern County Transportation Department	Encroachment Permit

contamination of drinking water. The DHS would review plans and specifications prior to construction.

The RWQCB-LH regulates the source and the end use of reclaimed water. Its main involvement in the Tertiary and Secondary reclaimed water systems would be through the CSDLAC to modify the reclamation requirements to include the specific reclaimed water users and to review the Engineering Report describing treatment and distribution facilities and users. RWQCB-LH's main involvement in the Rosamond system would be through RCSD and would be similar to Tertiary and Secondary system involvement. In addition, National Pollutants Discharge Elimination System (NPDES) Construction Activity Permits may need to be obtained. These permits are required for stormwater runoff from construction projects impacting an area of 5 acres or more.

Water rights and funding alternatives would require involvement from the State Water Resources Control Board (SWRCB). Approval of a Petition for Change of Place and Purpose of Use is required for any change in discharge location or quantity of wastewater. If a low interest loan is chosen as a funding alternative, applications for the Water Reclamation Loan Program and State Revolving Fund are through the SWRCB.

In addition to the permits and approvals described above, compliance with the California Environmental Quality Act (CEQA) would be required.

Local

Concerned with drinking water contamination (cross connection control), the Los Angeles County Department of Health Services and the Kern County Environmental Health Department requires plan review and inspection of the distribution system and onsite user facilities. The County Department of Health Services coordinates with RWQCB-LH and State DHS.

Encroachment permits are required for all construction work done within local right-of-way. These include the Cities of Palmdale and Lancaster, the Los Angeles County Department of Public Works (Excavation Permit), the Los Angeles County Flood Control District, and the Kern County Transportation Department.

OTHER INSTITUTIONAL ISSUES

Before providing reclaimed water service, it would be necessary to secure agreements between the following entities:

- CSDLAC and Purveyors
- Purveyors and users
- CSDLAC and DOA

A contract between CSDLAC and the purveyors is required for sale of reclaimed water to the purveyors. Contracts between the purveyors and users and between CSDLAC and DOA (customer service agreement) would establish the requirements for use of reclaimed water and would specify that the users understand the regulations controlling use of reclaimed water.

FINANCING ALTERNATIVES

To finance the construction cost of the reclaimed water facilities, sufficient capital may be obtained through the following funding sources:

- Water Reclamation Loan Program
- State Revolving Fund
- Small Reclamation Projects Act of 1956
- Connection Fees

Water Reclamation Loan Program

The development of cost-effective water reclamation projects for the augmentation of water supplies constitutes the main purpose of the Water Reclamation Loan Program (WRLP). The WRLP is administered by the SWRCB's Office of Water Recycling and provides $30 million to local public agencies under the Clean Water and Water Reclamation Bond Law of 1988. These funds are available to assist in the design and construction costs of water reclamation projects. Although a maximum loan amount per project is not specified in the Bond Loan, SWRCB policy limits each project to $5 million. Loans covering 100 percent of eligible costs may be provided for a maximum period of 20 years at an interest rate of one-half the rate paid by the State on the most recent sale of state general obligation bonds. The present rate is 4 percent. A water reclamation project is eligible for the WRLP under the 1988 Bond Law if it is cost-effective compared to the cost of new freshwater supply alternatives and if no federal assistance is available at the time of need. Available funds would generally be committed to those projects with completed facilities planning which have met all loan program requirements and are ready to proceed. General requirements include a completed facilities plan with a project report, a complete environmental document, and a draft revenue program. In addition, all projects must comply with the California Environmental Quality Act (CEQA) prior to loan authorization. According to SWRCB staff, funds for projects in the near future are very limited.

State Revolving Fund

Created by the Federal Clean Water Act and administered by the SWRCB, the State Revolving Fund (SRF) offers low cost loans capitalized in part by federal funds. The primary objective of the SRF is to assist in the construction of Publicly-Owned Treatment Works (POTWs) for the protection and promotion of public health, safety, and welfare. The loans are distributed based on a priority system that ranks projects in classes from "A" to "F." Reclamation projects are ranked in class E and

receive lower priority than projects ranked A through D. A loan term of 20 years with the first loan repayment due one year after project completion is set for projects costing under $25 million, and an interest rate of one-half the rate of the most recent government obligation bond sales is applied. The amount of funding available for reclamation projects is generally more readily available for the SRF than the WRLP. In general, projects must meet similar requirements to be eligible for either SRF or WRLP assistance; however, because the SRF includes federal funds, compliance with the National Environmental Protection Act (NEPA) and other federal regulations are required.

Small Reclamation Projects Act of 1956

Funds are provided under the U.S. Bureau of Reclamation's Small Reclamation Projects Act of 1956, which has the following objective:

> "to bring about improvement in resource management of infrastructure, to achieve more effective and efficient use of water and related resources, and to achieve broader and more contemporary public value benefits and national resource objectives that might not otherwise be implemented in the absence of those Federal assistance loan programs."

Eligibility is based on specific elements that are addressed by the proposed project. Specifically, the project must include commercial irrigation (agriculture) and must address at least two of the five "Natural Resources and Water Policy Objectives." The AVWG reclaimed water project would most likely address Objective 2, Water Conservation to Meet Changing Water Use Demands, and Objective 3, Maintaining and Enhancing the Environment.

Connection Fees

An additional source of funding for the reclaimed water system may be through connection fees. Through new growth in the Antelope Valley, connection fees paid by developers seeking to use reclaimed water could be allocated to reclaimed water programs.

ECONOMIC ANALYSIS

Economic analyses were performed for the reclaimed water distribution facilities and the treatment facilities. Unit cost (annual cost per acre-foot of reclaimed water demand) for each system is listed in Table 6-14. In order to calculate the unit cost of the distribution facilities, the annualized capital cost for each system was added to the estimated annual water purchase cost and the estimated annual O&M cost. The total annual cost (annualized capital, water purchase, and O&M) was then divided by the estimated reclaimed water demand for each system to obtain the unit cost. Unit cost excluding annualized capital costs are also presented.

(1994 DOLLARS)

Distribution Facilities	Reclaimed Water Demand (AR/YR)	Annualized Construction Cost[1]	Annual Water Purchases Cost [2]	ANNUAL O&M COST				Includes Annual Capital Cost		Excludes Annual Capital Cost	
				Pumping Cost [3]	Parts Cost [4]	Labor Cost [5]	Total O&M Cost	Total Annual Cost	Cost per AF	Total Annual Cost	Cost per AF
Tertiary System	5,688	$3,714,866	$341,280	$709,145	$84,725	$28,800	$822,670	$4,878,816	$858	$1,163,950	$205
Secondary System	26,493	$6,876,823	$1,589,580	$899,800	$120,024	$14,400	$1,034,224	$9,500,627	$359	$2,623,804	$99
Rosamond System	758	$845,363	$0	$55,200	$14,786	$7,200	$77,186	$922,549	$1,218	$77,186	$102
TOTAL	32,939	$11,437,052	$1,930,860	$1,664,145	$219,535	$50,400	$1,934,080	$15,301,992	$465	$3,864,940	$117

Treatment Facilities	Reclaimed Water Demand (AF/YR)	Annualized Construction Cost [1]	Annual O&M Cost[6]	Includes Annual Capital Cost		Excludes Annual Capital Cost	
				Total Annual Cost	Cost per AF	Total Annual Cost	Cost per AF
Tertiary System	5,688	$2,488,092	$2,195,370	$5,683,462	$999	$2,195,370	$386
Rosamond System	758	$787,789	$462,000	$1,249,789	$1,649	$462,000	$609
TOTAL	6,446	$3,275,881	$57,370	$6,933,251	$1,076	$2,657,370	$412

(1) Assumes 20 year period at 8%interest rate.
(2) For tertiary and secondary systems, cost to purchase reclaimed water from County Sanitation Districts of Los Angeles County. Current cost estimated to be $60/acre-feet. For Rosamond system; assumed RCSD operates WRP and purveys water.
(3) Assumes 80% pump efficiency, 90% motor efficiency, and electricity cost of $0.10 per KW-hr. Includes operation costs of booster and reuse pumps.
(4) Assumes annual parts cost to be 1% of construction costs of pumping stations, plus 0.1% of construction costs of storage reservoirs and pipelines.
(5) Assumes $25 per hour.
(6) From Dave Richards "A Summary of Wastewater Reclamation Costs in California".

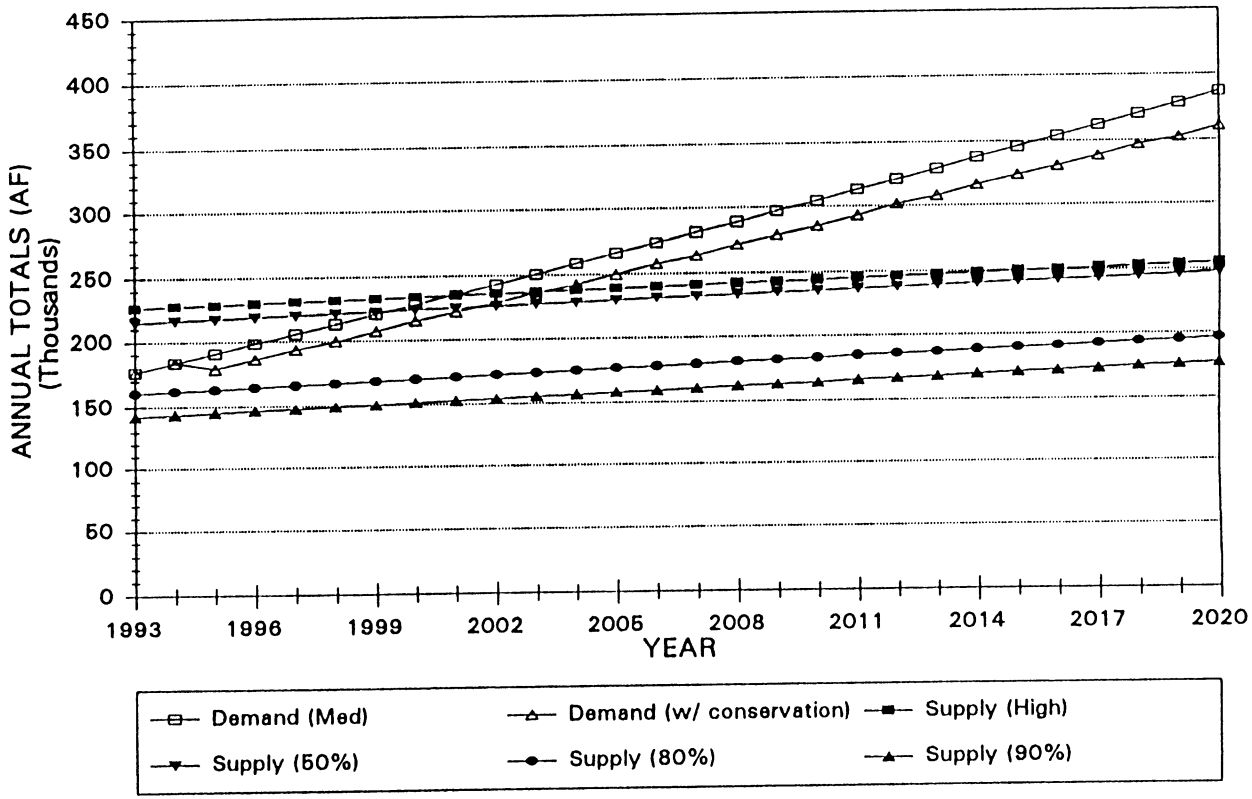
In order to calculate the unit cost of the treatment facilities, the annualized capital costs for each system were added to the estimated annual O&M costs. The total annual cost (annualized capital and O&M) was then divided by the estimated annual production for each system to obtain the unit cost. Unit costs excluding annualized capital are also presented.

Annualized capital costs were calculated based on a 20-year period at an 8 percent interest rate. (This assumes traditional financing methods rather than a low interest loan.) Annual water purchase costs for the tertiary and secondary systems were estimated by multiplying the reclaimed water demand by the cost of reclaimed water (estimated at $60 per acre-foot). No annual water purchase costs for the Rosamond system were included, since RCSD operates the WRP and would most likely operate the reclaimed water system. Annual O&M costs for the distribution facilities were estimated by combining estimated pumping costs, parts cost, and labor costs. Pumping costs were estimated based on 80 percent pump efficiencies, 90 percent motor efficiencies, and an electricity cost of $0.10 per kilowatt-hour. Parts costs were estimated to be 1 percent of construction costs of pump stations and 0.1 percent of construction cost of reservoirs and pipelines. Labor costs were estimated based on a labor rate of $25 per hour. Annual O&M costs for the treatment facilities were based on a presentation by Dave Richard, et al, entitled "A Summary of Wastewater Reclamation Costs in California."

Table 6-14 shows the unit cost of the reclaimed water distribution facilities and the unit cost of the treatment facilities for each system. As shown in the table, the unit cost for the distribution facilities for the tertiary, secondary and Rosamond systems are $858, $359 and $1,218 per acre-foot respectively (includes annualized capital). The unit cost for the treatment facilities for the tertiary and Rosamond systems are $999 and $1,649 per acre-foot respectively (includes annualized capital). Total unit cost (distribution and treatment) for the tertiary, secondary and Rosamond systems are $1,857, $359 and $2,867 per acre-foot. These costs assume construction of the project is financed at market rates instead of low interest loans. The unit costs would be reduced if low interest loans were utilized for construction financing.

RELIABILITY

Figure 6-14 depicts the medium demand with and without implementation of conservation measures and projected supply estimated at the 50, 80, and 90 percent probability levels. The most optimistic supply assumption (i.e., delivery of 100 percent of available water supplies) is also shown. Figure 6-14 is based on Figures 4-16 and 5-12 with one exception, the reclaimed water supply for the year 2020 is taken as the supply that will meet the demand for the high potential reclaimed water users identified in Table 7-5 (approximately 35,600 acre-feet). As shown on Figure 6-14, the estimated 1993 water demand is met approximately 73 percent of the time. Without a conservation program and including the reclaimed water system identified in this chapter, by the year 1999, 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2001, 100 percent of the potential water supplies would be required to meet the water



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Supply and Projected Demand
(Includes Reclaimed Water Use)

August 1994
K/J 934620.00

Figure 6–14

Figure 6–14

demand. With a conservation program and including the reclaimed water system, by the year 2002, 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2003, 100 percent of the potential water supplies would be required to meet the water demand.

CHAPTER 7

AQUIFER STORAGE AND RECOVERY

This chapter evaluates the feasibility of implementing an aquifer storage and recovery program within the Antelope Valley. Elements of the chapter include an overview of aquifer storage and recovery methods, followed by discussions on the hydrology of the Antelope Valley, hydraulic characteristics of the Antelope Valley, current condition of the aquifer, quantity and quality of available groundwater information, potential water sources for recharge, regulatory issues, and characteristics for good infiltration and injection sites. A summary of relevant studies, as well as factors specific to surface infiltration, and discussions on potential surface recharge areas, feasibility of infiltration, potential injection sites and feasibility of injection is also presented.

OVERVIEW OF AQUIFER STORAGE AND RECOVERY METHODS

One of the elements of the Antelope Valley Water Resources Study is an evaluation of the feasibility of Aquifer Storage and Recovery (ASR). For purposes of this evaluation, ASR will include the following methods of storing and recovering water from the groundwater basin:

- Spreading/Infiltration - use of surface spreading basins to allow infiltration of water into the aquifer.

- Injection - use of new or existing wells for direct injection of water into the aquifer.

- In-lieu Use - use of an alternative source of water, other than groundwater, when available, and use of groundwater when the alternative source is unavailable. In-lieu use is not discussed in this chapter but will be addressed as part of the overall water resources management plan.

ASR should be considered a conjunctive use program which integrates the management of local groundwater basins with use of imported supplies of surface water. Some of the benefits of an ASR program include:

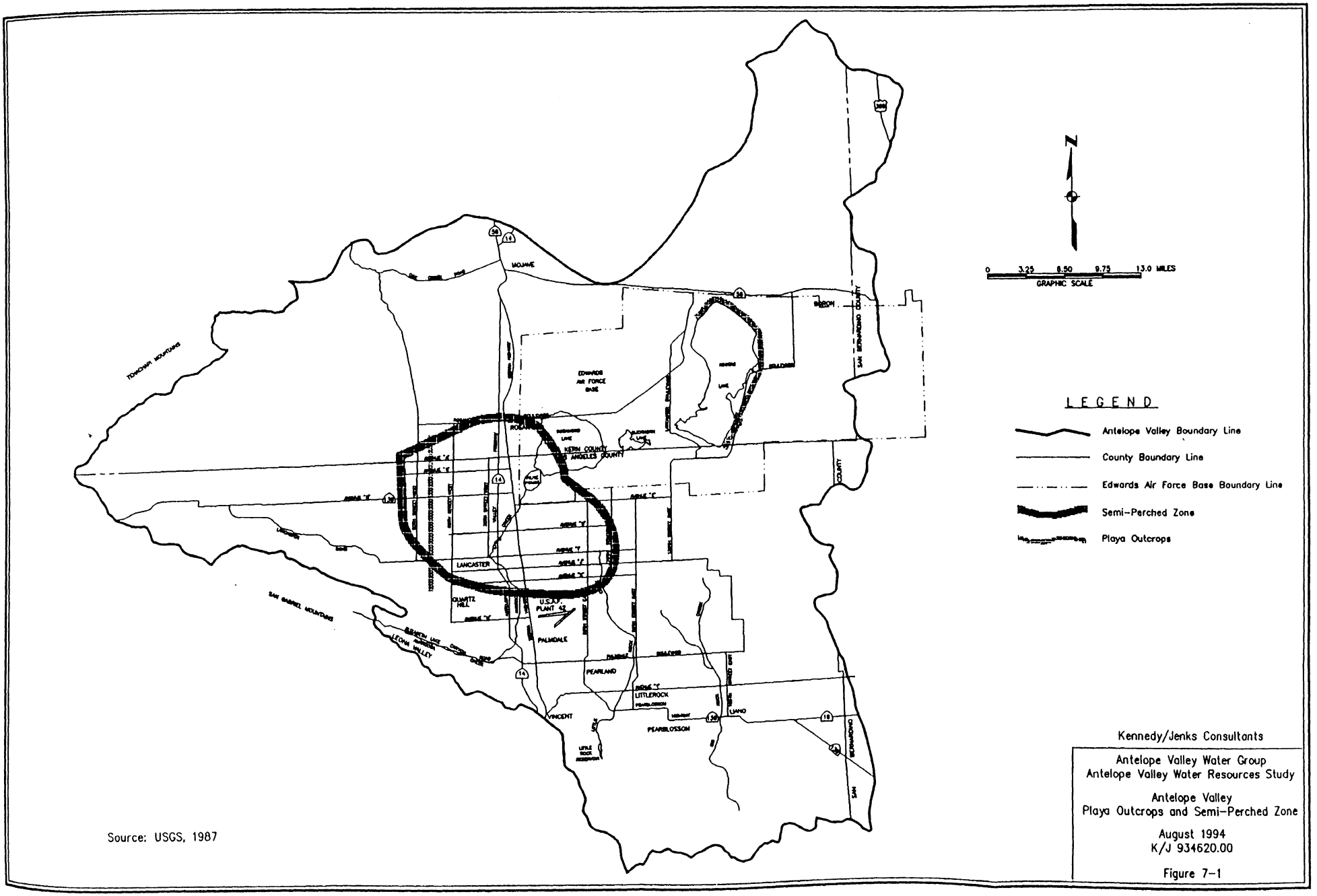
- Improved water supply reliability.

- Optimized use of alternative reliability.

- Reduction of subsidence problems.

- Reduction of pumping lifts.

- Increased flexibility of operations.



Source: USGS, 1987

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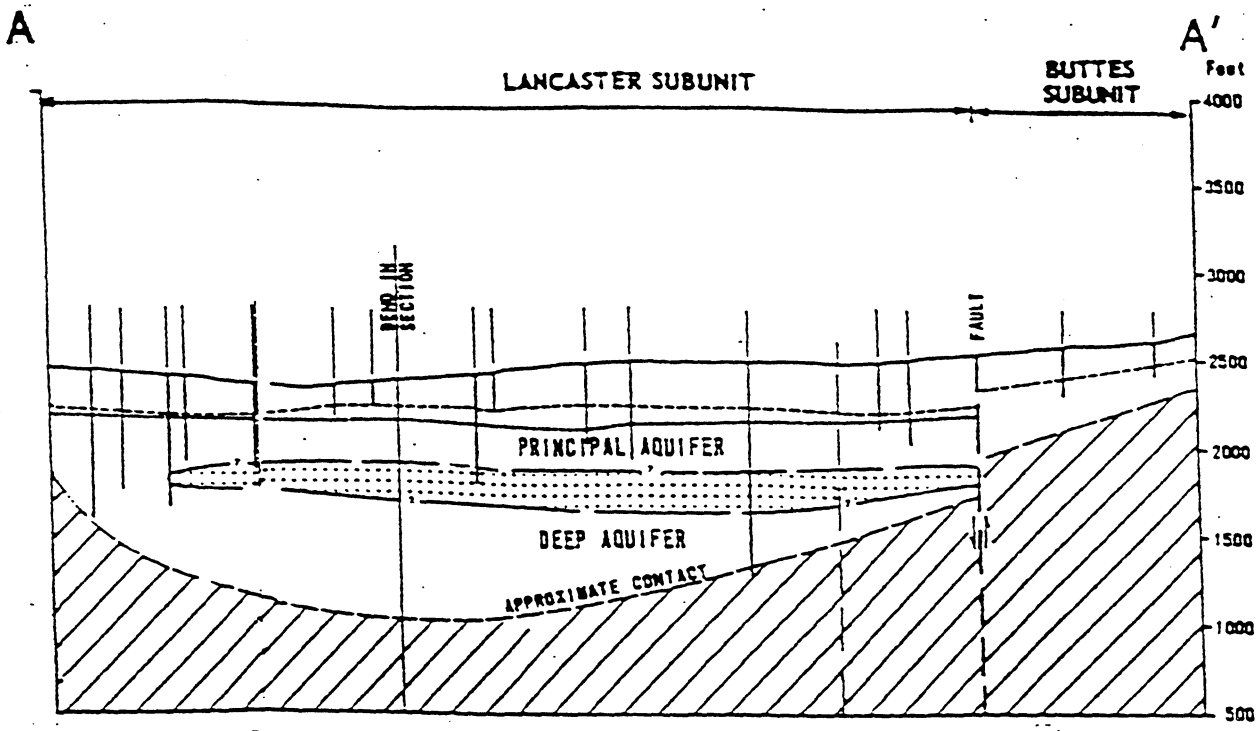
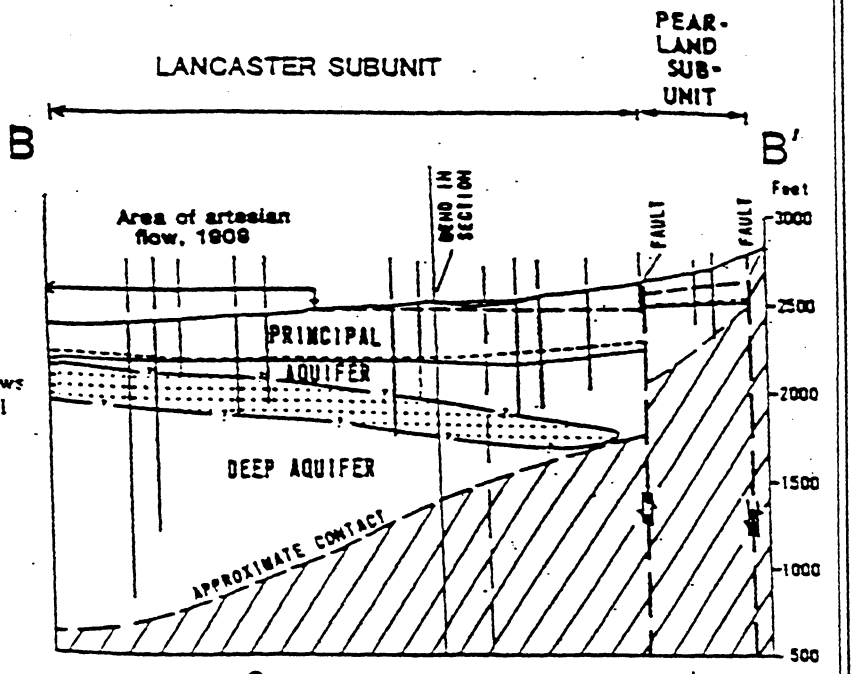
Antelope Valley
Playa Outcrops and Semi-Perched Zone

August 1994
K/J 934620.00

Figure 7-1



Generalized geologic cross-section A-A'



Generalized geologic cross-section B-B'

UNCONSOLIDATED DEPOSITS

LACUSTRINE DEPOSITS

CONSOLIDATED ROCKS

FAULT—Approximately located; arrows indicate direction of relative vertical movement

WELL—Dashed where perforated

WATER LEVEL, 1909

WATER LEVEL, 1964

WATER LEVEL, 1982

Geology modified from Bloyd (1967) and Durbin (1978)
Lacustrine deposits shown diagrammatically

Location of section lines shown on Figure 7-2

Source: LACDPW, 1989

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Antelope Valley
Geologic Cross-Sections

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Figure 7-1

relatively coarse which indicates relatively high percolation rates. Very few published studies have been conducted which document percolation rates, however field testing is relatively easy to conduct.

CURRENT CONDITION OF THE AQUIFER

A brief description of the water levels and water quality for the groundwater aquifer in the Antelope Valley is presented below.

Water Levels

Irrigated agriculture started in the Antelope Valley in the 1890s with documented evidence of 50,000 acres of land irrigated with surface water. However, the unreliability of surface water led to the development of groundwater use starting in 1912 with the highest pumping occurring in the 1950s and 1960s. By 1919, there were an estimated 500 wells drilled in Antelope Valley with the number rising to about 600 wells in 1940 and more than 1,000 by 1950. In 1956, there were about 135,000 acres of dry and irrigated agricultural land under production in the Valley (USGS, 1967) with a peak annual water usage of about 415,000 acre-feet per year (USGS, 1993).

As the Valley has developed, many of the agricultural land uses have been converted to urban and industrial land uses. For the first time since the 1890s, groundwater pumpage for municipal supply exceeded the demand for agricultural supply in 1988 (USGS, 1993). The estimated total water demand in 1990 for the Valley was about 135,000 acre-feet per year which was met by surface water, groundwater and State Water Project (SWP) water.

Groundwater levels have declined by as much as 200 feet (USGS, 1994). This decline has significantly increased pumping costs, resulting in overdrafting of the aquifer and land subsidence. The introduction of imported water from the SWP to the Valley in 1973 reduced the demand for groundwater, thereby allowing groundwater levels to recover somewhat. However, there is still a significant groundwater depression in the Valley as shown on Figure 7-5.

The high pumping rates of the 1950's and 1960's resulted in groundwater overdraft and subsidence of the ground surface as shown on Figure 7-6. Some of the areas of highest subsidence are coincident with current groundwater depressions. Studies by the USGS in 1993 indicate that the maximum estimated land subsidence from 1930 to 1992 was about 6.6 feet. In addition, there is approximately 290 square miles which have subsided by at least 1 foot, relating to a reduction in aquifer storage of about 500,000 acre-feet (USGS, 1994).

Water Quality

Water quality is generally good (i.e. Total Dissolved Solids (TDS) < 1000 parts per million (ppm)) Valley-wide except for the northeast part of Valley, the borders of the Lancaster Subunit, and some shallow wells in North Edwards and Boron. Poorer

Source: USGS, 1994

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Antelope Valley Water Resources Study

Groundwater Depressions
in Antelope Valley, 1992

August 1994
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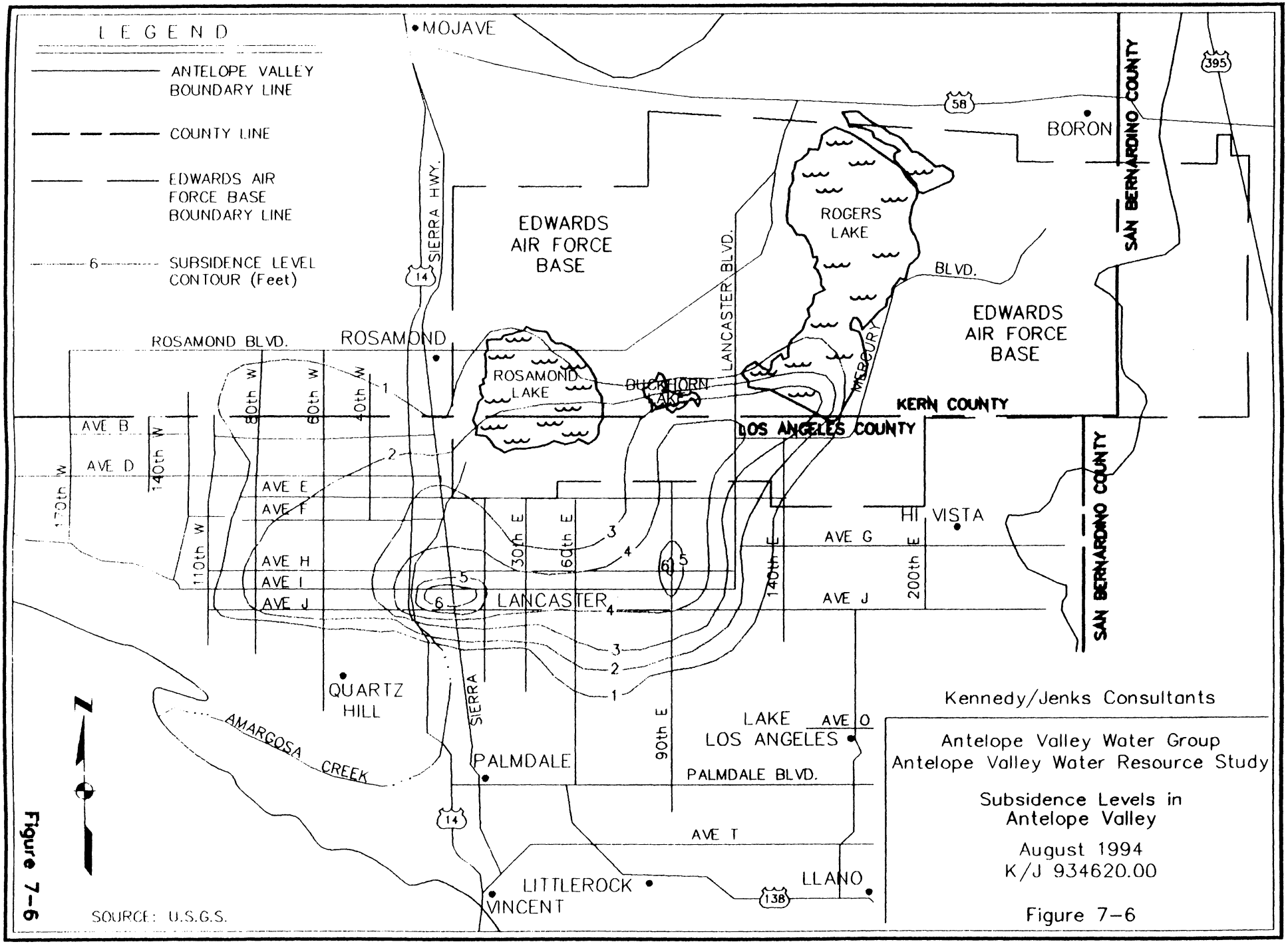
Figure 7-5


LEGEND
ANTELOPE VALLEY BOUNDARY LINE
COUNTY LINE
EDWARDS AIR FORCE BASE BOUNDARY LINE
6 SUBSIDENCE LEVEL CONTOUR (Feet)
MOJAVE
BORON
ROGERS LAKE
EDWARDS AIR FORCE BASE
SIERRA HWY.
LANCASTER BLVD.
MERCURY BLVD.
ROSAMOND BLVD.
ROSAMOND
ROSAMOND LAKE
BUCKHORN LAKE
KERN COUNTY
LOS ANGELES COUNTY
SAN BERNARDINO COUNTY
HI VISTA
AVE B
AVE D
AVE E
AVE F
AVE G
AVE H
AVE I
AVE J
AVE O
AVE T
LANCASTER
QUARTZ HILL
AMARGOSA CREEK
PALMDALE
PALMDALE BLVD.
LAKE LOS ANGELES
LITTLEROCK
VINCENT
LLANO
SOURCE: U.S.G.S.
Figure 7-6
Kennedy/Jenks Consultants
Antelope Valley Water Group
Antelope Valley Water Resource Study
Subsidence Levels in Antelope Valley
August 1994
K/J 934620.00
Figure 7-6

water quality appears to be associated in areas with hard-rock outcrops and areas underlain by the shallow playa deposits where evaporation has concentrated solutes. In general, the water quality over time has remained relatively unchanged over the entire Valley and generally meets maximum contaminant limits (MCLs) (USGS, 1987). The exception to the good groundwater quality is some high concentrations of boron associated with naturally-occurring boron deposits, and high nitrates associated with fertilizer use and poultry farming near the areas of Littlerock and Quartz Hill. Most of the groundwater withdrawals for municipal and agricultural use are drawn from the upper principal aquifer. Water quality data for specific areas are provided in later sections.

QUANTITY AND QUALITY OF AVAILABLE GROUNDWATER INFORMATION

Over three thousand wells have been drilled in Antelope Valley that have been recorded with the California Department of Water Resources. The USGS has prepared a computerized water-level database for these wells where the data fields include the local well number based on township, range, and section; the use of the water; the depth of well; the perforated interval; elevation of the land surface; the date of data collection, and the water level elevation. These data are not available for all of the wells and many of the wells contain measurements for only a few years. A listing of the well numbers would take many pages and therefore is not included in this report. A diskette with the well numbers and water level data are available.

In order to have a more complete picture of the aquifer characteristics at a single well, three basic pieces of information are required for that well including:

- Water level data over time.
- Water quality data over time.
- Well construction data such as geologic well logs, driller's logs, perforated intervals, construction material, and electric logs.

The omission of the well-construction data make evaluations of changes to the water quality or water levels in the groundwater difficult. The situation is made even more difficult in a multi-layer aquifer system as occurs in parts of the Antelope Valley.

Water Level Data

The USGS has compiled a database of water levels from their own data as well as those of the Department of Water Resources, for over 3,000 wells in the Antelope Valley (USGS, 1994b). However, the sheer size of the Valley prevents detailed study because even the 3,000 wells results in an average well density of about 2 wells per square mile. The USGS monitors water level for about 200 of those wells, however the majority of the 3,000 wells have data from only one point in time. Only 260 wells contain long-term water level data as shown on Figure 7-7.

Water Quality Data

Similarly, the water quality data that were available from the USGS and from a CD-ROM of groundwater data are also quite sparse. As shown on Figure 7-8, there are over 2,500 wells with 1 water quality sample (most data were collected in the 1950s and 1960s). However, as shown on Figure 7-9, the number of wells with more than 10 water quality samples drops significantly to about 60 wells. Many of the wells of interest have water quality data that are more than 15 years old. The USGS has continued to monitor approximately 40 wells for water quality parameters in the Antelope Valley.

The water quality data that are currently available can only give a general overview of the condition of the aquifer. Additional site-specific data will be necessary to assess the condition of the aquifer and the potential impacts of recharge on the overall groundwater quality.

Well Construction Data

In addition to water quality and water level data, well data (such as lithologic logs and descriptions of construction) are also an important component. Because the multi-layered aquifer system in the Antelope Valley, the well logs and knowledge of the depth and perforated intervals of the wells is vital to assessing the hydrogeology and the potential interactions between various aquifer zones. Based on the studies by the USGS, it appears that there are about 2,500 wells for which well construction data are available as shown on Figure 7-10. USGS, working with the Antelope Valley East Kern Water Agency (AVEK) in the 1970s and 1980s, computerized many of the well logs and other data for the more urbanized portions of the Valley. These data could provide an accessible source upon which site-specific investigations could be based.

POTENTIAL WATER SOURCES FOR RECHARGE

There are a variety of source waters that could be available for recharge into the groundwater of the Antelope Valley. They include:

- SWP
  - Treated potable water
  - Untreated water directly from the California Aqueduct

- Reclaimed Water (for spreading only)
  - Secondary treatment
  - Tertiary treatment

- Surface Water
  - Little Rock Creek and Little Rock Reservoir
  - Big Rock Creek
  - Amargosa Creek

The locations of the potential sources of recharge water for the Valley are shown on Figure 7-11. In addition, the range in TDS values of the potential sources of groundwater in the Antelope Valley is shown on Figure 7-12. The average raw SWP TDS values is an average of the annual average from 1976 to 1989 and 1993 (1993 TDS average is obtained from the average of January through June of 1993).

The highest groundwater TDS level within the wells for which data were evaluated was 1840 mg/L in a well located on Edwards AFB where perched water tables and the accompanying high salts occur. The low groundwater TDS of 125 mg/L occurred in a well in the Los Angeles County Waterworks (LACWW) wellfield near Lancaster. The average TDS value was estimated at about 300 mg/L based on the wells for which water quality was evaluated.

REGULATORY ISSUES

Groundwater recharge programs are currently regulated under several jurisdictions depending on the location and type of recharge program and the nature of the source waters. At present, neither the Environmental Protection Agency (EPA) nor the California Regional Water Quality Control Board-Lahontan Region (RWQCB-LH) (agencies expected to have the greatest involvement), have set procedures for review of groundwater recharge projects. Discussions with EPA staff indicate that they review groundwater recharge programs on a case-by-case basis.

Federal Regulations

The EPA regulates the discharges of waste to the subsurface under its Underground Injection Control (UIC) program as part of the Safe Drinking Water Act (SDWA). The UIC program divides injections wells into 5 classes. Wells that inject potable water or reclaimed water would be classified as Class V wells which would require, at present, only documentation of the injection. However, EPA staff indicate that they are concerned with potential degradation of the aquifer by salts and total dissolved solids but assess the injection or recharge on a case-by-case basis taking into account the potential beneficial uses of the recharged water. Discharges to dry creek beds, particularly of reclaimed water may require a National Pollutant Discharge Elimination System (NPDES) permit which is administered by the RWQCB-LH.

State Regulations

A groundwater recharge program for the Valley may be regulated by the RWQCB-LH and the Department of Health Services. Both are discussed below.

RWQCB-LH. The RWQCB-LH Water Quality Control Plan for the South Lahontan Basin (Basin Plan) lists no numerical Water Quality Objectives for groundwater. However, narrative objectives for groundwater contained in the Basin Plan include:

- Non-degradation policy which allows changes to water quality if:

- The change is consistent with maximum benefit to the people of the State.

- The change does not unreasonably affect present and anticipated beneficial uses of water.

- The change does not result in water quality less than that prescribed in water quality control plans or policies.

- Groundwater shall not contain taste or odor-producing substances that cause a nuisance or adversely affect beneficial uses.

- Groundwater used for domestic or municipal supply shall have a median concentration of coliform organisms over a seven-day period of less than 2.2/100 milliliters.

- Groundwaters designated for domestic or municipal supply shall not contain concentrations of chemical constituents in excess of the specified MCL.

- Groundwaters designated for domestic or municipal supply shall not contain concentrations of radionuclides in excess of the specified MCL.

If reclaimed water is discharged to spreading grounds that are within the dry creek beds of any of the creeks, the discharge may be regulated under the NPDES program that the RWQCB-LH administers for the EPA.

In the past, the RWQCB-LH has issued either waste discharge requirements or waivers of waste discharge requirements for implementation of groundwater recharge programs. The RWQCB-LH will also be concerned with the potential degradation of the aquifer by salts and total dissolved solids but also assesses the individual recharge or injection on a case-by-case basis.

Department of Health Services. The Department of Health Services (DHS) regulates drinking water quality, hazardous waste and reclaimed water use and may advise the RWQCB-LH on discharge requirements. In addition, the DHS is currently working on revising the requirements for recharge of reclaimed water in Title 22. For direct injection, requirements are expected to include 1) oxidized, filtered and disinfected water as well as organics removal, 2) a maximum groundwater basin contribution of 50 percent for reclaimed water, 3) a minimum retention time of 12 months in the basin prior to withdrawal at a domestic supply well, and 4) a minimum horizontal distance of 2,000 feet between the point of injection and the point of withdrawal at a domestic supply well.

For surface spreading, different requirements are expected to be applied to different levels of treated wastewater. There are expected to be three categories of treated wastewater acceptable for spreading:

- Category I (oxidation, filtration, disinfection and organics removal).

CHAPTER 8

EFFECTS OF CHANGES IN GROUNDWATER LEVELS

This chapter discusses the effects of changes in groundwater levels in the Antelope Valley. A brief introduction as well as discussions on potential damages attributable to changes in groundwater levels, land subsidence in California, and changes in groundwater levels in the Antelope Valley are presented.

INTRODUCTION

According to the United States Geological Survey (USGS), groundwater levels in the Lancaster area have declined by as much as 200 feet from 1915 to 1988 (USGS, 1994). Conversely, well hydrographs maintained by Antelope Valley-East Kern Water Agency (AVEK) indicate groundwater levels in portions of the Valley have risen in recent years. Appendix E presents figures from a recent USGS report showing the potentiometric head (representative of groundwater levels) in the Antelope Valley from 1957 and 1992. As shown in the USGS figures, groundwater levels generally declined from 1957 to 1975. However, between 1975 and 1981, groundwater levels in the eastern portion of the valley changed only slightly, in the central portion declined, and in the western portion increased. From 1981 to 1992, groundwater levels in the Valley generally increased although they continued to decline in the Lancaster area. (Between 1989 and 1993, records of well water levels in the Lancaster area have stabilized or risen (LACWW, 1994)).

Declining groundwater levels over a long period of time generally indicate over-extraction from a groundwater basin; conversely, increasing groundwater levels over a long period of time may indicate under-extraction from a basin (or recovery from over-extraction). In addition to these obvious indications, changes in groundwater levels are of concern, because a variety of damages can result. These potential damages are discussed in the following section.

POTENTIAL DAMAGES ATTRIBUTABLE TO CHANGES IN GROUNDWATER LEVELS

Potential damages attributable to changes in groundwater levels include land subsidence, increased pumping costs, waterlogging, and water quality degradation. Damages can range from minor structural damage to major physical damage to the ground surface rendering land virtually useless. Table 8-1 lists potential damages attributable to changes in groundwater levels.

Potential Damages Attributable to Declining Groundwater Levels

As indicated in Table 8-1, declining groundwater levels potentially result in two primary damages: 1) land subsidence and 2) increased pumping costs. These two types of damages are discussed in greater detail below.

TABLE 8-1

POTENTIAL DAMAGES ATTRIBUTABLE TO CHANGES IN GROUNDWATER LEVELS

Declining Groundwater Levels	Increasing Groundwater Levels
Land subsidence resulting in the following: • Development of cracks, fissures, sinklike depressions and softspots. • Change in natural drainage patterns often resulting in increased areas of flooding or increased erosion. • Degradation of groundwater quality. • Reduction in groundwater storage. • Change in gradient in gravity pipelines (sanitary and storm sewers) or canals often resulting in lost capacity. • Damage to well casings, pipelines, buildings, roads, railroads, bridges, levees, etc. • Costs associated with repairs and rebuilding. • Costs associated with construction of new facilities such as pumping stations for gradient changes. • Reduction in land value. • Lawsuits. Increased pumping costs	Waterlogging resulting in the following: • Increased liquefaction potential. • Structural damage. • Rendering septic systems useless. • Costs associated with repairs and rebuilding. • Reduction in land value. Water quality degradation.

surface in 1916. Recovery of artesian head in 1970-75 was due to increase in surface water imports, favorable rainfall supply, and decreased pumping of groundwater.

Partial estimates of the costs attributed to subsidence in the Santa Clara Valley indicate total costs were in excess of $35 million.

San Joaquin Valley

By 1966, yearly extraction of groundwater for irrigation in the San Joaquin Valley reached nearly 10 million acre-feet per year. This excessive withdrawal created an overdraft of approximately 4 million acre-feet per year in the 1950s and early 1960s. The potentiometric surface in some areas was drawn down nearly 600 feet. Importation of surface water resulted in groundwater withdrawal decrease, and, by the early 1970s, hundred of wells were unused, artesian heads were recovering, and subsidence was sharply reduced.

Partial estimates of the costs attributed to subsidence in the San Joaquin Valley indicate total costs were in excess of $50 million.

CHANGES IN GROUNDWATER LEVELS IN ANTELOPE VALLEY

The Antelope Valley has experienced declining and increasing groundwater levels. Damages attributable to declining groundwater levels have been identified within the study area; and damages attributable to increasing groundwater levels have been identified. Studies conducted related to both declining and increasing groundwater levels are described below.

Declining Groundwater Levels

Groundwater use in the Antelope Valley was at its highest in the 1950s and 1960s as a result of agricultural demands (USGS, 1994a). According to USGS, land subsidence in Antelope Valley was first reported by Lewis and Miller in the 1950s (USGS, 1992). Since then, studies have shown subsidence levels of up to 7 feet occurring in some areas of Antelope Valley. (See Figure 8-2.) Conversations held with various agencies and companies indicate that within the Antelope Valley, the Lancaster and Edwards Air Force Base (EAFB) areas are currently experiencing problems or damages that appear to be related to land subsidence. (See Figure 8-3 for locations of areas.) Table 8-3 lists land subsidence problems identified in Antelope Valley.

The following paragraphs present brief discussions on several studies done on land subsidence in Antelope Valley.

USGS Report 92-4035. USGS (1992) reported that as much as 2 feet of land subsidence had affected Antelope Valley by 1967 and was causing surface

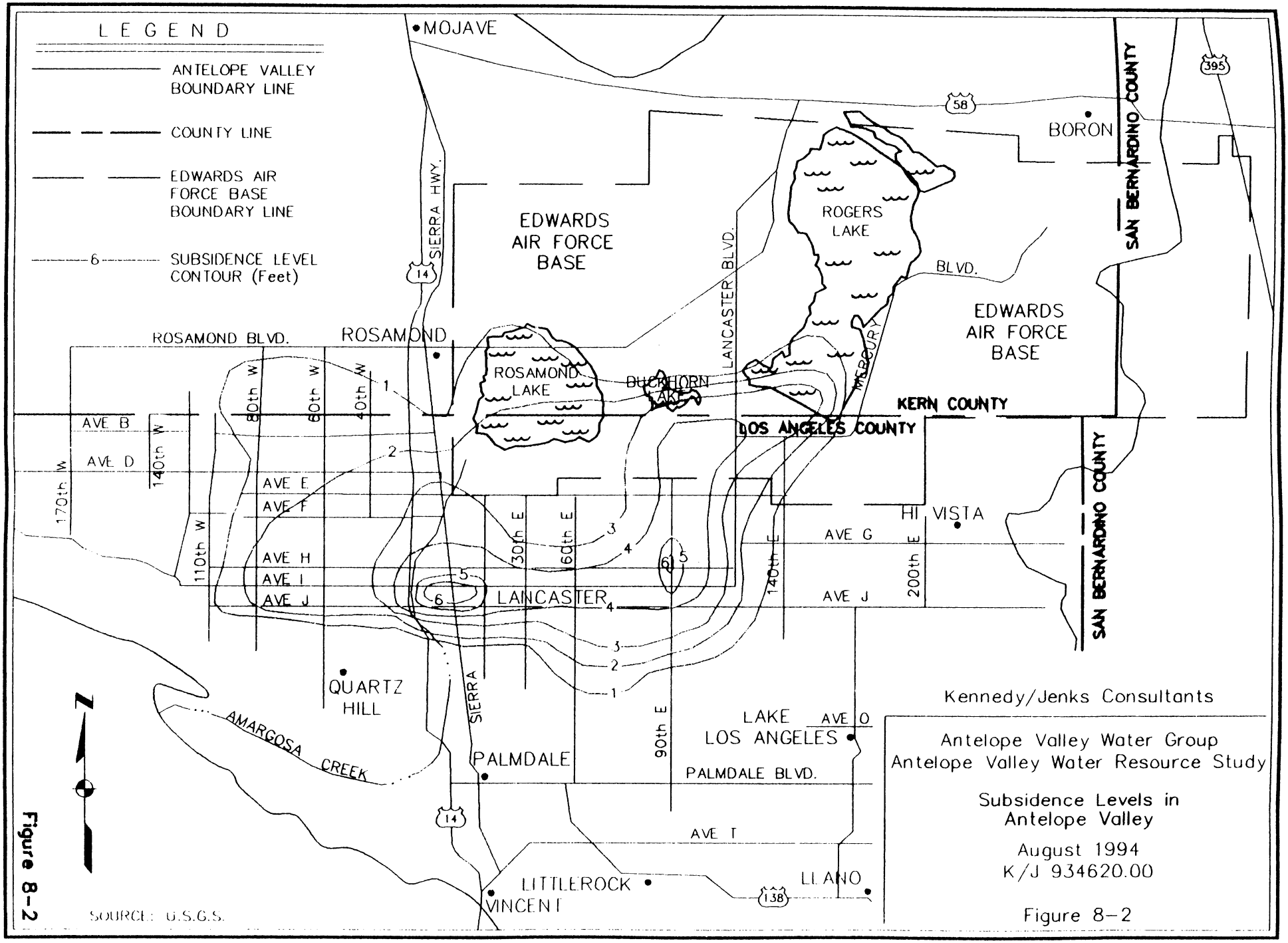

LEGEND
ANTELOPE VALLEY BOUNDARY LINE
COUNTY LINE
EDWARDS AIR FORCE BASE BOUNDARY LINE
6 SUBSIDENCE LEVEL CONTOUR (Feet)
MOJAVE
BORON
EDWARDS AIR FORCE BASE
ROGERS LAKE
SIERRA HWY.
LANCASTER BLVD.
MERCURY BLVD.
ROSAMOND BLVD.
ROSAMOND
ROSAMOND LAKE
BUCKHORN LAKE
KERN COUNTY
LOS ANGELES COUNTY
SAN BERNARDINO COUNTY
AVE B
AVE D
AVE E
AVE F
AVE G
AVE H
AVE I
AVE J
AVE O
AVE T
170th W
140th W
110th W
80th W
60th W
40th W
30th E
60th E
140th E
200th E
90th E
HI VISTA
LANCASTER
QUARTZ HILL
AMARGOSA CREEK
SIERRA
PALMDALE
LAKE LOS ANGELES
PALMDALE BLVD.
LITTLEROCK
VINCENT
LLANO
58
395
14
138
N
SOURCE: U.S.G.S.
Kennedy/Jenks Consultants
Antelope Valley Water Group
Antelope Valley Water Resource Study
Subsidence Levels in Antelope Valley
August 1994
K/J 934620.00
Figure 8-2

Figure 8-2

CHAPTER 9

WATER RESOURCE PROTECTION PLAN

The previous chapters of this report evaluate the existing water resources of the Antelope Valley as well as the need to develop additional water resources or implement additional water management techniques. This chapter integrates these evaluations into a water resource protection plan so that a consensus approach to providing an acceptable level of water resource reliability for the Antelope Valley can be developed. A description of recommended monitoring programs is also presented.

CONCLUSIONS OF PREVIOUS CHAPTERS

Based on the evaluations presented in previous chapters, the following general conclusions and observations are summarized:

1. The Antelope Valley encompasses approximately 2,400 square miles. The area has an arid environment and precipitation varies widely.

2. Since the mid-1980's, the population in the Antelope Valley has grown rapidly. Significant growth is expected to continue in all areas, except Edwards Air Force Base and Boron, during the study period (1993 to 2020).

3. As the population increases, corresponding water demands are expected to increase. Increased water demands can be attributed almost exclusively to the expected development of the Valley. Agricultural water demands are expected to decline during the study period. These demands would be expected to decline even further if the areas were not necessary for wastewater disposal purposes.

4. The Valley currently has several available water resources, including groundwater, imported State water, diversions from Littlerock Creek, and reclaimed water. Of these, all are currently being utilized; however, imported State water and reclaimed water are not being utilized at their full capability. Unfortunately, unlike groundwater, the lack of use results in a loss of the water resource. Littlerock Dam is currently being modified and this modification is expected to increase the ability to utilize stormwater diversions from Littlerock Creek.

5. The Antelope Valley Groundwater Basin is divided into twelve subunits and is comprised of two primary aquifers: the principal aquifer and the deep aquifer. The groundwater quality is generally considered excellent. The recharge of the groundwater has been estimated to be 31,200 to 59,100 acre-feet per year; however, a consensus safe yield has not been agreed upon.

6. With the exception of the groundwater supply, the available water resources are subject to delivery fluctuations. The reliability of the groundwater supply is generally considered to have a 100 percent delivery reliability. Because of limitations on Delta exports of water as well as fluctuations in hydrologic conditions, there is considerable delivery uncertainty associated with State water deliveries. Similarly, fluctuations in hydrologic conditions and limitations of diversion capabilities affect the delivery reliability of water from Littlerock Creek. Reclaimed water reliability is affected by the uncertainty associated with wastewater generation projections but generally has a 100 percent reliability when reclaimed water use is much lower than wastewater generation.

7. Based on the water supplies currently utilized in the Antelope Valley, the probability of meeting the 1993 water demand is estimated to be approximately 73 percent. This delivery reliability is generally below the objectives of comparable water utilities. By the year 2000, this probability of meeting the projected water demand is expected to decline to zero (i.e. demand exceeds the total available supplies), unless additional water management programs are implemented.

8. The water purveyors currently compensate for the lack of water supply reliability by groundwater extractions in excess of prior recharge estimates.

9. A review of historical groundwater levels indicates that the transition from agricultural to urban land use causes a decline in groundwater levels but the delivery of State water can offset adverse effects on groundwater levels. The delivery of State water to agricultural areas can result in rising groundwater levels.

10. Full development of the identified water conservation program is estimated to save nearly 500,000 acre-feet of water over the 1994 to 2020 planning period; however, the program would not affect the water demand until the year 1995. Without the water conservation program, the probability of meeting the 1995 water demand is estimated to be approximately 66 percent. With the water conservation program, the probability increases to approximately 71 percent. The date at which demand exceeds the total available supply would be extended to the year 2002.

11. Potential expansion of existing reclaimed water uses appears feasible. The identified reclaimed water system would distribute both secondary and tertiary treated wastewater. The projected reclaimed water use of high potential users is 35,600 acre-feet per year.

12. Full development of the identified reclaimed water potential would increase the delivery reliability of water supplies. Without the identified reclaimed water system or the water conservation program, the probability of meeting the 1995 water demand is estimated to be approximately 67 percent. With both the reclaimed water program and the conservation program, the probability increases to approximately 72 percent. The date at which demand exceeds the total available supply would be extended to the year 2004.

13. Aquifer storage and recovery (ASR) involves groundwater recharge by spreading or injection. Recovery would be accomplished by wells, primarily existing wells. ASR can also be accomplished by in lieu delivery of alternative water sources. Based on the hydrogeologic characteristics of the Antelope Valley, groundwater recharge by both spreading and injection appears feasible. Potential water sources for recharge include State water, reclaimed water, and local stormwater. The areas having the most potential for spreading are Amargosa Creek south of Avenue "N" between 10th Street West and Division Street, Littlerock Creek near Avenue "N" between 60th Street and 70th Street East, and Amargosa Creek near Elizabeth Lake Road and 25th Street West. The areas having the most potential for injection are Los Angeles County Waterworks (LACWW) wells located south of Avenue "K" between 10th Street West and Division Street; LACWW wells located south of Avenue "L" between 10th Street West and Division Street; and Palmdale Water District (PWD) wells south of Avenue "P" between 20th Street East and 40th Street East. Site specific evaluations will be required to evaluate the recharge potential and technical, economic and environmental feasibility of each site.

14. Groundwater levels have declined significantly in certain areas of the Antelope Valley. In these areas, land subsidence has generally accompanied the declining groundwater levels. Although damages attributed to land subsidence have been relatively modest, significant problems have been identified in other areas of California. Similarly, rising groundwater levels can also cause problems such as waterlogging and water quality degradation.

BASIC WATER RESOURCE PROTECTION STRATEGY

Based on the identified water resource problems as well as the evaluations presented in the previous chapters, a basic water resource protection strategy has been developed. The strategy focuses on minimizing demand growth, protecting and optimizing the use of existing water resources, and developing additional water resources to meet projected future demands. Specific elements of the recommended strategy are presented below:

- Manage the Groundwater Basin. The Antelope Valley Groundwater Basin has a large capacity to store water. Over the last several decades, the volume of water in storage has declined significantly but is still large. Urbanization of the Valley is the primary cause of increased groundwater use and this factor is expected to continue as the primary cause of increased water demands. Accordingly, to bring groundwater extractions more in line with the estimated safe yield of the Basin, the first phase of this element should be to limit any further reductions in groundwater levels. When this objective has been accomplished, the second phase of this element should be to replenish the Basin to the extent feasible so that it can be utilized to compensate for delivery fluctuations in other water supplies, particularly the delivery of State water.

- Protect Groundwater Quality. The Antelope Valley Groundwater Basin is an important component of the water resources for the Valley. Not only does the Basin provide a reliable yield but it also can serve as a reservoir to optimize the use of the Valley's other water resources. One of the primary threats to the use of this valuable resource is potential water quality degradation. Generally, the groundwater quality is excellent. To maintain this water quality, it is important to protect the Basin from contamination by industrial activities and other land uses, introduction of foreign water with a lower quality, or rising groundwater levels that free contaminants adsorbed onto soil particles.

- Reduce Long Term Water Demands. The need for additional water supplies can be mitigated by long-term reductions in water demands. By implementation of selected water conservation programs, the existing water resources can be extended cost-effectively. Furthermore, the ability to obtain and transfer supplemental water supplies may be facilitated by the efficient use of available supplies.

- Improve Utilization of Available Water Supplies. Because groundwater moves slowly, under-utilization generally does not result in a significant loss of this resource. Conversely, under-utilization of reclaimed water, stormwater or imported State water could result in irretrievable resource losses unless capabilities to store and recover these water supplies are available. The recent modifications to Littlerock Dam and Reservoir and potential aquifer storage and recovery programs are activities which should improve utilization of the available water supplies. Direct utilization of the reclaimed water, stormwater, and imported State water in lieu of groundwater would minimize the requirements of potential ASR programs.

- Improve State Water Project (SWP) Reliability. Of the water resources available to the Antelope Valley, imported State water is by far the most significant and has the greatest potential for providing additional future water supplies. Unfortunately, this water supply also currently has the greatest delivery uncertainty. Issues related to environmental concerns in the Bay-Delta, SWP financing and water supply allocations are being addressed by Federal and State agencies. Because the resolution of these issues will have a significant affect on the water supply/demand balance in the Antelope Valley, active participation in these negotiations is essential.

- Obtain Additional Imported Water Supplies. Regardless of whether the utilization of existing water resources is optimized, additional imported water supplies will be necessary to meet projected water demands. To minimize groundwater overdraft, these additional supplies should be obtained in timely increments. In order to acquire additional water supplies, the necessary financial resources must be available and water agencies in the Antelope Valley must be ready to act. The greatest opportunity to acquire additional imported water appears to be through water transfers among SWP or Central Valley Project contractors.

RECOMMENDED ACTIONS

To implement the basic strategy outlined above, the water purveyors in the Antelope Valley must initiate several institutional, engineering, financial, and public education activities. The recommended actions that appear to be the most important are:

1. Create an institutional framework to manage the development and use of water supplies.

To maintain equity among the competing water users and manage the utilization of the available water supplies, an institutional framework is desirable. The selected framework must be capable of accommodating the large number of water interests in the Antelope Valley. There are basically four approaches to the creation of multi-jurisdictional groundwater management:

- coordinated agreement by the water purveyors
- joint exercise of powers
- codified special districts
- special act legislation

Each of these approaches are discussed in the following paragraphs.

Coordinated Agreement by the Water Purveyors. Through a contract arrangement among the purveyors, the functions of groundwater management can be accomplished. This arrangement would require agreement between the signatory parties to exercise any power, including enforcement, or collect any levies. This approach has been utilized by other water utilities, particularly investor-owned utilities, to resolve specific groundwater utilization disputes. It should be noted, however, that agreements with investor-owned utilities should receive the approval of the California Public Utilities Commission to support their validity. The primary difficulties with this approach are as follows:

- Although the approach may be appropriate to resolve individual issues, it would be difficult to utilize this approach for issues as complex as groundwater management.

- Unanimous agreement among the parties would be necessary to perform any groundwater management function and specific agreements among the parties would be necessary for each new function. This process could be time-consuming and cumbersome.

- Because groundwater rights are similar to property rights, parties other than the current water purveyors could initiate groundwater use within the basin. To continue effective groundwater management, it would be necessary for these parties to also become signatories to the agreements.

For these reasons, coordinated agreement among the water purveyors does not appear to be a viable approach to groundwater management unless the issues are relatively well-defined. Recent legislation (AB 255) may make this approach viable if the basin is in critical overdraft as identified in DWR Bulletin 118. AB 255, enacted in 1991, authorizes any local agency whose jurisdiction includes groundwater basins subject to critical overdraft to establish, by ordinance or resolution, programs for the management of groundwater resources within the area in which water service is being provided. The bill authorizes the local agency to fix and collect fees, subject to voter approval, for the extraction of groundwater and to levy a water replenishment assessment. The measure also requires local agencies with overlapping boundaries which conduct groundwater management programs to meet, at least annually, to coordinate their programs. AB 3030, enacted in 1992, expands the authority contained in AB 255 for local agencies to manage groundwater. AB 3030 provides the authority and procedures to develop and implement groundwater management plans. Groundwater management authority created under AB 3030 generally has the powers granted to a water replenishment district. The characteristics and powers contained in AB 3030 are summarized in Table 9.1.

Joint Exercise of Powers. Under the provisions of Article 1 of Chapter 5, Division 7, Title 1, of the Government Code, public agencies in California can exercise any powers common to the parties. If the water purveyors were public agencies, this approach could be utilized to perform certain groundwater management functions.

Recent legislation (AB 2014) also allows mutual water companies to participate with public agencies in joint powers agreements. Water interests in the Antelope Valley include the County of Los Angeles, cities, special districts, investor-owned water companies, mutual water companies, Federal government, and individual water users. The County of Los Angeles or certain special districts could be utilized to represent unincorporated areas overlying the sub-basins.

The primary difficulty with this approach is that the powers of the joint powers authority would be limited to the powers common to the Cities, special districts, mutual water companies, and the County. In addition, joint powers authorities are generally formed so that unanimity is required to take actions. The adequacy of the authority's powers will depend on the specific approach to groundwater management desired by the authority. A joint powers authority could also exercise the powers provided in AB 3030.

Codified Special Districts. The California Water code contains provisions for the formation of several types of special water districts. Based on a review of these enabling acts, water replenishment districts appear to be the most appropriate codified special district to perform groundwater management activities. The characteristics and powers of a water replenishment district are summarized in Table 9.1.

The primary function of a water replenishment district is to obtain supplemental water supplies to directly or indirectly replenish an overdrafted groundwater basin. This approach to groundwater management is somewhat reactive in that it focuses on mitigating overdraft conditions rather than other water management techniques such as conjunctive operation of the basin.

Special Act Legislation. Because each special legislative act is customized for a particular situation, a groundwater management agency formed by special act legislation tends to be unique. Upon passage these acts are usually codified in the Water Code Appendix. An example of a special act groundwater management agency is the Orange County Water District which was created in 1933.

Based on a review of these acts, enabling legislation generally contains the following provisions:

a. formation
b. internal organization
c. powers
d. financing authority
e. enforcement

Special act groundwater management agencies are formed by action of the legislature. Until the enactment of AB 255 and AB 3030, special act legislation is the most common non-judicial approach to formation of a groundwater

management agency. Generally, these agencies are governed by a board of directors consisting of five to seven members. The selection method for board members varies widely. In most cases the board of directors is appointed or is composed of a combination of appointed and elected members. Depending on their unique role in local water regulation, the agencies have differing powers. Generally, the agencies are empowered to conduct groundwater studies and perform groundwater management by regulation of both extractions and beneficial uses of extracted water. Usually, these agencies can also perform groundwater replenishment activities. Like watermasters established by adjudication, assessments for extraction or replenishment are the most common form of financing authority although other authorities such as benefit assessments and standby charges are usually provided. The authority to enforce its powers is also provided through a variety of enforcement powers.

The enabling legislation of several special act groundwater management agencies was reviewed. The characteristics and powers of these agencies are summarized in Table 9.1. As indicated, the powers and organization of each agency has been customized for the individual political and technical situation of that area. Consequently, each agency differs from the others. Because these agencies are designed for the unique conditions of an area, special act legislation has become the most common non-judicial approach to groundwater management.

Recommended Institutional Approach. Based on the forgoing discussion of the alternative institutional approaches to groundwater management, it is apparent that the most desirable approach is to utilize AB 3030 or special act legislation to create a groundwater management agency. By utilizing special act legislation, the board and its powers can be customized to the unique political and hydrogeologic conditions of the area.

The procedures to implement the powers authorized under AB 3030 are outlined in the legislation (codified in Part 2.75 of the Water Code). Cooperation among the water purveyors overlying a groundwater basin are strongly encouraged and groundwater management powers are limited to the local agencies service area.

To initiate special act legislation, the water purveyors in the Antelope Valley should initiate discussions regarding the general form of the agency, with particular focus on the composition of the board of directors and groundwater management powers. If general consensus is achieved, draft legislation can be prepared and circulated for review by the individual water purveyors. When the provisions of the legislation has been mutually agreed upon, a legislative sponsor to carry the legislation can be selected.

2. Determine the safe yield of the Antelope Valley Groundwater Basin.

In its study plan to develop a groundwater management model for the Antelope Valley, USGS estimates that the estimated natural recharge of the groundwater basin ranges from 31,200 to 59,100 acre-feet per year based on equalizing adjustments to recharge estimates of previous investigations. Although this range

is relatively narrow compared to the projected water demands of the Antelope Valley, it is important to develop the foundation upon which a consensus safe yield estimate can be based.

The USGS study plan presents a sophisticated approach that utilizes hydrologic monitoring, chemical tracers, and remote sensing to develop estimates of natural recharge. These estimates would be incorporated into a proposed groundwater flow model which could be utilized to provide safe yield estimates based on the selected groundwater management strategy.

Whether this management modeling approach or a less sophisticated hydrologic approach is utilized, a single safe yield estimate for the groundwater basin, or preferably a single safe yield estimate for each sub-basin, would be desirable. This estimate would provide the basis upon which consensus can be achieved and upon which a water management plan can be based. In the absence of a consensus estimate, conflict among the groundwater users is likely to occur as the cost of alternative water supplies increase. Accordingly, it is recommended that the water interests in the Antelope Valley review alternative approaches to developing safe yield estimates, determine the most appropriate approach, and perform the necessary studies.

3. Continue the Current Groundwater Monitoring Program and Publish an Annual Report on Basin Conditions.

As part of a cooperative effort of the Antelope Valley East Kern Water Agency (AVEK) and Edwards Air Force Base (EAFB), USGS currently conducts a comprehensive monitoring program in the Antelope Valley. Monitoring activities include groundwater levels, groundwater quality, land surface deformation (subsidence), aquifer compaction, and streamflow.

Groundwater levels are currently monitored as part of the cooperative AVEK network in conjunction with groundwater studies at EAFB. The AVEK network is comprised of about 150 wells within the Antelope Valley. Water levels are measured annually or semiannually. Forty Piezometers were installed at EAFB by the USGS, 12 of which are currently monitored continuously (every 15 minutes). Combined, these networks are fairly sparse, given the size of the valley (about 2,400 square miles). Making best use of available wells and existing monitoring efforts by various entities, and installing monitoring wells in key areas could improve the groundwater level network substantially.

USGS measures groundwater quality in 5 to 10 wells per year from the AVEK network described above. Other agencies, notably the Department of Water Resources and the Los Angeles County Sanitation Districts also measure groundwater quality. In addition, public water suppliers perform analyses of their water supplies as required by the California Department of Health Services and Title 22 of the California Code of Regulations.

USGS has collected geodetic data using the Global Positioning System (GPS) for the purpose of determining land subsidence at EAFB in 1989, and valley-wide in 1992. The valley-wide network consists of 85 benchmarks. Unfortunately, several of these benchmarks have been destroyed since 1992 because of various construction-related causes (e.g. installation of Metro Line tracks, and road widening). Accordingly, it is recommended that remaining benchmarks be protected, or that new "offset" benchmarks be provided by marking them in such a way that construction crews would not destroy them without approval. In addition, the network could be expanded to include tighter control in subsidence-prone areas by including all existing and future production wells in these areas.

Three extensometers have been installed at two sites at EAFB for the direct and continuous measurement of aquifer-system compaction, which results in land subsidence. GPS surveys are typically done on an annual or less frequent basis, which could be inadequate for monitoring to avoid land subsidence. Extensometers provide a real-time measurement of aquifer-system compaction, which can aid in making decisions regarding the daily distribution of groundwater withdrawals.

USGS currently operates 8 rain gages in Antelope Valley, which supplement the Los Angeles County and National Oceanic and Atmospheric Administration networks. Precipitation data are important for estimating groundwater recharge as well as rainfall/runoff relationships for flood control purposes.

Streamflow data are sparse in the Antelope Valley. USGS currently operates 8 continuous gages, but only one of them is on the three primary sources of groundwater recharge from the San Gabriels (Big Rock, Little Rock, and Amargosa Creeks), and that gage is in the upper reaches of Bid Rock Creek before the creek passes through Valyermo. Accordingly, installation of additional continuous-monitoring gages is recommended.

A significant volume of data is collected annually. These data provide limited value without technical interpretation. Accordingly, it is recommended that the data be published on an annual basis, together with a summary report of the Basin conditions and groundwater management activities. This document should be informative to both water managers as well as the public.

4. Develop a program to optimize the use of available water supplies.

To optimize the use of groundwater, annual extractions should be reduced to safe yield levels. In lieu of groundwater, other water supplies should be utilized to the extent feasible. In the use of alternative water supplies, priority should be given to utilization of supplies which may be lost by non-use. Currently, the supplemental water supply whose use could be better utilized is imported State water. When State water is available, it should be fully utilized, thereby reserving the groundwater for periods of reduced delivery of State water. Similarly, when made available, reclaimed water should be utilized to maximum extent provided by the distribution system, and groundwater recharge should remain an important

consideration in all stormwater management plans. To the extent that direct use of these resources cannot be accomplished, facilities to recover the resources and store them in underground aquifers should be provided.

The primary barriers to reducing groundwater use is the lower cost of groundwater compared to surface water and access to alternative water supplies. To overcome these barriers it is recommended that the groundwater management authority implement or facilitate the implementation by others of the water conservation, reclaimed water, stormwater management, and aquifer storage and recovery programs recommended in this study. These activities are discussed in the following recommended action. In addition, it is recommended that the authority consider the application of groundwater replenishment assessments to fund a portion of the program costs. A replenishment assessment is typically levied on extractions beyond an allocated annual volume. These allocations are usually limited to the safe yield of the Basin, although transition periods to achieve this level are often utilized. To implement this assessment, the available safe yield of the Basin must be allocated equitably among the competing users. At a minimum, replenishment assessments should be levied on new or increased groundwater use.

The primary barrier to shifting groundwater use to alternative supplies such as imported State water is again economic (i.e. the lower cost of groundwater). Accordingly, it is recommended that the groundwater management authority also consider the application of basin equity assessments. A basin equity assessment is typically an assessment levied on one water source (e.g. groundwater) to reduce the cost of another source (e.g. State water or reclaimed water); thus, basin equity assessments are revenue neutral. The amount of these assessments are dependent upon the magnitude of the desired water use shift as well as the urgency of the shift.

5. Develop the recommended water conservation, reclaimed water, stormwater management, and aquifer storage and recovery programs.

Previous chapters of this report describe water conservation, reclaimed water, stormwater management, and aquifer storage and recovery programs. These programs are intended to reduce water demands or improve the utilization of the available water supplies, thereby reducing the need and extending the timing for additional imported water supplies. Accordingly, it is recommended that the groundwater management authority implement or facilitate the implementation by others of these programs.

To implement these programs, more detailed program-specific planning studies will be necessary. In these studies, one of the key issues that should be addressed is the cost allocation between the water management elements of the program and the other institutional beneficiaries. With the exception of the water conservation program for which only cost-effective water management activities are included, the programs provide benefits to related activities. For example, the reclaimed water, together with the aquifer storage and recovery program, is expected to

reduce the cost of wastewater disposal. Similarly, stormwater recharge activities may be necessary to implement flood control facilities. Accordingly, the relative benefits of the recommended programs should be evaluated so that an equitable distribution of costs can be determined.

6. Actively encourage the California Department of Water Resources to complete the State Water Project and/or improve reliability.

The reliability of imported water from the State Water Project has been undergoing significant changes. These changes are primarily the result of environmental concerns in the Bay-Delta and possible revisions to the water and cost allocation procedures of the California Department of Water Resources (DWR).

As a result of a series of biological opinions issued by the United States Fish and Wildlife Service, water exports from the Bay-Delta have been restricted and are currently interrupted by ongoing estimates of "takings" of endangered species. This operating procedure has created considerable uncertainty over the amount of water that may be exported by the SWP as well as over operational reservoir releases or potential water transfers from north of the Delta. Accordingly, it is recommended that the State water contractors in the Antelope Valley monitor the development of Federal-State Bay Delta protection plans and encourage the development of consistent operating procedures for Delta water exports.

The issues related to DWR's water allocation procedures involve Article 18(a) of the SWP contract which specifies the procedures for water shortage allocations and the issues related to DWR's cost allocation procedures involve the need of the SWP agricultural contractors to receive repayment relief, particularly for the water supply diverted for Bay-Delta water quality improvements. Article 18(a) of the SWP contract specifies that water supply reductions are proportioned according to the contractor's entitlement and applied to the contractor's request. Historically, DWR has proportioned the reductions based on the contractor's request and also applied the reduction to the contractor's request. Because demands for State water are increasing and the available supply is restricted, the water shortage provisions of Article 18(a) will become increasingly more important. Similarly, as the agricultural contractors continue to advocate repayment relief, the cost of State water to the municipal and industrial contractors may increase. The California Research Bureau has recently evaluated alternative approaches to SWP financing. Several of these alternatives would significantly increase the future cost of imported water. For these reasons, it is recommended that the State water contractors in the Antelope Valley actively participate in discussion with DWR over water and cost allocation issues.

7. Obtain additional imported water supplies.

Water demand projections for the Antelope Valley indicate that the underlying water demands are expected to range from 363,000 to 420,000 acre-feet by the year 2020. Even with an active water conservation program, the medium water demand projection is 361,000 acre-feet in the year 2020. If the recommended

reclaimed water program is implemented, the maximum available water supply is estimated to be 256,000 acre-feet in the year 2020; however, reliability issues related to imported State water are likely to result in deliveries below this level. Therefore, it is apparent that additional imported water supplies will be necessary. The probable source of additional imported water supplies will be other State water contractors with excess or unaffordable entitlements. Furthermore, it would be desirable for the State water contractors in the Antelope Valley to immediately initiate the acquisition of these water supplies and complete the acquisition of some additional water prior to the year 2000. In acquiring additional water supplies, it is recommended that the State water contractors implement a phased water acquisition program as cost-effective water supplies become available. By utilizing a phased program, additional water supplies can be obtained prior to the development needs of the area while minimizing the financial impact of the new water supplies.

To implement a water acquisition program, sufficient financial resources will be necessary. Because the need for additional imported water is caused primarily by new development, it is recommended that the cost of these water supplies be incorporated into the facility capacity fees levied on new development.

8. Develop a revenue plan to implement the recommended programs.

To implement the recommendations of this study, the costs associated with the recommendations must be allocated equitably among the beneficiaries (i.e. local vs. regional, water supply vs. wastewater disposal, and groundwater recharge vs. stormwater management). In addition, the costs allocated to water management activities must be distributed equitably among the competing water interest (i.e. new vs. existing, groundwater vs. surface water, agricultural vs. municipal, and retail vs. wholesale). The allocated costs are anticipated to include the costs of the recommended programs, acquisition costs of additional water supplies, equalization of water supply costs, and administration costs of water management. To provide sufficient revenues to fund these costs, the following revenue sources are recommended:

Replenishment Assessments. Replenishment assessments are assessments imposed on groundwater extractions in excess of the safe yield allocation. It is recommended that these assessments be used to fund the portion of the recommended programs allocated to water management.

Basin Equity Assessments. Basin equity assessments are revenue-neutral assessments imposed on groundwater users that have access to alternative water supplies. It is recommended that these assessments be used to encourage the utilization of alternative water supplies.

Production Assessments. Production assessments are assessments imposed on all groundwater use or all water use regardless of the source. It is recommended that these assessments be used to support the administration costs of water management.

Facility Capacity Fees. Facility capacity fees are fees imposed on new development to offset the economic impact on public facilities. It is recommended that these fees by utilized to acquire the additional imported water supplies to serve the new development.

Standby Charges. Standby charges are charges imposed on landowners on a per parcel or per acre basis. It is recommended that these charges be considered as an alternative to replenishment, basin equity, or production assessments when groundwater extractions are not or cannot be metered.

9. Initiate a public education program.

The water resources protection plan includes recommendations that the proposed groundwater management authority and the water purveyors in the Antelope Valley implement several programs to improve water management. Improvements include reductions in projected water demands, better use of the available water resources, and acquisition of additional imported water supplies. These programs will require new revenue sources to equitably fund the recommended programs. To effectively communicate the objectives and activities of the new water management institution, an active public education program is recommended.

There are two levels to the recommended public education program. One level would focus on the need for integrated water management in the Antelope Valley, the framework of the recommended programs, and the financial resources required. The other level would focus on the implementation issues of the individual programs. To obtain public support for a new water management institution as well as its associated fees and charges, the public must understand the legitimacy and nature of complex water issues and the effectiveness of the recommended institutions and programs. Furthermore, each of the recommended programs is also complex, and the public must understand the justification and activities of the individual programs.

The success of the public education program will depend on the unanimity and credibility of the existing water institutions in the Antelope Valley in presenting the information necessary to understand these complex issues. This credibility is developed not only through public education but also through public participation in the development of the programs to address the wide range of water issues facing the Antelope Valley.

Conservation pricing is also characterized by one or more of the following components:

c. Rates in which the unit rate is constant regardless of the quantity used (uniform rates) or increases as the quantity used increases (increasing block rates);

d. Seasonal rates or excess-use surcharges to reduce peak demands during summer months;

e. Rates based upon the long-run marginal cost or the cost of adding the next unit of capacity to the system;

f. Lifeline rates.

12. LANDSCAPE WATER CONSERVATION FOR NEW AND EXISTING SINGLE FAMILY HOMES.

Implementation methods shall be at least as effective as providing guidelines, information and incentives for installation of more efficient landscapes and water saving practices (e.g., encouraging local nurseries to promote sales and use of low water using plants, providing landscape water conservation materials in new home owner packets and water bills, sponsoring demonstration gardens); and enacting and implementing landscape water conservation ordinances or, if the supplier does not have the authority to enact ordinances, cooperating with cities, counties, and the green industry in the service area to develop and implement landscape water conservation ordinances pursuant to the "Water Conservation in Landscaping Act ("Act") (California Government Code §§ 65590 et seq.). The ordinance shall be at least as effective as the Model Water Efficient Landscape Ordinance being developed by the Department of Water Resources.

13. WATER WASTE PROHIBITION.

Implementation methods shall be enacting and enforcing measures prohibiting gutter flooding, sales of automatic (self-regenerating) water softeners, single pass cooling systems in new connections, nonrecirculating systems in all new conveyer car wash and commercial laundry systems, and nonrecycling decorative water fountains.

9. COMMERCIAL AND INDUSTRIAL WATER CONSERVATION.

Implementation methods shall be at least as effective as identifying and contacting the top 10% of the industrial and commercial customers directly (by mail and/or telephone); offering audits and incentives sufficient to achieve customer implementation; and providing follow-up audits at least once every five years if necessary.

10. NEW COMMERCIAL AND INDUSTRIAL WATER USE REVIEW.

Implementation methods shall be at least as effective as assuring the review of proposed water uses for new commercial and industrial water service and making recommendations for improved water use efficiency before completion of the building permit process.

11. CONSERVATION PRICING.

Implementation methods shall be at least as effective as eliminating nonconserving pricing and adopting conserving pricing. For signatories supplying both water and sewer service, this BMP applies to pricing of both water and sewer service. Signatories that supply water but not sewer service shall make good faith efforts to work with sewer agencies so that those sewer agencies adopt conservation pricing for sewer service.

Nonconserving pricing provides no incentives to customers to reduce use. Such pricing is characterized by one or more of the following components:

a. Rates in which the unit price decreases as the quantity used increases (declining block rates);

b. Rates that involve charging customers a fixed amount per billing cycle regardless of the quantity used;

c. Pricing in which the typical bill is determined by high fixed charges and low commodity charges.

Conservation pricing provides incentives to customers to reduce average or peak use, or both. Such pricing includes:

a. Rates designed to recover the cost of providing service; and

b. Billing for water and sewer service based on metered water use.

cemeteries, parks and publicly owned landscapes on or adjacent to road rights-of-way); contacting them directly (by mail and/or telephone); offering landscape audits using methodology such as that described in the Landscape Water Management Handbook prepared for the California Department of Water Resources; and cost-effective incentives sufficient to achieve customer implementation; providing follow-up audits at least once every five years; and providing multi-lingual training and information necessary for implementation.

6. LANDSCAPE WATER CONSERVATION REQUIREMENTS FOR NEW AND EXISTING COMMERCIAL, INDUSTRIAL, INSTITUTIONAL, GOVERNMENTAL, AND MULTI-FAMILY DEVELOPMENTS.

Implementation methods shall be enacting and implementing landscape water conservation ordinances, or if the supplier does not have the authority to enact ordinances, cooperating with cities, counties and the green industry in the service area to develop and implement landscape water conservation ordinances pursuant to the "Water Conservation in Landscaping Act" ("Act") (California Government Code §§ 65590 et seq.). The ordinance shall be at least as effective as the Model Water Efficient Landscape Ordinance being developed by the Department of Water Resources. A study of the effectiveness of this BMP will be initiated within two years of the date local agencies must adopt ordinances under the Act.

7. PUBLIC INFORMATION.

Implementation methods shall be at least as effective as ongoing programs promoting water conservation and conservation related benefits including providing speakers to community groups and the media; using paid and public service advertising; using bill inserts; providing information on customers' bills showing use in gallons per day for the last billing period compared to the same period the year before; providing public information to promote other water conservation practices; and coordinating with other governmental agencies, industry groups and public interest groups.

8. SCHOOL EDUCATION.

Implementation methods shall be at least as effective as ongoing programs promoting water conservation and conservation related benefits including working with the school districts in the water supplier's service area to provide educational materials and instructional assistance.

Implementation methods shall be at least as effective as contacting the loc building departments and providing information to the inspectors; and cor tacting major developers and plumbing supply outlets to inform them of th requirement.

b. SUPPORT OF STATE AND FEDERAL LEGISLATION PROHIBI TING SALE OF TOILETS USING MORE THAN 1.6 GALLON PER FLUSH.

c. PLUMBING RETROFIT.

Implementation methods shall be at least as effective as delivering retrofit kits including high quality low-flow showerheads to pre-1980 homes that do not have them and toilet displacement devices or other devices to reduce flush volume for each home that does not already have ULF toilets; offering to install the devices; and following up at least three times.

3. DISTRIBUTION SYSTEM WATER AUDITS, LEAK DETECTION AND REPAIR.

Implementation methods shall be at least as effective as at least once every three years completing a water audit of the water supplier's distribution system using methodology such as that described in the American Water Works Association's "Manual of Water Supply Practices, Water Audits and Leak Detection;" advising customers whenever it appears possible that leaks exist on the customers' side of the meter; and performing distribution system leak detection and repair whenever the audit reveals that it would be cost effective.

4. METERING WITH COMMODITY RATES FOR ALL NEW CONNECTIONS AND RETROFIT OF EXISTING CONNECTIONS.

Implementation methods shall be requiring meters for all new connections and billing by volume of use; and establishing a program for retrofitting any existing unmetered connections and billing by volume of use; for example, through a requirement that all connections be retrofitted at or within six months of resale of the property or retrofitted by neighborhood.

5. LARGE LANDSCAPE WATER AUDITS AND INCENTIVES.

Implementation methods shall be at least as effective as identifying all irrigators of large (at least 3 acres) landscapes (e.g., golf courses, green belts, common areas, multi-family housing landscapes, schools, business parks,

APPENDIX K

PRELIMINARY DRAINAGE STUDY

PALMDALE BUSINESS PARK CENTER
PRELIMINARY DRAINAGE STUDY

Submitted to:

LOCKHEED DEVELOPMENT CORPORATION
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Revised NOVEMBER, 1993
DECEMBER 1992

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LIST OF EXHIBITS

Exhibit I-1 - Vicinity map

Exhibit I-2 - USGS Quad Map

Exhibit I-3 - Land Use and Project Summary

Exhibit II-1 - Drainage Master Plan - 1988 - Master Plan Facilities

Exhibit II-2 - Anaverde Creek Basin - 1992 - Study Area

Exhibit II-3 - Anaverde Creek Basin - 1992 - Proposed Regional Facilities

Exhibit IV-1 - Off-site Hydrologic Map - Existing Condition

Exhibit IV-2 - On-site Hydrology Map - Existing Condition

Exhibit V-1 - Hydrology Map - Developed Condition

Exhibit V-2 - Modified Drainage Map to Establish Capital Flood Run-off at Northeast Corner

Exhibit V-3 - Developed Q-50 at Northeast Corner of the Project Site

I. INTRODUCTION AND PROJECT SETTING

A) Purpose and Scope

This preliminary hydrology study has been prepared for the development of the Palmdale Business Park Center Specific Plan. Hydrologic analysis has been performed to analyze the existing undeveloped site conditions and the projected conditions after development. This study has been performed in accordance with the Drainage Management Plan of the City of Palmdale.

Section II of this report discusses the current and proposed Master Plans of Drainage for the City of Palmdale and the relationships to this proposed development.

Section III of this report summarizes the findings of our analysis.

Section IV of this report contains the results of the hydrologic analysis for the undeveloped off-site and on-site conditions.

Section V of this report contains the results of the hydrologic analysis for the developed project.

B) Project Description

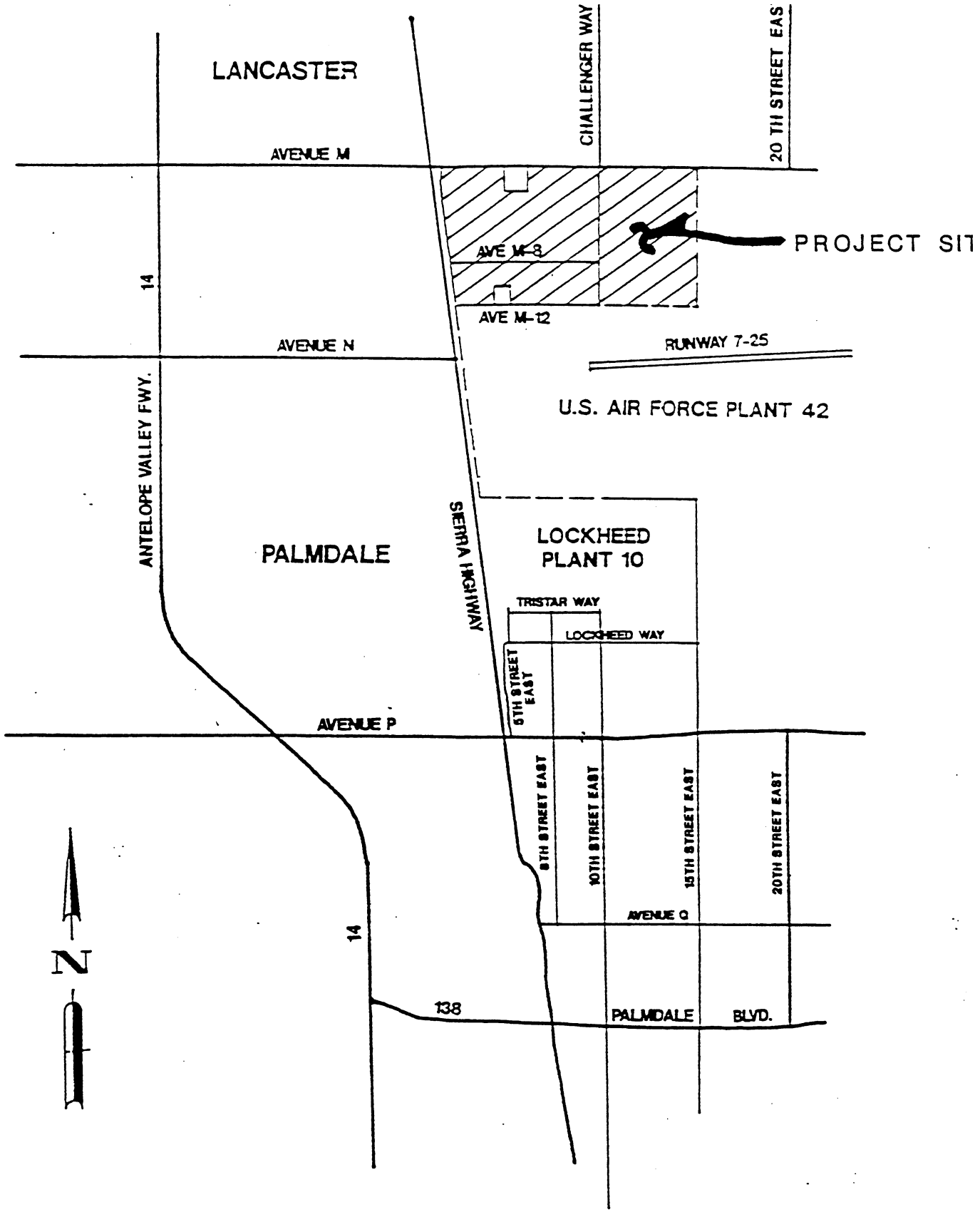
Palmdale Business Park Center is owned by Lockheed Corporation and consists of approximately 632 acres of undeveloped, unzoned land within the City limits. The current General Plan designates the site as Specific Plan Area 10; Lockheed North.

The property is bounded on the north by Avenue M, which forms the boundary between the cities of Palmdale and Lancaster west of Challenger Way; by the United State Air Force Plan 42 on the east and south; and by Southern Pacific Railroad right of way and Sierra Highway on the west. There are two out parcels consisting of the seven acre Los Angeles County Waterworks site and a five acre parcel in private party ownership.

A vicinity map is provided on Exhibit I-1, and the surrounding area is illustrated on the USGS Quad Map, Exhibit I-2.

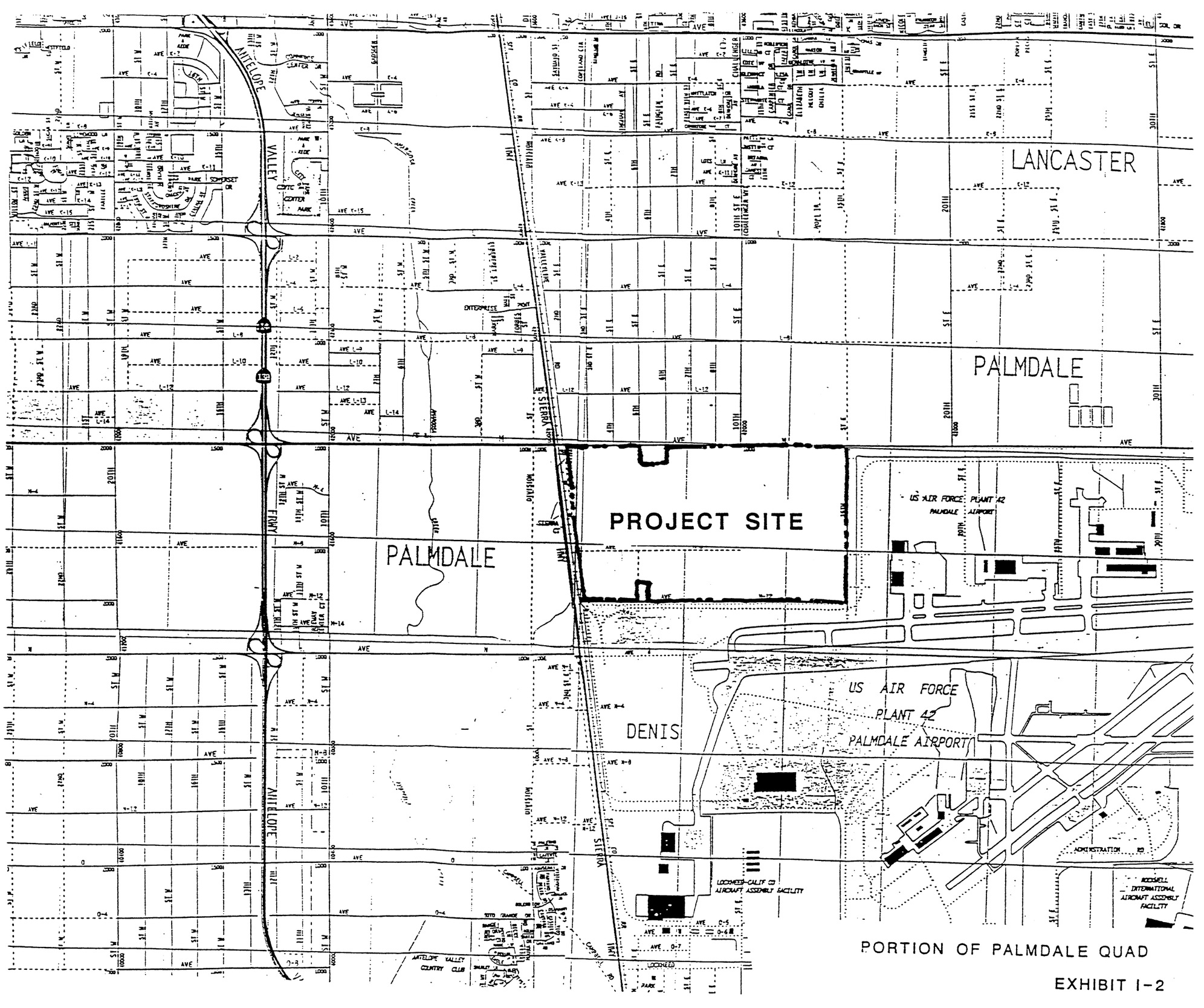
As proposed, Palmdale Business Park Center is a master planned, high quality commercial and industrial complex with an integral 27-hole golf facility. The site plan demonstrates a yield of approximately 336 buildable acres with a 54 acre potion fronting Avenue M devoted to commercial uses. The remaining 281 acres are envisioned as a business park with an emphasis on light industrial and airport related uses. The golf course covers 236 acres and the project rights of way constitute approximately 55 acres. The balance of 6 acres is dedicated to open space.

The Land Use Plan and Project Summary is illustrated on Exhibit I-3.



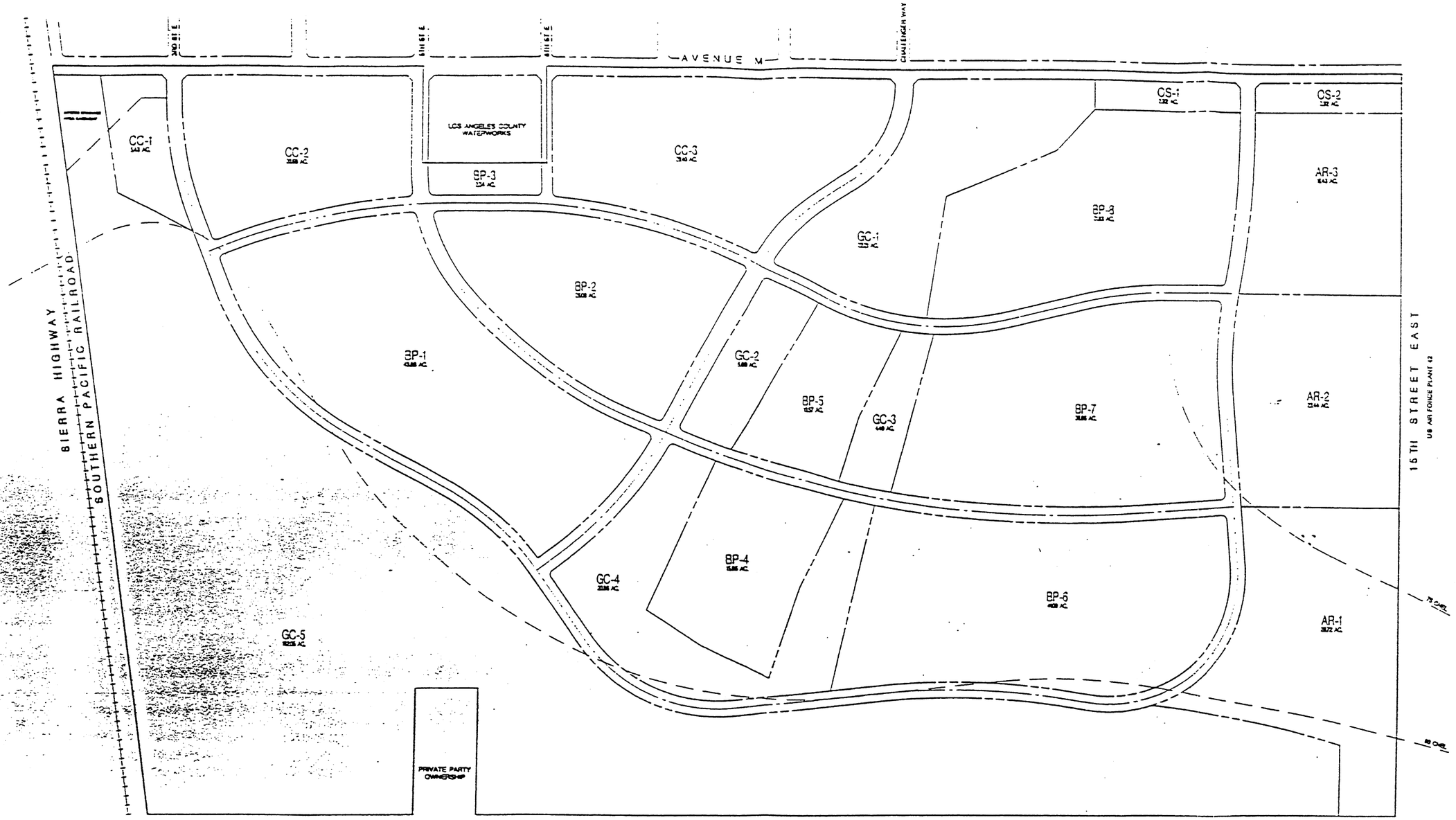
VICINITY MAP

1"= 2000'



PORTION OF PALMDALE QUAD

EXHIBIT I-2



PALMDALE BUSINESS PARK CENTER

SPECIFIC PLAN
PALMDALE, CALIFORINA

LOCKHEED CORPORATION
4500 PARK GRANADA BLVD
CALABASSAS CA 91339-0220
(818) 876-2212

PROJECT SUMMARY

COMMUNITY COMMERCIAL		AIRPORT RELATED		GOLF COURSE	
CC - 1	5.43	AR - 1	28.72	GC-1	22.21
CC - 2	20.69	AR - 2	23.44	GC-2	4.89
CC - 3	29.40	AR - 3	18.43	GC-3	4.49
SUBTOTAL	55.52 AC.	SUBTOTAL	70.59 AC.	GC-4	20.86
				GC-5	182.06
				SUBTOTAL	236.30 AC.
BUSINESS PARK		OPEN SPACE		STREET RIGHT OF WAY	53.83 AC.
BP - 1	43.88	OS - 1	2.92		
BP - 2	26.09	OS - 2	2.92		
BP - 3	2.34	SUBTOTAL	5.84 AC.	TOTAL	632.40 AC.
BP - 4	15.66				
BP - 5	10.57				
BP - 6	41.08				
BP - 7	36.66				
BP - 8	31.83				
SUBTOTAL	210.32 AC.				

NORTH

DECEMBER 3, 1992

David A. Price
ASSOCIATES

LAND USE PLAN AND PROJECT SUMMARY

EXHIBIT I-3

II. CITY MASTER PLAN OF DRAINAGE

A) Summary of the City Master Plan of Drainage

In recent years, the City of Palmdale has grown at a rapid rate while the construction of flood control facilities has lagged behind the development. The Los Angeles County Department of Public Works completed the final report on the Antelope Valley Comprehensive Plan of Flood Control and Water Conservation (Comprehensive Plan) in June 1987 which shows the location and sizes of projected regional facilities for the entire Antelope Valley.

The lack of existing drainage facilities within the City of Palmdale, the lack of downstream regional drainage facilities within the City of Lancaster, the need to supplement the Comprehensive Plan and the need to provide the City staff and the development community with a planning document led to the preparation of a Master Plan of Drainage for the City of Palmdale. The following objectives were set forth in this Drainage Master Plan:

- Establish hydrologic and hydraulic criteria.
- Conduct hydrologic and hydraulic analyses for the areas within and tributary to the City.
- Develop ultimate drainage systems within the City limits and provide for interim systems, where feasible.
- Identify the costs of the proposed facilities and establish an improvement priority program.
- Develop drainage fees.

The Drainage Master Plan Facilities are shown on Exhibit II-1.

Since the preparation of the Master Plan of Drainage, several factors have arisen which have led the City of Palmdale to further study the drainage issues which relate to the Anaverde Creek Basin. Some of these factors are summarized below.

1. Since 1988, when the Master Plan of Drainage was prepared, various developments have been approved within the City. These developments have resulted in modifications to the Master Plan of Drainage to fit the site specific development needs based upon detailed studies. In addition, land use classifications have been modified within smaller areas within the City.

CITY MASTER PLAN OF DRAINAGE - CONTINUED

2. Excavation within the Anaverde Retention Basin, one of the three retention basins proposed within the Anaverde Creek Basin of the Master Plan of Drainage, has encountered shallow bedrock. Current estimates indicated that the Anaverde Retention Basin will not be able to be constructed to the volume proposed in the Master Plan of Drainage. Downstream regional facilities will therefore need to be upsized to accommodate the run-off from this basin which had previously been planned for full retention.

3. The Specific Plan developments of the Ritter Ranch and the City Park are proposed within the westernmost portions of the Anaverde Creek Basin. Drainage studies for these developments do not provide for the construction of the City Ranch Basin which is proposed in the Comprehensive Plan.

4. The development of the Plant 42 Basin needs to be modified due to site constraints which were not considered in the Regional Master Plan of Drainage.

The City of Palmdale has commissioned a comprehensive study of the entire Anaverde Creek Basin to provide for updated recommendation for the facilities identified in the Master Plan of Drainage.

Phase 1 of this study consisted of a Hydrology study for the Anaverde Creek Basin, upstream of the Antelope Valley Freeway.. This study was completed in December 1991.

Phase 2 of this study consisted of an overall hydrologic update, feasibility analysis, master plan facility analysis and cost estimates for the Anaverde Creek Basin. The results of Phase 1 were utilized in the preparation of the Phase 2 report.

The Phase 2 report, ANAVERDE CREEK BASIN HYDROLOGY STUDY, ANTELOPE VALLEY FREEWAY TO AIR FORCE PLANT 42 BASINS, was prepared by AKM Consulting Engineers, and completed in July 1992.

The results of these studies have not yet been formally incorporated into the Master Plan of Drainage. However, the City of Palmdale has indicated that it is working towards finalizing the revisions to the Master Plan in the near future.

The proposed Regional Facilities are shown on Exhibit II-3 and the Proposed Regional Facility sizes are shown in Table III-3.

CITY MASTER PLAN OF DRAINAGE - CONTINUED

The hydrologic data, presented in the Anaverde Creek Basin Hydrology Study, has been utilized in the evaluation of Master Plan facilities which impact the Palmdale Business Park Center Specific Plan. This report proposes additional modifications to the regional facilities which have been proposed in the Master Plan of Drainage and the Anaverde Creek Basin Hydrology Study. The modifications are more fully described within Section V (Developed Condition) of this report.

TABLE II-1

ANAVERDE BASIN REGIONAL FACILITY SIZES					
NODE US	NODE DS	Q_{50} (cfs)	L (ft)	S	SIZE
39C	40C	313	2100	.015	66"
40C	41BC	372	1200	.015	66"
41BC	44BD	706	1500	.015	84"
44BD	45AB	851	1200	.015	6x6.5T
45AB	56AB	1674	2750	.015	10x7 T
56AB	69AF	2225	1900	.006	14x8.5 T
69AF	70A	2566	1400	.006	16x8.5 T
70A	(110AB) 75A	2715	1550	.006	18x8.5 T
91EF	92E	282	1300	.015	60"
92E	93E	329	1400	.015	66"
93E	95BC	638	1250	.013	84"
95BC	96B	866	1400	.006	8x7 T
96B	97B	907	1100	.006	10x7 T
97B	108BD	1218	2800	.006	12x7 T
108BD	109B	1478	2700	.006	14x7 T
109B	110AB	1487	1000	.004	16x7 T
110AB	111A	4035	1750	.008	18x9 T
111A	112A	4035	1250	.008	18x9 T
112A	116AC	4041	2150	.004	20x10 T
116AC	119AD	4064	1200	.004	20x10 T
119AD	122AF	4098	3050	.007	20x10 T

TABLE II-1

ANAVERDE BASIN REGIONAL FACILITY SIZES (Continued)					
NODE US	NODE DS	Q_{50} (cfs)	L (ft)	S	SIZE
125B	126B	299	800	.02	60"
129BC	131BD	299	1200	.015	60"
131BD	132BD	374	1000	.015	66"
132B	133B	418	1500	.015	72"
133B	134B	487	1250	.015	78"
134B	141BD	576	500	.006	10x6 B
141BD	142B	862	1200	.006	12x6 B
142B	149BC	912	1250	.006	12x6 B
149BC	156BC	1240	2750	.005	14x7 B
156BC	163BC	1497	2650	.005	2-9x7 B
163BC	169BD	1734	2700	.005	2-9x8 B
169BC	171B	1766	2700	.004	2-9.5x8 B
172AB		5858			
235C	236C	52	1750	0.004	48"
236C	241CE	157	800	0.004	60"
241CE	243CD	279	1400	0.006	72"
243CD	244C	323	1300	0.0074	72"
244C	246CE	386	600	0.008	75"
246CE	247C	456	1300	0.008	78"
247C	249C	526	1800	0.008	84"
249C	253CE	574	2300	0.0078	90"

TABLE II-1

ANAVERDE BASIN REGIONAL
FACILITY SIZES
(Continued)

NODE US	NODE DS	Q_{50} (cfs)	L (ft)	S	SIZE
253CE	264CD	689	600	0.016	90"
264CD	265C	1026	3400	.0057	12.5x6 B
265C	266C	1049	2000	.0057	12.5x6 B
266C	275CE	1305	2600	.0057	9x8 T
275CE	278CF	1378	2000	.005	9x8 T
278CF	279AC	1424	2900	.006	11x8 T

12/16/92

B. Summary of the City Drainage Policy

The drainage policy of the City of Palmdale impacts all proposed development in several ways. These impacts include the following:

1. New developments must provide for the construction of regional facilities identified in the Master Plan of Drainage or must contribute to a fund to construct these facilities through the payment of Drainage Fees.

2. New developments must incorporate the construction of flood control basins to provide for storage of storm water run-off generating from the developed sites.

3. New developments must include provisions for elimination of nuisance flows which would otherwise leave the development as surface flows during dry weather conditions. Dry well systems and on-site containment are accepted mitigation measures for nuisance water management.

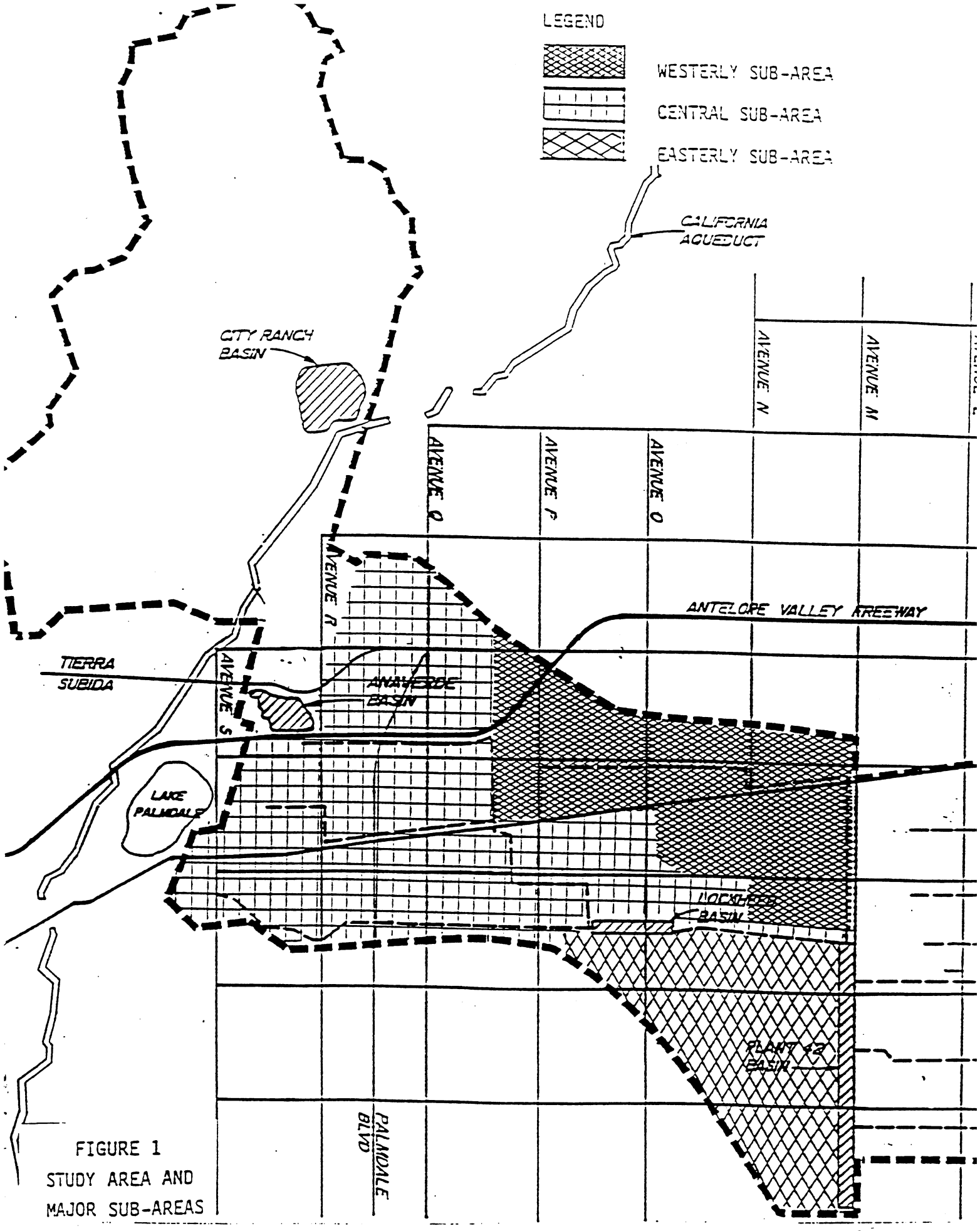


FIGURE 1
STUDY AREA AND
MAJOR SUB-AREAS

OURCE: ANAVERDE CREEK BASIN HYDROLOGY STUDY ANTELOPE VALLEY FREEWAY TO AIR FORCE PLANT 42 BASINS
PREPARED BY: A K M CONSULTING ENGINEERS - JULY 1992

ANAVERDE CREEK BASIN - 1992

CITY OF PALMDALE

DRAINAGE MASTER PLAN

LEGEND

PROJECT SITE

DRAINAGE MASTER PLAN – 198

MASTER PLAN FACILITIES

EXHIBIT II-1

1" = 1000'

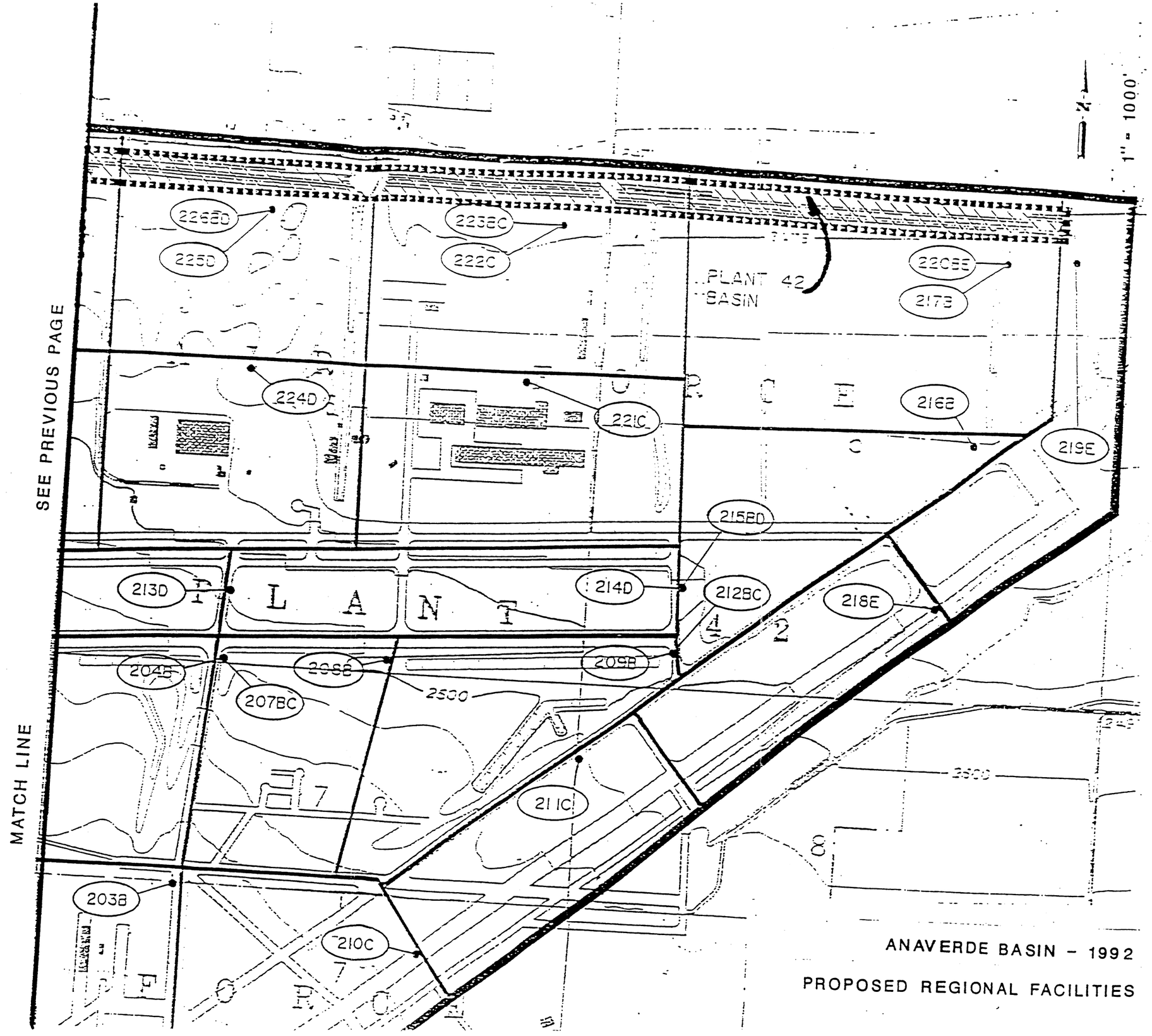
SEE NEXT PAGE

MATCH LINE

ANAVERDE BASIN – 1992

PROPOSED REGIONAL FACILITIES

EXHIBIT II-3



ANAVERDE BASIN - 1992

PROPOSED REGIONAL FACILITIES

III. SUMMARY

This report has been prepared to provide a preliminary hydrologic analysis of the proposed Palmdale Business Park Center Specific Plan. The findings contained herein are intended to provide a general overview of the drainage facilities which are required to develop this project and to provide a preliminary analysis of the master planned regional facilities which are affected, and/or required, due to this development.

The following is a brief summary of the findings identified in this preliminary study:

A) On-Site Infrastructure Facilities

1. Storm Drain

A storm drain system will be constructed to convey storm run-off from the internal street system to the proposed regional facilities. This storm drain system shall consist of catch basins and reinforced concrete pipe which shall be constructed within the public streets or within easements dedicated to the City of Palmdale.

All proposed on-site infrastructure storm drains shall be maintained by the City of Palmdale.

The preliminary design of these facilities has been based upon storm run-off generated by the 25-year storm.

2. Retention Facilities

All run-off which is tributary to the golf course area of the project is planned to be fully retained within this area. The tributary flows are generated from the off-site run-off which enters the golf course near the southeast corner, localized street drainage which shall be conveyed to the golf course through several parkway culvert systems and the golf course watershed itself.

The run-off volume which is tributary to the golf course, based upon a 50-year storm event, is estimated to be approximately 36 ac-ft. The capacity of the golf course is estimated to be approximately 118 ac-ft using a 50% capacity for storage at an average depth of 1 foot.

The developed portion of the project comprises approximately 396 acres. Utilizing a required detention volume of one acre foot per 5 acres of developed commercial land the estimated retention requirement for the entire project is approximately 80 ac-ft.

The golf course has retention capacity in excess of the

required 80 ac-ft, however, until downstream regional facilities are constructed to discharge regional flows into the unlined channel, only 36 ac-ft can be retained. The estimated balance of retention capacity, approximately 44 ac-ft, is proposed to be mitigated by incremental expansion of the Plant 42 Retention Basin and/or development of interim on-site retention facilities.

B. Master Plan Regional Facilities

As described in this report, modifications to the approved Palmdale Master Plan of Drainage and the supplemental Anaverde Creek Basin Hydrology Study have been proposed.

In summary, the peak capital flood run-off in the master planned RCB in Sierra Highway will ultimately be re-routed through this development through an unlined, low velocity, trapezoidal channel. Construction of this channel facility along with an underground pipe system in Avenue M will replace a portion of the RCB in Sierra Highway and the lined trapezoidal channel along the south side of Avenue M.

These modified regional facilities will be designed to safely convey the 50-year frequency regional flows to the Plant 42 Retention Basin while allowing adequate access to the proposed development.

The modified regional facilities, as identified in this report, should be incorporated into the Master Plan of Drainage for the City of Palmdale.

At this time, the Plant 42 Detention Facilities do not have the capacity to accept additional run-off. Any increase in run-off to the Plant 42 facilities, whether from the proposed Lockheed development or from the watershed upstream of the Lockheed development, will be required to mitigate impacts upon the Plant 42 facilities subject to the approval of the USAF and the City of Palmdale.

An option for incremental expansion of the Plant 42 Retention Basin is discussed in this report. If this incremental expansion option is selected then this expansion shall be constructed to the ultimate design of the Plant 42 Retention Basin facility. The proposed expansion shall be performed so as to satisfy the retention requirements of this development as well as to facilitate the hydraulic capability of the proposed master plan storm drain system.

As the modified regional drainage facilities will replace the previously approved regional drainage facilities the cost of these modified facilities may be credited against the Drainage Fees which the City of Palmdale assesses for each development. The details pertaining to fee credits and reimbursements for the construction of regional drainage facilities shall be defined in

SUMMARY - CONTINUED

a Development Agreement for the Palmdale Business Park Specific Plan.

The Development Agreement shall also address the potential fee credits and/or reimbursements associated with the proposed option for expansion of a portion of the Plant 42 Retention Basin to it's ultimate design.

IV. UNDEVELOPED CONDITION

A) Design Standards and Method of Analysis

The hydrology study for the existing undeveloped condition has been conducted utilizing the Modified Rational Method, developed by the Los Angeles County Flood Control District, in accordance with the Drainage Management Plan of the City of Palmdale. Hydrologic computations were made using the F0601 computer program.

As directed by the City of Palmdale, the soils type used for all hydraulic calculations was assumed to be Type 103, Zone I. This is consistent with the assumptions for soil type utilized in the City's Proposed Master Plan of Drainage for the Anaverde Basin.

The initial times of concentrations for each delineated sub-basin have been computed by utilizing the Time of Concentration Nomograph provided as Figure V-4 in the City of Palmdale Drainage Management Plan.

The existing undeveloped condition has been analyzed using a design frequency of a 50-year storm (Capital Flood).

Several localized depressions exist upon the site. In some cases the 50-year storm run-off which is tributary to these depressions is fully contained within these areas. The volumes of these depressions have been analyzed using the RETARD program, prepared by CIVILCADD/CIVILDESIGN. Generated output hydrographs from the F0601 program have been used as the input for the RETARD reservoir routing program and new hydrographs have been generated based upon the outflow characteristics of these existing basins.

B) Existing Condition

The proposed Palmdale Business Park Center is located within the Anaverde Creek Basin of the Master Plan of Drainage for the City of Palmdale. Currently, none of the proposed infrastructure facilities identified in th is Master Plan of Drainage have been constructed in the vicinity of this project.

Natural site drainage is generally towards the northeast. Existing drainage patterns have resulted in three significant on-site drainage courses as follows:

UNDEVELOPED CONDITIONS - CONTINUED

1. Drainage Area "A" - Storm flows from the westerly portion of the Anaverde Creek Basin are intercepted by an earthen swale which is located westerly of the project site, between Sierra Highway and the Southern Pacific Railroad. These flows then travel northerly in this earthen swale to a trestle crossing under the railroad and into the most northwesterly corner of the site approximately 400 feet south of Avenue M. These flows then travel northerly, within a natural swale, and exit the project through an arch-pipe culvert system, under Avenue M, which then discharges into an earthen channel northerly of Avenue M. Approximately 12.8 acres of the project is currently tributary to this drainage course.

   Existing peak on-site run-off within Area "A" have been computed to be 15 cfs for the 50-year storm.

2. Drainage Area "B" - The central portion of the project site, consisting of approximately 257 acres, slopes northeasterly to a low point on the southside of Avenue M which is located approximately 200' easterly of Challenger Way (10th Street East). An existing grated inlet/parkway culvert facility has been constructed at this location to convey run-off northerly, across Avenue M, into an existing natural watercourse.

   Existing peak run-off water Area "B" have been computed to be 91 cfs for the 50-year storm.

3. Drainage Area "C" - The eastern portion of the project site, consisting of approximately 312 acres, slopes northeasterly to a low point on the southside of Avenue M which is located immediately west of 15 Street East. An existing grated inlet/parkway culvert has been constructed at this location to convey run-off northerly, across Avenue M, into an existing natural watercourse.

   Existing peak run-off, for Area "C" including the off-site run-off described below, has been computed to be 142 cfs for the 50-year storm.

   Off-site drainage which is tributary to the site, other than described in Drainage Area A, is minimal. Sierra Highway and the Southern Pacific Railroad provide an effective barrier along the west boundary of the site. Run-off easterly of the site is contained within the Anaverde Creek facilities, which are located within the USAF Plant 42. Run-off from the south has been minimized by the construction of railroad and access road facilities,

within Plant 42, along the southerly boundary of the project. These facilities serve to divert the run-off from the south, easterly to a culvert under the railroad which is located approximately 800 feet west of the southeast corner of the project. This culvert system, consisting of two 18" RCP, the railroad embankment and the existing depression of the southside of this railroad serve as a detention basin. The total tributary run-off to this culvert has been computed to be 50 cfs. These flows are routed through this culvert system with a resultant maximum outflow of 21 cfs.

An additional 32 acres, located between the southerly property line and the railroad, confluences with the outflow of this culvert. The resultant confluenced flows have been computed to be 27 cfs for the 50-year storm. These flows currently overflow into the project site approximately 800' west of the southeast corner of the site.

The Summary Table for the undeveloped condition is shown on Table IV-1.

The Off-site Hydrology Map for the undeveloped condition is shown on Exhibit IV-1 and the On-site Hydrology Map for the undeveloped condition is shown on Exhibit IV-2.

TABLE IV-1

SUMMARY TABLE

- UNDEVELOPED CONDITION -

Descrition	Computer Node No.	Area (Ac)	Q50 (cfs)	Remarks
OFF-SITE	38BF	144	50	At ex.2-18" RCP under Railroad track
	47BC	32	27	At SE corner of P.L
ON-SITE				
Area "A"	4A	20	15	L.P on "M" avenue.
Area "B"	96BF	257	91	South of "M" avenue.
Area "C"	76BF	347	142	NE corner of Project.
Depres. Area				
No.1	78D	62	35	Water stored 100%
No.2	1A	4	4	"
No.3	19B	95	48	Assume continuously flow to downstream.

OFF-SITE HYDROLOGY CALCULATION

- UNDEVELOPED CONDITION -

50 YEAR STORM

SUMMARY TABLE
TIME OF CONCENTRATION CALCULATION

Based on : Time of Concentration Nomograph for Initial Area
Figure : V.4

Land use : Undeveloped condition

Location No.	Area (Ac)	Top El. (ft)	Bot. El. (ft)	H (ft)	Lenght (ft)	Tc (min)	
						Nomograph	Used
1A	8.0	2570.7	2557.0	13.7	830	17.5	17
2A	5.8	2560.0	2553.1	6.9	850	20.2	20
3A	5.1	2555.2	2549.5	5.7	700	19.0	19
4B	7.3	2567.2	2553.2	14.0	1000	19.5	20
5B	5.6	2557.5	2551.0	6.5	1000	22.7	23
6B	4.3	2552.5	2545.0	7.5	700	18.0	18
8C	8.2	2557.5	2544.5	13.0	1000	19.6	20
9C	6.2	2549.5	2541.0	8.5	1000	21.5	21
12D	6.0	2557.5	2546.7	10.8	1000	20.2	20
13D	10.8	2547.5	2535.8	11.7	1000	20.0	20
16E	5.8	2566.0	2549.0	17.0	1000	19.0	19
17E	8.0	2560.0	2545.8	14.2	1000	19.6	20
18E	10.0	2547.5	2540.5	7.0	900	21.1	21
19E	9.7	2542.3	2531.4	10.9	930	19.5	19
22F	4.9	2543.5	2533.5	10.0	1000	20.5	21
23F	3.4	2536.0	2527.8	8.2	860	19.5	19
26C	7.9	2546.5	2536.0	10.5	1000	20.0	20
27C	7.0	2535.0	2529.7	5.3	970	23.5	23
28C	8.3	2536.0	2523.7	12.3	1000	19.8	20
31D	10.0	2531.8	2517.5	14.3	1000	19.5	20
34E	10.0	2528.0	2513.5	14.5	1000	19.5	20
37F	11.0	2522.5	2513.4	9.1	700	18.0	18
40C	7.6	2552.5	2540.8	11.7	1000	20.0	20
41C	4.2	2545.6	2537.0	8.6	950	21.0	21
42C	3.5	2540.0	2532.4	7.6	900	21.0	21
43C	4.1	2534.0	2526.0	8.0	1000	22.0	22
44C	4.1	2528.0	2517.0	11.0	1000	20.0	20
45C	4.1	2520.3	2512.2	8.1	1000	21.8	22
46C	3.8	2518.2	2511.3	6.9	650	17.5	18

SUMMARY TABLE

OFF-SITE HYDROLOGY CALCULATION

- UNDEVELOPED CONDITION -

Location No.	Area (Ac)	Total Area (Ac)	Total Q50 (cfs)	Remarks	Location No.	Area (Ac)	Total Area (Ac)	Total Q50 (cfs)	Remarks
1A	8	8	9	Begin	25B	-	90	42	
2A	6	14	11		26C	8	8	7	Begin
3A	5	19	11	To Ex.18"RCP	27C	7	15	12	
4B	7	7	7	Begin	28C	8	23	17	End
5B	6	13	10		29BC	-	113	51	Confluenced
6B	4	17	10		30B	-	113	50	
7B	0	17	10	End	31D	10	10	9	Begin & End
8C	8	8	7	Begin	32BD	-	123	50	Confluenced
9C	6	14	12	End	33B	-	123	50	
10BC	-	31	18	Confluenced	34E	10	10	9	Begin & End
11B	-	31	17		35BE	-	133	50	Confluenced
12D	6	6	6	Begin	36B	-	133	49	
13D	11	17	14	End	37B	11	11	11	Begin & End
14BD	-	48	26	Confluenced	38BF	-	144	50	Confluenced
15B	-	48	23		39B	-	-	21	From 2-18"RCP
16E	6	6	6	Begin	40C	8	8	7	Begin
17E	8	14	13		41C	4	12	8	
18E	10	24	20		42C	4	16	6	
19E	10	34	23	End	43C	4	20	6	
20BE	-	82	42	Confluenced	44C	4	24	6	
21B	-	82	41		45C	4	28	6	
22F	5	5	4	Begin	46C	4	32	8	End
23F	3	8	7	End	47BC	-	32	27	To Bus. Park Center
24BF	-	90	43	Confluenced					

MODIFIED RATIONAL METHOD HYDROLOGY

LOCKHED BUSINESS PARK - FILE : LOCKHED STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1	1A	8.	9.	8.	9.	2	830.	.00470	.00	.00	0.	103	17	I50	.00
1	2A	6.	6.	14.	11.	2	680.	.00530	.00	.00	0.	103	20	I50	.00
1	3A	5.	5.	19.	11.	0	0.	.00000	.00	.00	0.	103	19	I50	.00
1	4B	7.	7.	7.	7.	2	450.	.00490	.00	.00	0.	103	20	I50	.00
1	5B	6.	5.	13.	10.	2	900.	.00780	.00	.00	0.	103	23	I50	.00
1	6B	4.	4.	17.	10.	3	700.	.00570	.00	.00	0.	103	18	I50	.00
1	7B	0.	0.	17.	9.	0	0.	.00000	.00	.00	0.	103	18	I50	.00
1	8C	8.	7.	8.	7.	2	450.	.00780	.00	.00	0.	103	20	I50	.00
1	9C	6.	5.	14.	12.	0	0.	.00000	.00	.00	0.	103	21	I50	.00

CONFLUENCE Q'S

1 10B TB 1181 QB 9. QBC 11. QC 1. 1 10C TC 1163 QC 12. QC3 16. QB 4.

1 10BC TBC 1170 QBC 18. QB 8. QC 11.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1	10BC	14.	12.	31.	18.	2	800.	.00650	.00	.00	0.	103	0	I50	.00
1	11B	0.	0.	31.	17.	0	0.	.00000	.00	.00	0.	103	21	I50	.00
1	12D	6.	6.	6.	6.	2	850.	.01280	.00	.00	0.	103	20	I50	.00
1	13D	11.	10.	17.	14.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

CONFLUENCE Q'S

1 14B TB 1176 QB 17. QBD 21. QD 4. 1 14D TD 1165 QD 14. QDB 24. QB 10.

1 14BD TBD 1169 QBD 26. QB 14. QD 13.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1	14BD	17.	14.	48.	26.	2	800.	.00550	.00	.00	0.	103	0	I50	.00
1	15B	0.	0.	48.	23.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
1	16E	6.	6.	6.	6.	2	300.	.01070	.00	.00	0.	103	19	I50	.00
1	17E	8.	7.	14.	13.	2	630.	.00750	.00	.00	0.	103	20	I50	.00
1	18E	10.	9.	24.	20.	2	920.	.01050	.00	.00	0.	103	21	I50	.00
1	19E	10.	10.	34.	23.	0	0.	.00000	.00	.00	0.	103	19	I50	.00

CONFLUENCE Q'S

1 20B TB 1175 QB 23. QBE 42. QE 18. 1 20E TE 1168 QE 23. QEB 39. QB 16.

1 20BE TBE 1175 QBE 42. QB 23. QE 18.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1	20BE	34.	23.	82.	42.	2	600.	.00600	.00	.00	0.	103	0	I50	.00
1	21B	0.	0.	82.	41.	0	0.	.00000	.00	.00	0.	103	19	I50	.00
1	22F	5.	4.	5.	4.	2	520.	.01100	.00	.00	0.	103	21	I50	.00
1	23F	3.	3.	8.	7.	0	0.	.00000	.00	.00	0.	103	19	I50	.00

MODIFIED RATIONAL METHOD HYDROLOGY

LOCKHED BUSINESS PARK - FILE : LOCKHED

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	STORM RAIN ZONE	DAY PCT IMPV
* CONFLUENCE Q'S														
* 1 24B TB 1179 QB	41. QBF	43. QF	2.	1 24F TF 1164 QF	7. QF3	25. QB	18.							
* 1 24BF TBF 1177 QBF	43. QB	40. QF	3.											
1 24BF	8.	7.	90.	43.	2	600.	.00680	.00	.00	0.	103	0	I50	.00
1 25B	0.	0.	90.	42.	0	0.	.00000	.00	.00	0.	103	19	I50	.00
1 26C	8.	7.	8.	7.	2	590.	.01260	.00	.00	0.	103	20	I50	.00
1 27C	7.	6.	15.	12.	2	660.	.00910	.00	.00	0.	103	23	I50	.00
1 28C	8.	7.	23.	17.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
* CONFLUENCE Q'S														
* 1 29B TB 1182 QB	42. QBC	48. QC	6.	1 29C TC 1168 QC	17. QC3	40. QB	22.							
* 1 29BC TBC 1178 QBC	51. QB	41. QC	10.											
1 29BC	23.	17.	113.	51.	2	700.	.00890	.00	.00	0.	103	0	I50	.00
1 30B	0.	0.	113.	50.	0	0.	.00000	.00	.00	0.	103	19	I50	.00
1 31D	10.	9.	10.	9.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
* CONFLUENCE Q'S														
* 1 32B TB 1183 QB	50. QBD	50. QD	0.	1 32D TD 1155 QD	9. QDB	16. QB	6.							
* 1 32BD TBD 1183 QBD	50. QB	50. QD	0.											
1 32BD	10.	9.	123.	50.	2	550.	.00730	.00	.00	0.	103	0	I50	.00
1 33B	0.	0.	123.	49.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
1 34E	10.	9.	10.	9.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
* CONFLUENCE Q'S														
* 1 35B TB 1186 QB	49. QBE	50. QE	0.	1 35E TE 1155 QE	9. QEB	17. QB	8.							
* 1 35BE TBE 1186 QBE	50. QB	49. QE	0.											
1 35BE	10.	9.	133.	50.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
1 36B	0.	0.	133.	50.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
1 37F	11.	11.	11.	11.	0	0.	.00000	.00	.00	0.	103	18	I50	.00

MODIFIED RATIONAL METHOD HYDROLOGY

LOCXHED BUSINESS PARK - FILE : LOCXHED

STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
				CONFLUENCE Q'S										
1 38B TB 1186 QB		50. QBF		50. QF		0.		1 38F TF 1155 QF		11. QF3		29. QB		17.
1 38BF TBF 1186 QBF		50. QB		50. QF		0.								

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1 38BF	11.	11.	144.	50.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
1 39B	0.	21.	0.	21.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
1 40C	8.	7.	8.	7.	2	950.	.00560	.00	.00	0.	103	20	I50	.00
1 41C	4.	4.	12.	8.	2	900.	.00340	.00	.00	0.	103	21	I50	.00
1 42C	4.	4.	16.	6.	2	1000.	.00640	.00	.00	0.	103	21	I50	.00
1 43C	4.	3.	20.	6.	2	1000.	.00900	.00	.00	0.	103	22	I50	.00
1 44C	4.	4.	24.	6.	2	1000.	.00480	.00	.00	0.	103	20	I50	.00
1 45C	4.	3.	28.	6.	2	350.	.00260	.00	.00	0.	103	22	I50	.00
1 46C	4.	4.	32.	8.	0	0.	.00000	.00	.00	0.	103	18	I50	.00
				CONFLUENCE Q'S										
1 47B TB 1208 QB		21. QBC		26. QC		5.		1 47C TC 1166 QC		8. QC3		25. QB		17.
1 47BC TBC 1227 QBC		27. QB		21. QC		6.								

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1 47BC	32.	8.	32.	27.	0	0.	.00000	.00	.00	0.	103	0	I50	.00

* INPUT HYDROGRAPH (See page no. for detailed calculation) FOR FLOOD ROUTING THRU THE EXIST. 2-18" RCP UNDER RAILROAD TRACK.

FILE: LOCKHCD. HYD

```
7     1   38B    144. 721186      50.200  4
8  5   0.       0. 100.      3. 200.      3. 300.      3. 400.      3.
8 10 500.       3. 600.      3. 700.      4. 800.      4. 900.      4.
8 151000.       4.1050.      5.1100.      5.1110.      5.1120.      5.
8 201130.       6.1131.      6.1132.      6.1133.      6.1134.      6.
8 251135.       6.1136.      6.1137.      6.1138.      6.1139.      6.
8 301140.       6.1141.      6.1142.      6.1143.      6.1144.      7.
8 351145.       7.1146.      7.1147.      8.1148.      8.1149.     10.
8 401150.      12.1151.     15.1152.     22.1153.     26.1154.     27.
8 451155.      29.1156.     30.1157.     32.1158.     33.1159.     34.
8 501160.      35.1161.     36.1162.     37.1163.     37.1164.     38.
8 551165.      39.1166.     39.1167.     40.1168.     40.1169.     40.
8 601170.      37.1171.     37.1172.     36.1173.     36.1174.     38.
8 651175.      38.1176.     39.1177.     41.1178.     42.1179.     43.
8 701180.      44.1181.     46.1182.     47.1183.     48.1184.     49.
8 751185.      50.1186.     50.1187.     50.1188.     50.1189.     49.
8 801190.      49.1191.     48.1192.     47.1193.     46.1194.     45.
8 851195.      44.1196.     42.1197.     41.1198.     40.1199.     39.
8 901200.      38.1201.     36.1202.     35.1203.     34.1204.     33.
8 951205.      32.1206.     30.1207.     29.1208.     28.1209.     27.
81001210.      26.1211.     26.1212.     25.1213.     24.1214.     23.
81051215.      22.1216.     22.1217.     21.1218.     20.1219.     20.
81101220.      19.1221.     18.1222.     18.1223.     17.1224.     17.
81151225.      16.1226.     16.1227.     15.1228.     15.1229.     15.
81201230.      14.1231.     14.1232.     13.1233.     13.1234.     13.
81251235.      12.1236.     12.1237.     12.1238.     11.1239.     11.
81301240.      11.1241.     11.1242.     10.1243.     10.1244.     10.
81351245.      10.1246.      9.1247.      9.1248.      9.1249.      9.
81401250.       8.1251.      8.1252.      8.1253.      8.1254.      8.
81451255.       8.1256.      7.1257.      7.1258.      7.1259.      7.
81501260.       7.1261.      7.1262.      7.1263.      6.1264.      6.
81551265.       6.1266.      6.1267.      6.1268.      6.1269.      6.
81601270.       6.1271.      6.1272.      6.1273.      6.1274.      5.
81651275.       5.1276.      5.1277.      5.1278.      5.1279.      5.
81701280.       5.1281.      5.1282.      5.1283.      5.1284.      5.
81751285.       5.1286.      5.1287.      5.1288.      5.1289.      5.
81801290.       5.1291.      5.1292.      4.1293.      4.1294.      4.
81851295.       4.1296.      4.1297.      4.1298.      4.1299.      4.
81901300.       4.1310.      4.1320.      4.1330.      4.1340.      4.
81951350.       4.1360.      4.1370.      4.1380.      4.1390.      4.
82001400.       3.1420.      3.1440.      3.1460.      3.1500.      3.
```

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1991 Version 2.0

Study Date : 12/18/92 Input hydrograph file name : LOCKHED.HYD
Output hydrograph file name: PLAN1.rtd
LOCKHEED BUSINESS PARK CENTER - FLOOD ROUTING - 50 YEAR STORM
FLOOD ROUTING THRU EXISTING 2-18" RCP UNDER RAILROAD TRACK
FILE : PLAN1 INPUT HYDROGRAPH : LOCKHED.HYD
PETER DUK DEC. 18-1992

Church Engineering, 2501 Alton Ave., Irvine, CA - S/N 602

User entry of depth-outflow-storage data

Hydrograph time unit varies
Initial depth in storage basin = 0.00(Ft.)

Initial basin depth = 0.00 (Ft.)
Initial basin storage = 0.00 (Ac.Ft)
Initial basin outflow = 0.00 (CFS)

Depth vs. Storage and Depth vs. Discharge data @ 1 Min. Intervals:

Basin Depth (Ft.)	Storage (Ac.Ft)	Outflow (CFS)	(S-O*dt/2) (Ac.Ft)	(S+O*dt/2) (Ac.Ft)
0.000	0.000	0.000	0.000	0.000
1.700	0.134	16.000	0.123	0.145
2.700	3.664	26.000	3.646	3.682

Hydrograph Detention Basin Routing
Hydrograph at 1 38 B Storm Day: 4 Drainage Area = 144.00
Total flood hydrograph volume this storm day = 11.15 Ac. Ft.

Graph values: 'I'= unit inflow; 'O'=outflow at time shown

Time (Min)	Inflow (CFS)	Outflow (CFS)	Storage (Ac.Ft)	.0	12.5	25.1	37.6	50.1	Depth (Ft.)
0	0.0	0.0	0.000	O	|	|	|	|	0.0
100	3.1	2.9	0.025	IO	|	|	|	|	0.3
200	3.0	3.0	0.025	IO	|	|	|	|	0.3
300	3.0	3.0	0.025	IO	|	|	|	|	0.3
400	3.0	3.0	0.025	IO	|	|	|	|	0.3
500	3.0	3.0	0.025	IO	|	|	|	|	0.3
600	3.1	3.1	0.026	IO	|	|	|	|	0.3
700	4.0	4.0	0.033	I O	|	|	|	|	0.4
800	4.0	4.0	0.033	I O	|	|	|	|	0.4
900	4.0	4.0	0.033	I O	|	|	|	|	0.4
1000	4.0	4.0	0.033	I O	|	|	|	|	0.4
1050	5.1	5.0	0.042	I O	|	|	|	|	0.5
1100	5.0	5.0	0.042	I O	|	|	|	|	0.5
1110	5.0	5.0	0.042	I O	|	|	|	|	0.5
1120	5.0	5.0	0.042	I O	|	|	|	|	0.5
1130	6.0	5.5	0.046	I O	|	|	|	|	0.6
1131	6.1	5.6	0.047	I O	|	|	|	|	0.6
1132	6.0	5.7	0.048	I O	|	|	|	|	0.6
1133	6.0	5.7	0.048	I O	|	|	|	|	0.6
1134	6.0	5.8	0.048	I O	|	|	|	|	0.6

1138	6.0	5.9	0.049	O					0.6
1139	6.0	5.9	0.050	O					0.6
1140	6.0	5.9	0.050	O					0.6
1141	6.1	6.0	0.050	O					0.6
1142	6.0	6.0	0.050	O					0.6
1143	6.0	6.0	0.050	O					0.6
1144	7.0	6.1	0.051	OI					0.7
1145	7.0	6.3	0.052	OI					0.7
1146	7.1	6.4	0.054	O					0.7
1147	8.0	6.6	0.056	OI					0.7
1148	8.0	6.8	0.057	OI					0.7
1149	10.0	7.3	0.061	O I					0.8
1150	12.0	8.0	0.067	O I					0.9
1151	15.1	9.1	0.076	O	I				1.0
1152	22.0	11.1	0.093	O	I				1.2
1153	26.0	13.3	0.112	O	I				1.4
1154	27.0	15.4	0.129	O	I				1.6
1155	29.0	16.0	0.147	O	I				1.7
1156	30.1	16.1	0.167	O	I				1.7
1157	32.0	16.2	0.189	O	I				1.7
1158	33.0	16.2	0.212	O	I				1.7
1159	34.0	16.3	0.236	O	I				1.7
1160	35.0	16.4	0.262	O	I				1.7
1161	36.1	16.4	0.289	O	I				1.7
1162	37.0	16.5	0.317	O	I				1.8
1163	37.0	16.6	0.345	O	I				1.8
1164	38.0	16.7	0.375	O	I				1.8
1165	39.0	16.8	0.406	O	I				1.8
1166	39.1	16.9	0.436	O	I				1.8
1167	40.0	16.9	0.468	O	I				1.8
1168	40.0	17.0	0.500	O	I				1.8
1169	40.0	17.1	0.531	O	I				1.8
1170	37.0	17.2	0.559	O	I				1.8
1171	37.1	17.3	0.586	O	I				1.8
1172	36.0	17.4	0.612	O	I				1.8
1173	36.0	17.4	0.637	O	I				1.8
1174	38.0	17.5	0.666	O	I				1.9
1175	38.0	17.6	0.694	O	I				1.9
1176	39.1	17.7	0.723	O	I				1.9
1177	41.0	17.8	0.755	O	I				1.9
1178	42.0	17.9	0.789	O	I				1.9
1179	43.0	18.0	0.823	O	I				1.9
1180	44.0	18.1	0.859	O	I				1.9
1181	46.1	18.2	0.898	O	I				1.9
1182	47.0	18.3	0.937	O	I				1.9
1183	48.0	18.4	0.978	O	I				1.9
1184	49.0	18.5	1.020	O	I				2.0
1185	50.0	18.6	1.064	O	I				2.0
1186	50.1	18.8	1.107	O	I				2.0
1187	50.0	18.9	1.150	O	I				2.0
1188	50.0	19.0	1.193	O	I				2.0
1189	49.0	19.1	1.234	O	I				2.0
1190	49.0	19.2	1.275	O	I				2.0
1191	48.1	19.3	1.315	O	I				2.0
1192	47.0	19.5	1.353	O	I				2.0
1193	46.0	19.6	1.389	O	I				2.1
1194	45.0	19.7	1.424	O	I				2.1
1195	44.0	19.7	1.458	O	I				2.1
1196	42.1	19.8	1.488	O	I				2.1
1197	41.0	19.9	1.518	O	I				2.1
1198	40.0	20.0	1.545	O	I				2.1

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1202  35.0  20.3  1.638  |         |   O     |      I  |         |  2.1
1203  34.0  20.3  1.657  |         |   O     |    I    |         |  2.1
1204  33.0  20.4  1.675  |         |    O    |    I    |         |  2.1
1205  32.0  20.4  1.691  |         |    O    |   I     |         |  2.1
1206  30.1  20.4  1.704  |         |    O    |  I      |         |  2.1
1207  29.0  20.5  1.716  |         |    O    | I       |         |  2.1
1208  28.0  20.5  1.726  |         |    O    |I        |         |  2.2
1209  27.0  20.5  1.735  |         |    O    |I        |         |  2.2
1210  26.0  20.6  1.743  |         |    O    I         |         |  2.2
1211  26.1  20.6  1.750  |         |    O    I         |         |  2.2
1212  25.0  20.6  1.756  |         |    O  I |         |         |  2.2
1213  24.0  20.6  1.761  |         |    O  I |         |         |  2.2
1214  23.0  20.6  1.764  |         |    OI   |         |         |  2.2
1215  22.0  20.6  1.766  |         |    OI   |         |         |  2.2
1216  22.1  20.6  1.768  |         |    OI   |         |         |  2.2
1217  21.0  20.6  1.769  |         |    O    |         |         |  2.2
1218  20.0  20.6  1.768  |         |   IO    |         |         |  2.2
1219  20.0  20.6  1.767  |         |   IO    |         |         |  2.2
1220  19.0  20.6  1.765  |         |   IO    |         |         |  2.2
1221  18.1  20.6  1.761  |         |  I O    |         |         |  2.2
1222  18.0  20.6  1.758  |         |  I O    |         |         |  2.2
1223  17.0  20.6  1.753  |         | I  O    |         |         |  2.2
1224  17.0  20.6  1.748  |         | I  O    |         |         |  2.2
1225  16.0  20.6  1.742  |         | I  O    |         |         |  2.2
1226  16.1  20.5  1.735  |         | I  O    |         |         |  2.2
1227  15.0  20.5  1.728  |         |I   O    |         |         |  2.2
1228  15.0  20.5  1.720  |         |I   O    |         |         |  2.1
1229  15.0  20.5  1.713  |         |I   O    |         |         |  2.1
1230  14.0  20.4  1.704  |         I    O    |         |         |  2.1
1231  14.1  20.4  1.695  |         |I   O    |         |         |  2.1
1232  13.0  20.4  1.685  |         I    O    |         |         |  2.1
1233  13.0  20.4  1.675  |         I    O    |         |         |  2.1
1234  13.0  20.3  1.665  |         I   O     |         |         |  2.1
1235  12.0  20.3  1.653  |        I|   O     |         |         |  2.1
1236  12.1  20.3  1.642  |        I|   O     |         |         |  2.1
1237  12.0  20.2  1.631  |        I|   O     |         |         |  2.1
1238  11.0  20.2  1.618  |        I|   O     |         |         |  2.1
1239  11.0  20.2  1.605  |        I|   O     |         |         |  2.1
1240  11.0  20.1  1.593  |        I|   O     |         |         |  2.1
1241  11.1  20.1  1.580  |        I|   O     |         |         |  2.1
1242  10.0  20.1  1.566  |       I |   O     |         |         |  2.1
1243  10.0  20.0  1.552  |       I |   O     |         |         |  2.1
1244  10.0  20.0  1.539  |       I |   O     |         |         |  2.1
1245  10.0  19.9  1.525  |       I |   O     |         |         |  2.1
1246   9.1  19.9  1.510  |     I   |   O     |         |         |  2.1
1247   9.0  19.9  1.495  |     I   |   O     |         |         |  2.1
1248   9.0  19.8  1.480  |     I   |   O     |         |         |  2.1
1249   9.0  19.8  1.465  |     I   |   O     |         |         |  2.1
1250   8.0  19.7  1.449  |     I   |   O     |         |         |  2.1
1251   8.1  19.7  1.433  |     I   |   O     |         |         |  2.1
1252   8.0  19.6  1.417  |     I   |   O     |         |         |  2.1
1253   8.0  19.6  1.401  |     I   |   O     |         |         |  2.1
1254   8.0  19.5  1.385  |     I   |   O     |         |         |  2.1
1255   8.0  19.5  1.369  |     I   |   O     |         |         |  2.0
1256   7.1  19.5  1.352  |    I    |   O     |         |         |  2.0
1257   7.0  19.4  1.335  |    I    |   O     |         |         |  2.0
1258   7.0  19.4  1.318  |    I    |   O     |         |         |  2.0
1259   7.0  19.3  1.301  |    I    |   O     |         |         |  2.0
1260   7.0  19.3  1.284  |    I    |   O     |         |         |  2.0
1261   7.1  19.2  1.268  |    I    |   O     |         |         |  2.0
1262   7.0  19.2  1.251  |    I    |   O     |         |         |  2.0
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1266	6.1	19.0	1.179	I	O				2.0
1267	6.0	18.9	1.161	I	O				2.0
1268	6.0	18.9	1.143	I	O				2.0
1269	6.0	18.8	1.126	I	O				2.0
1270	6.0	18.8	1.108	I	O				2.0
1271	6.1	18.7	1.091	I	O				2.0
1272	6.0	18.7	1.073	I	O				2.0
1273	6.0	18.6	1.056	I	O				2.0
1274	5.0	18.6	1.037	I	O				2.0
1275	5.0	18.5	1.019	I	O				2.0
1276	5.1	18.5	1.000	I	O				1.9
1277	5.0	18.4	0.982	I	O				1.9
1278	5.0	18.3	0.963	I	O				1.9
1279	5.0	18.3	0.945	I	O				1.9
1280	5.0	18.2	0.927	I	O				1.9
1281	5.1	18.2	0.909	I	O				1.9
1282	5.0	18.1	0.890	I	O				1.9
1283	5.0	18.1	0.872	I	O				1.9
1284	5.0	18.0	0.854	I	O				1.9
1285	5.0	18.0	0.836	I	O				1.9
1286	5.1	17.9	0.819	I	O				1.9
1287	5.0	17.9	0.801	I	O				1.9
1288	5.0	17.8	0.783	I	O				1.9
1289	5.0	17.8	0.766	I	O				1.9
1290	5.0	17.7	0.748	I	O				1.9
1291	5.1	17.7	0.731	I	O				1.9
1292	4.0	17.6	0.712	I	O				1.9
1293	4.0	17.6	0.693	I	O				1.9
1294	4.0	17.5	0.674	I	O				1.9
1295	4.0	17.5	0.656	I	O				1.8
1296	4.1	17.4	0.637	I	O				1.8
1297	4.0	17.4	0.619	I	O				1.8
1298	4.0	17.3	0.601	I	O				1.8
1299	4.0	17.3	0.582	I	O				1.8
1300	4.0	17.2	0.564	I	O				1.8
1310	4.1	16.7	0.386	I	O				1.8
1320	4.0	16.2	0.215	I	O				1.7
1330	4.0	9.2	0.077	I O					1.0
1340	4.0	5.0	0.042	IO					0.5
1350	4.0	4.2	0.035	O					0.4
1360	4.1	4.1	0.034	O					0.4
1370	4.0	4.1	0.034	O					0.4
1380	4.0	4.0	0.034	O					0.4
1390	4.0	4.0	0.034	O					0.4
1400	3.0	3.5	0.029	IO					0.4
1420	3.1	3.1	0.026	O					0.3
1440	3.0	3.0	0.025	O					0.3
1460	3.0	3.0	0.025	O					0.3
1500	3.0	2.5	0.021	O					0.3

Remaining water in basin = 0.02 (Ac.Ft)

Peak flow out of basin = 20.63(CFS)

Peak flow time = 1217 Min., time interval # = 103

Maximum depth in basin = 2.16(Ft.)

FLOW TO ON-SITE BUSINESS PARK CENTER AT NODE 42 J

ON-SITE HYDROLOGY CALCULATION

- UNDEVELOPED CONDITION -

50 YEAR STORM

ON-SITE HYDROLOGY CALCULATION

- AREA "A" & "B" -

SUMMARY TABLE
TIME OF CONCENTRATION CALCULATION

Based on : Time of Concentration Nomograph for Initial Area (Figure V.4)

Land Use : Undeveloped condition - File : Onsite.sum

Location No.	Area (Ac)	Top El. (ft)	Bot. El. (ft)	H (ft)	Lenght (ft)	Tc (min) Nomograph	Used
1A	2.8	2542.0	2532.0	10.0	1000	20.5	20
2A	4.3	2538.0	2528.5	9.5	1000	21.0	21
3A	5.7	2534.0	2524.0	10.0	1000	20.5	21
4B	7.2	2528.5	2521.3	7.2	950	21.5	21
5B	7.8	2532.0	2521.1	10.9	1000	20.0	20
7C	4.1	2536.2	2527.0	9.2	850	19.0	19
8C	6.6	2535.2	2525.0	10.2	1000	20.5	21
9C	4.6	2526.8	2520.8	6.0	620	17.5	18
10C	8.0	2528.0	2519.2	8.8	1000	21.5	22
12B	7.2	2520.5	2515.0	5.5	1000	23.0	23
14D	8.0	2544.2	2535.2	9.0	1000	21.0	21
16E	8.6	2543.0	2534.0	9.0	1000	21.0	21
17E	6.8	2536.4	2528.6	7.8	770	18.7	19
20F	6.4	2539.0	2530.0	9.0	1000	21.0	21
21F	4.4	2534.5	2526.4	8.1	850	19.7	20
23D	6.4	2534.5	2524.8	9.7	1000	21.0	21
24D	5.4	2528.0	2519.6	8.4	900	20.0	20
25D	3.5	2528.0	2519.0	9.0	900	20.0	20
26D	1.4	2520.4	2518.0	2.4	320	14.0	14
27E	3.6	2536.4	2527.4	9.0	1000	21.0	21
28E	3.3	2528.8	2519.6	9.2	1000	21.0	21
31D	1.5	2519.0	2515.0	4.0	400	15.0	15
33E	3.3	2534.7	2523.8	10.9	1000	20.0	20
34E	3.8	2528.0	2519.2	8.8	1000	21.5	22
35E	3.0	2520.0	2513.6	6.4	1000	23.0	23
38F	6.5	2539.6	2529.6	10.0	1000	20.5	21
39F	4.4	2534.7	2525.1	9.6	1000	21.0	21
40F	2.9	2526.0	2519.0	7.0	1000	22.5	23
41F	10.6	2520.3	2511.9	8.4	950	21.0	21

AREA "A"

AREA "B"

45B	7.7	2518.0	2508.9	9.1	1000	21.0	21
47C	3.9	2546.4	2539.6	6.8	800	19.7	20
48C	3.7	2548.1	2538.6	9.5	1000	21.0	21
50D	4.0	2551.3	2543.0	8.3	1000	21.8	22
51D	3.2	2544.0	2536.0	8.0	800	19.0	19
53C	5.7	2544.5	2534.0	10.5	1000	20.0	20
54C	7.9	2537.5	2527.0	10.5	930	19.5	20
55C	10.6	2529.5	2522.0	7.5	850	20.0	20
56C	10.8	2524.9	2517.8	7.1	900	21.0	21
57C	9.3	2520.3	2513.3	7.0	800	19.7	20
59D	6.4	2518.7	2510.9	7.8	800	19.0	19
63D	4.2	2550.6	2539.1	11.5	1000	20.0	20
64D	2.8	2540.6	2533.4	7.2	630	17.0	17
65E	2.9	2551.3	2541.2	10.1	1000	20.5	21
69F	5.0	2551.3	2540.0	11.3	1000	20.0	20
70F	9.0	2543.5	2533.4	10.1	920	19.5	20
72D	6.8	2538.0	2529.5	8.5	1000	21.5	22
73D	3.2	2534.4	2525.0	9.4	1000	21.0	21
74D	3.1	2534.0	2521.0	13.0	900	19.0	19
75D	5.4	2528.5	2513.0	15.5	800	16.7	17
76D	6.1	2525.2	2510.0	15.2	850	17.5	18
77D	6.0	2519.7	2506.9	12.8	850	18.0	18
78D	7.6	2524.1	2506.9	17.2	600	14.0	14
80D	10.1	2518.0	2506.9	11.1	950	19.7	20
82C	8.8	2515.0	2505.0	10.0	1000	20.5	21
83C	6.4	2511.0	2502.0	9.0	700	17.2	17
86D	1.0	2518.0	2505.5	12.5	1000	19.5	20
90E	7.1	2518.0	2509.0	9.0	870	19.5	20
94F	4.0	2512.3	2506.2	6.1	680	18.0	18
95F	10.7	2510.0	2499.5	10.5	800	18.0	18

AREA "B"

SUMMARY TABLE

ON-SITE HYDROLOGY CALCULATION

- UNDEVELOPED CONDITION -

Location No.	Area (Ac)	Total Area (Ac)	Total Q50 (cfs)	Remarks	Location No.	Area (Ac)	Total Area (Ac)	Total Q50 (cfs)	Remarks
1A	3	3	3	Begin	50D	4	4	3	Begin
2A	4	7	6		51D	3	7	5	End
3A	6	13	10		52CD	-	15	12	Confluenced
4A	7	20	15	Low Point At "M" Ave.	53C	6	21	16	
5B	8	8	7	Begin	54C	8	29	19	
6B	-	8	6		55C	11	40	22	
7C	4	4	4	Begin	56C	11	51	26	
8C	7	11	10		57C	9	60	28	
9C	5	16	13		58C	-	60	27	
10C	8	24	18	End	59D	6	6	6	Begin & End
11BC	-	32	24	Confluenced	60D	-	6	5	
12B	7	39	25		61CD	-	66	31	Confluenced
13B	-	39	22		62C	-	66	31	
14D	8	8	7	Begin	63D	4	4	4	Begin
15D	-	8	6	End	64D	3	7	6	End
16E	9	9	8	Begin	65E	3	3	3	Begin
17E	7	16	13	End	66E	-	3	2	End
18DE	-	24	20	Confluenced	67DE	-	10	8	Confluenced
19D	-	24	19		68D	-	10	8	
20F	6	6	5	Begin	69F	5	5	5	Begin
21F	5	11	9	End	70F	9	14	11	End
22DF	-	35	28	Confluenced	71DF	-	24	19	Confluenced
23D	6	41	32		72D	7	31	23	
24D	6	47	31		73D	3	34	24	
25D	4	51	31		74D	3	37	25	
26D	1	52	30		75D	5	42	24	
27E	4	4	4	Begin	76D	6	48	26	
28E	3	7	5		77D	6	54	30	
29E	-	7	5	End	78D	8	62	35	

AREA "B"

30DE	-	59	34	Confluenced	79D	Stored 100% in Depression Area No. 1			
31D	2	61	34		80D	10	10	9	Begin & End
32D	-	61	34		81CD	-	76	36	Confluenced
33E	3	3	3	Begin	82C	9	85	40	
34E	4	7	5		83C	6	91	39	
35E	3	10	6	End	848C	-	234	89	Confluenced
36DE	-	71	38	Confluenced	85B	-	234	89	
37D	-	71	37		86D	1	1	1	Begin
38F	7	7	6	Begin	87D	-	1	1	End
39F	4	11	8		888D	-	235	90	Confluenced
40F	3	14	8		89B	-	235	90	
41F	11	25	11	End	90E	7	7	7	Begin
42DF	-	96	45	Confluenced	91E	-	7	6	End
43D	-	96	45		92BE	-	242	90	Confluenced
44BD	-	135	66	Confluenced	93B	-	242	90	
45B	8	143	66		94F	4	4	4	Begin
46B	-	143	65		95F	11	15	14	
47C	4	4	4	Begin	96BF	-	257	91	Confluenced
48C	4	8	7	End					
49C	-	8	7	End					

AREA "A"

MODIFIED RATIONAL METHOD HYDROLOGY

LOCKHEED BUSINESS PARK - EXIST. CONDITION - LOCHED3 STORM DAY =

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	1A	3.	3.	3.	3.	2	480.	.00730	.00	.00	0.	103	20	I50	.00
2	2A	4.	4.	7.	6.	2	430.	.01050	.00	.00	0.	103	21	I50	.00
2	3A	6.	5.	13.	10.	2	430.	.00630	.00	.00	0.	103	21	I50	.00
2	4A	7.	6.	20.	15.	0	0.	.00000	.00	.00	0.	103	21	I50	.00
2	5B	8.	7.	8.	7.	2	650.	.00290	.00	.00	0.	103	20	I50	.00
2	6B	0.	0.	8.	6.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
2	7C	4.	4.	4.	4.	2	280.	.00710	.00	.00	0.	103	19	I50	.00
2	8C	7.	6.	11.	10.	2	530.	.00790	.00	.00	0.	103	21	I50	.00
2	9C	5.	5.	16.	13.	2	430.	.00370	.00	.00	0.	103	18	I50	.00
2	10C	8.	7.	24.	18.	0	0.	.00000	.00	.00	0.	103	22	I50	.00

CONFLUENCE Q'S

* 2 11B TB 1174 QB 6. QBC 19. QC 13. 2 11C TC 1170 QC 18. QC3 24. QB 6.
* 2 11BC TBC 1170 QBC 24. QB 6. QC 18.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	11BC	24.	18.	32.	24.	2	600.	.00700	.00	.00	0.	103	0	I50	.00
2	12B	7.	6.	39.	25.	2	720.	.00430	.00	.00	0.	103	23	I50	.00
2	13B	0.	0.	39.	22.	0	0.	.00000	.00	.00	0.	103	23	I50	.00
2	14D	8.	7.	8.	7.	2	700.	.00940	.00	.00	0.	103	21	I50	.00
2	15D	0.	0.	8.	6.	0	0.	.00000	.00	.00	0.	103	21	I50	.00
2	16E	9.	8.	9.	8.	2	600.	.00900	.00	.00	0.	103	21	I50	.00
2	17E	7.	7.	16.	13.	0	0.	.00000	.00	.00	0.	103	19	I50	.00

CONFLUENCE Q'S

* 2 18D TD 1169 QD 6. QDE 18. QE 12. 2 18E TE 1164 QE 13. QED 19. QD 6.
* 2 18DE TDE 1166 QDE 20. QD 6. QE 13.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	18DE	16.	13.	24.	20.	2	360.	.00610	.00	.00	0.	103	0	I50	.00
2	19D	0.	0.	24.	19.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
2	20F	6.	5.	6.	5.	2	420.	.00860	.00	.00	0.	103	21	I50	.00
2	21F	5.	5.	11.	9.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

CONFLUENCE Q'S

* 2 22D TD 1169 QD 19. QDF 28. QF 8. 2 22F TF 1163 QF 9. QFD 25. QD 15.
* 2 22DF TDF 1168 QDF 28. QD 19. QF 9.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	22DF	11.	9.	35.	28.	2	270.	.00590	.00	.00	0.	103	0	I50	.00
2	23D	6.	5.	41.	32.	2	660.	.00790	.00	.00	0.	103	21	I50	.00
2	24D	6.	6.	47.	31.	2	180.	.00330	.00	.00	0.	103	20	I50	.00
2	25D	4.	4.	51.	31.	2	250.	.00400	.00	.00	0.	103	20	I50	.00

MODIFIED RATIONAL METHOD HYDROLOGY

LOCKHEED BUSINESS PARK - EXIST. CONDITION - LOCHED3

STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2 26D	1.	1.	52.	30.	0	0.	.00000	.00	.00	0.	103	14	I50	.00
2 27E	4.	4.	4.	4.	2	920.	.00850	.00	.00	0.	103	21	I50	.00
2 28E	3.	3.	7.	5.	2	230.	.00700	.00	.00	0.	103	21	I50	.00
2 29E	0.	0.	7.	5.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

CONFLUENCE Q'S

2 30D TD 1177 QD 30. QDE 34. QE 3. 2 30E TE 1171 QE 5. QED 31. QD 26.

2 30DE TDE 1178 QDE 34. QD 30. QE 4.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2 30DE	7.	5.	59.	34.	2	400.	.00750	.00	.00	0.	103	0	I50	.00
2 31D	2.	3.	61.	34.	2	300.	.00470	.00	.00	0.	103	15	I50	.00
2 32D	0.	0.	61.	34.	0	0.	.00000	.00	.00	0.	103	15	I50	.00
2 33E	3.	3.	3.	3.	2	580.	.00790	.00	.00	0.	103	20	I50	.00
2 34E	4.	3.	7.	5.	2	790.	.00710	.00	.00	0.	103	22	I50	.00
2 35E	3.	2.	10.	6.	0	0.	.00000	.00	.00	0.	103	23	I50	.00

CONFLUENCE Q'S

2 36D TD 1182 QD 34. QDE 37. QE 4. 2 36E TE 1171 QE 6. QED 26. QD 19.

2 36DE TDE 1181 QDE 38. QD 33. QE 4.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2 36DE	10.	6.	71.	38.	2	320.	.00530	.00	.00	0.	103	0	I50	.00
2 37D	0.	0.	71.	37.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
2 38F	7.	6.	7.	6.	2	660.	.00680	.00	.00	0.	103	21	I50	.00
2 39F	4.	4.	11.	8.	2	870.	.00700	.00	.00	0.	103	21	I50	.00
2 40F	3.	2.	14.	8.	2	920.	.00770	.00	.00	0.	103	23	I50	.00
2 41F	11.	10.	25.	11.	0	0.	.00000	.00	.00	0.	103	21	I50	.00

CONFLUENCE Q'S

2 42D TD 1184 QD 37. QDF 45. QF 7. 2 42F TF 1164 QF 11. QFD 22. QD 11.

2 42DF TDF 1184 QDF 45. QD 37. QF 7.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2 42DF	25.	11.	96.	45.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
2 43D	0.	0.	96.	45.	0	0.	.00000	.00	.00	0.	103	21	I50	.00

CONFLUENCE Q'S

2 44B TB 1180 QB 22. QBD 64. QD 42. 2 44D TD 1184 QD 45. QDB 66. QB 21.

2 44BD TBD 1183 QBD 66. QB 21. QD 45.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

MODIFIED RATIONAL METHOD HYDROLOGY

LOCKHEED BUSINESS PARK - EXIST. CONDITION - LOCHED3 STORM DAY =

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	44BD	96.	45.	135.	66.	2	490.	.00740	.00	.00	0.	103	0	I50	.00
2	45B	8.	7.	143.	66.	2	730.	.00950	.00	.00	0.	103	21	I50	.00
2	46B	0.	0.	143.	65.	0	0.	.00000	.00	.00	0.	103	21	I50	.00
2	47C	4.	4.	4.	4.	2	250.	.00400	.00	.00	0.	103	20	I50	.00
2	48C	4.	4.	8.	7.	2	350.	.00740	.00	.00	0.	103	21	I50	.00
2	49C	0.	0.	8.	7.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
2	50D	4.	3.	4.	3.	2	800.	.00880	.00	.00	0.	103	22	I50	.00
2	51D	3.	3.	7.	5.	0	0.	.00000	.00	.00	0.	103	19	I50	.00

CONFLUENCE Q'S

2 52C TC 1167 QC 7. QCD 12. QD 5. 2 52D TD 1167 QD 5. QDC 12. QC 7.

2 52CD TCD 1167 QCD 12. QC 7. QD 5.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	52CD	7.	5.	15.	12.	2	140.	.01430	.00	.00	0.	103	0	I50	.00
2	53C	6.	6.	21.	16.	2	820.	.00850	.00	.00	0.	103	20	I50	.00
2	54C	8.	7.	29.	19.	2	670.	.00750	.00	.00	0.	103	20	I50	.00
2	55C	11.	10.	40.	22.	2	620.	.00680	.00	.00	0.	103	20	I50	.00
2	56C	11.	10.	51.	26.	2	680.	.00660	.00	.00	0.	103	21	I50	.00
2	57C	9.	8.	60.	28.	2	550.	.01160	.00	.00	0.	103	20	I50	.00
2	58C	0.	0.	60.	27.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
2	59D	6.	6.	6.	6.	2	480.	.00830	.00	.00	0.	103	19	I50	.00
2	60D	0.	0.	6.	5.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

CONFLUENCE Q'S

2 61C TC 1173 QC 27. QCD 31. QD 4. 2 61D TD 1165 QD 5. QDC 24. QC 19.

2 61CD TCD 1172 QCD 31. QC 27. QD 5.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	61CD	6.	5.	66.	31.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
2	62C	0.	0.	66.	31.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
2	63D	4.	4.	4.	4.	2	600.	.00950	.00	.00	0.	103	20	I50	.00
2	64D	3.	3.	7.	6.	0	0.	.00000	.00	.00	0.	103	17	I50	.00
2	65E	3.	3.	3.	3.	2	750.	.01040	.00	.00	0.	103	21	I50	.00
2	66E	0.	0.	3.	2.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

CONFLUENCE Q'S

2 67D TD 1164 QD 6. QDE 8. QE 2. 2 67E TE 1171 QE 2. QED 6. QD 3.

2 67DE TDE 1165 QDE 8. QD 6. QE 2.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	67DE	3.	2.	10.	8.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
2	68D	0.	0.	10.	8.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

MODIFIED RATIONAL METHOD HYDROLOGY

LOCKHEED BUSINESS PARK - EXIST. CONDITION - LOCHED3

STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	69F	5.	5.	5.	5.	2	800.	.00830	.00	.00	0.	103	20	I50	.00
2	70F	9.	8.	14.	11.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

CONFLUENCE Q'S

2 71D TD 1165 QD 8. QDF 19. QF 11. 2 71F TF 1165 QF 11. QFD 19. QD 8.

2 71DF TDF 1165 QDF 19. QD 8. QF 11.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	71DF	14.	11.	24.	19.	2	630.	.00620	.00	.00	0.	103	0	I50	.00
2	72D	7.	6.	31.	23.	2	400.	.01130	.00	.00	0.	103	22	I50	.00
2	73D	3.	3.	34.	24.	2	220.	.01820	.00	.00	0.	103	21	I50	.00
2	74D	3.	3.	37.	25.	2	560.	.01430	.00	.00	0.	103	19	I50	.00
2	75D	5.	6.	42.	24.	2	210.	.01430	.00	.00	0.	103	17	I50	.00
2	76D	6.	6.	48.	26.	2	100.	.02000	.00	.00	0.	103	18	I50	.00
2	77D	6.	6.	54.	30.	0	0.	.00000	.00	.00	0.	103	18	I50	.00
* 2	78D	8.	11.	62.	35.	0	0.	.00000	.00	.00	0.	103	14	I50	.00
2	79D	0.	0.	0.	0.	2	600.	.00600	.00	.00	0.	103	20	I50	.00
2	80D	10.	9.	10.	9.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

CONFLUENCE Q'S

2 81C TC 1172 QC 31. QCD 33. QD 1. 2 81D TD 1155 QD 9. QDC 17. QC 7.

2 81CD TCD 1170 QCD 36. QC 30. QD 6.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	81CD	10.	9.	76.	36.	2	400.	.00480	.00	.00	0.	103	0	I50	.00
2	82C	9.	8.	85.	40.	2	370.	.00810	.00	.00	0.	103	21	I50	.00
2	83C	6.	7.	91.	39.	0	0.	.00000	.00	.00	0.	103	17	I50	.00

CONFLUENCE Q'S

2 84B TB 1190 QB 65. QBC 89. QC 24. 2 84C TC 1173 QC 39. QCB 75. QB 35.

2 84BC TBC 1189 QBC 89. QB 64. QC 25.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	84BC	91.	39.	234.	89.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
2	85B	0.	0.	234.	89.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
2	86D	1.	1.	1.	1.	2	330.	.01060	.00	.00	0.	103	20	I50	.00
2	87D	0.	0.	1.	1.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

CONFLUENCE Q'S

2 88B TB 1189 QB 89. QBD 90. QD 0. 2 88D TD 1164 QD 1. QDB 55. QB 54.

2 88BD TBD 1189 QBD 90. QB 89. QD 0.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

* INPUT HYDROGRAPH FOR DEPRESSION AREA N° 1 CALCULATION.
(See page N° for hydrograph detailed Calculation and page n°: Item) for depression Area Calculation.

MODIFIED RATIONAL METHOD HYDROLOGY

LOCKHEED BUSINESS PARK - EXIST. CONDITION - LOCHED3

STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	88BD	1.	1.	235.	90.	2	330.	.00760	.00	.00	0.	103	0	I50	.00
2	89B	0.	0.	235.	90.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
2	90E	7.	7.	7.	7.	2	780.	.01220	.00	.00	0.	103	20	I50	.00
2	91E	0.	0.	7.	6.	0	0.	.00000	.00	.00	0.	103	20	I50	.00

CONFLUENCE Q'S

2 92B TB 1191 QB 90. QBE 90. QE 1. 2 92E TE 1168 QE 6. QE3 66. QB 60.

2 92BE TBE 1191 QBE 90. QB 90. QE 1.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	92BE	7.	6.	242.	90.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
2	93B	0.	0.	242.	90.	0	0.	.00000	.00	.00	0.	103	20	I50	.00
2	94F	4.	4.	4.	4.	2	670.	.01000	.00	.00	0.	103	18	I50	.00
2	95F	11.	11.	15.	14.	0	0.	.00000	.00	.00	0.	103	18	I50	.00

CONFLUENCE Q'S

2 96B TB 1191 QB 90. QBF 91. QF 1. 2 96F TF 1161 QF 14. QF3 53. QB 40.

2 96BF TBF 1190 QBF 91. QB 90. QF 1.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
2	96BF	15.	14.	257.	91.	0	0.	.00000	.00	.00	0.	103	0	I50	.00

FILE: PLAIN3.HYD

```
7     2   780     62. 691163     35.200  4
3  5   0.      0. 100.      2. 200.      2. 300.      2. 400.      2.
3 10 500.      2. 600.      2. 700.      2. 800.      2. 900.      2.
3 151000.      2.1050.      2.1100.      3.1110.      3.1120.      3.
3 201130.      3.1131.      3.1132.      3.1133.      3.1134.      3.
3 251135.      3.1136.      3.1137.      3.1138.      3.1139.      3.
3 301140.      3.1141.      3.1142.      4.1143.      4.1144.      4.
3 351145.      4.1146.      5.1147.      5.1148.      6.1149.      7.
3 401150.      9.1151.     13.1152.     21.1153.     26.1154.     29.
3 451155.     30.1156.     31.1157.     32.1158.     32.1159.     33.
3 501160.     34.1161.     34.1162.     35.1163.     35.1164.     35.
3 551165.     35.1166.     31.1167.     31.1162.     30.1169.     29.
3 601170.     26.1171.     24.1172.     24.1173.     24.1174.     24.
3 651175.     25.1176.     25.1177.     24.1178.     24.1179.     23.
3 701180.     22.1181.     21.1182.     20.1183.     19.1184.     18.
3 751185.     17.1186.     16.1187.     15.1188.     15.1189.     14.
3 801190.     13.1191.     12.1192.     12.1193.     11.1194.     11.
3 851195.     10.1196.     10.1197.      9.1198.      9.1199.      8.
3 901200.      8.1201.      7.1202.      7.1203.      6.1204.      6.
3 951205.      6.1206.      6.1207.      5.1208.      5.1209.      5.
81001210.      5.1211.      4.1212.      4.1213.      4.1214.      4.
81051215.      4.1216.      4.1217.      3.1218.      3.1219.      3.
81101220.      3.1221.      3.1222.      3.1223.      3.1224.      3.
81151225.      3.1226.      3.1227.      3.1228.      3.1229.      3.
81201230.      3.1231.      2.1232.      2.1233.      2.1234.      2.
81251235.      2.1236.      2.1237.      2.1238.      2.1239.      2.
81301240.      2.1241.      2.1242.      2.1243.      2.1244.      2.
81351245.      2.1246.      2.1247.      2.1248.      2.1249.      2.
81401250.      2.1251.      2.1252.      2.1253.      2.1254.      2.
81451255.      2.1256.      2.1257.      2.1258.      2.1259.      2.
81501260.      2.1261.      2.1262.      2.1263.      2.1264.      2.
81551265.      2.1266.      2.1267.      2.1268.      2.1269.      2.
81601270.      2.1271.      2.1272.      2.1273.      2.1274.      2.
81651275.      2.1276.      2.1277.      2.1278.      2.1279.      2.
81701280.      2.1281.      2.1282.      2.1283.      2.1284.      2.
81751285.      2.1286.      2.1287.      2.1288.      2.1289.      2.
81801290.      2.1291.      2.1292.      2.1293.      2.1294.      2.
81851295.      2.1296.      2.1297.      2.1298.      2.1299.      2.
81901300.      2.1310.      2.1320.      2.1330.      2.1340.      2.
81951350.      2.1360.      2.1370.      2.1380.      2.1390.      2.
82001400.      2.1420.      2.1440.      2.1460.      2.1500.      2.
```

AREA: 62.0 Ac.
VOLUME: 5.77 Ac-Ft.

CIVILCADD/CIVILDESIGN Engineering Software. (c) 1991 Version 2.0

Study Date : 12/15/92 Input hydrograph file name : PLAIN3.HYD /
Output hydrograph file name: PLAIN4.rtd
CHECK CAPACITY OF THE EXIST. BASIN AT MIDDLE OF THE PROJECT SITE
PALMDALE BUSINESS PARK CENTER - LOCKHEED PROJECT
FILE : PLAIN4 - DEPRESSION AREA Nº 1

Church Engineering. 2501 Alton Ave.. Irvine. CA - S/N 602

Program computation of outflow v. depth

****

CALCULATED OUTFLOW DATA AT DEPTH = 1.10(Ft.)

****

Total outflow at this depth = 0.00(CFS)

****

CALCULATED OUTFLOW DATA AT DEPTH = 3.10(Ft.)

****

Total outflow at this depth = 0.00(CFS)

****

CALCULATED OUTFLOW DATA AT DEPTH = 3.60(Ft.)

****

Total outflow at this depth = 0.00(CFS)

****

CALCULATED OUTFLOW DATA AT DEPTH = 5.10(Ft.)

****

Weir capacity using equation Q = CLH^Exp(Using Feet as units)
Weir Length = 30.00(Ft.) C value = 3.00 Exp = 1.50
Weir flow: Depth = H = 1.50(Ft.) Flow = 165.34 (CFS)

Total outflow at this depth = 165.34(CFS)

Hydrograph time unit varies
Initial depth in storage basin = 0.00(Ft.)

Initial basin depth = 0.00 (Ft.)
Initial basin storage = 0.00 (Ac.Ft)
Initial basin outflow = 0.00 (CFS)

Depth vs. Storage and Depth vs. Discharge data @ 1 Min. Intervals:

1.100	0.783	0.000	0.783	0.783
3.100	5.209	0.000	5.209	5.209
3.600	6.314	0.000	6.314	6.314
5.100	13.401	165.341	13.287	13.515

Hydrograph Detention Basin Routing

Hydrograph at 2 78 0 Storm Day: 4 Drainage Area = 62.00

Total flood hydrograph volume this storm day = 5.77 Ac. Ft.

Graph values: 'I'= unit inflow: 'O'=outflow at time shown

Time (Min)	Inflow (CFS)	Outflow (CFS)	Storage (Ac.Ft)	.0	8.8	17.5	26.3	35.0	Depth (Ft.)
0	0.0	0.0	0.000	0	:	:	:	:	0.0
100	2.0	0.0	0.139	0I	:	:	:	:	0.2
200	2.0	0.0	0.415	0I	:	:	:	:	0.6
300	2.0	0.0	0.690	0I	:	:	:	:	1.0
400	2.0	0.0	0.966	0I	:	:	:	:	1.2
500	2.0	0.0	1.241	0I	:	:	:	:	1.3
600	2.0	0.0	1.517	0I	:	:	:	:	1.4
700	2.0	0.0	1.792	0I	:	:	:	:	1.6
800	2.0	0.0	2.067	0I	:	:	:	:	1.7
900	2.0	0.0	2.343	0I	:	:	:	:	1.8
1000	2.0	0.0	2.618	0I	:	:	:	:	1.9
1050	2.0	0.0	2.756	0I	:	:	:	:	2.0
1100	3.0	0.0	2.928	0 I	:	:	:	:	2.1
1110	3.0	0.0	2.970	0 I	:	:	:	:	2.1
1120	3.0	0.0	3.011	0 I	:	:	:	:	2.1
1130	3.0	0.0	3.052	0 I	:	:	:	:	2.1
1131	3.0	0.0	3.057	0 I	:	:	:	:	2.1
1132	3.0	0.0	3.061	0 I	:	:	:	:	2.1
1133	3.0	0.0	3.065	0 I	:	:	:	:	2.1
1134	3.0	0.0	3.069	0 I	:	:	:	:	2.1
1135	3.0	0.0	3.073	0 I	:	:	:	:	2.1
1136	3.0	0.0	3.077	0 I	:	:	:	:	2.1
1137	3.0	0.0	3.081	0 I	:	:	:	:	2.1
1138	3.0	0.0	3.086	0 I	:	:	:	:	2.1
1139	3.0	0.0	3.090	0 I	:	:	:	:	2.1
1140	3.0	0.0	3.094	0 I	:	:	:	:	2.1
1141	3.0	0.0	3.098	0 I	:	:	:	:	2.1
1142	4.0	0.0	3.103	0 I	:	:	:	:	2.1
1143	4.0	0.0	3.108	0 I	:	:	:	:	2.2
1144	4.0	0.0	3.114	0 I	:	:	:	:	2.2
1145	4.0	0.0	3.119	0 I	:	:	:	:	2.2
1146	5.0	0.0	3.126	0 I	:	:	:	:	2.2
1147	5.0	0.0	3.133	0 I	:	:	:	:	2.2
1148	6.0	0.0	3.141	0 I	:	:	:	:	2.2
1149	7.0	0.0	3.151	0 I	:	:	:	:	2.2
1150	9.0	0.0	3.163	0 I	:	:	:	:	2.2
1151	13.0	0.0	3.181	0 I	:	:	:	:	2.2
1152	21.0	0.0	3.205	0 I	:	:	:	:	2.2
1153	26.0	0.0	3.241	0 I	:	:	:	:	2.2
1154	29.0	0.0	3.281	0 I	:	:	:	:	2.2
1155	30.0	0.0	3.322	0 I	:	:	:	:	2.2
1156	31.0	0.0	3.365	0 I	:	:	:	:	2.3
1157	32.0	0.0	3.409	0 I	:	:	:	:	2.3
1158	32.0	0.0	3.453	0 I	:	:	:	:	2.3
1159	33.0	0.0	3.498	0 I	:	:	:	:	2.3
1160	34.0	0.0	3.545	0 I	:	:	:	:	2.3
1161	34.0	0.0	3.592	0 I	:	:	:	:	2.4
1162	35.0	0.0	3.639	0 I	:	:	:	:	2.4

1167	31.0	0.0	3.369	0	:	:	:	I	:	:	2.5
1168	30.0	0.0	3.911	0	:	:	:	I	:	:	2.5
1169	29.0	0.0	3.951	0	:	:	:	I	:	:	2.5
1170	26.0	0.0	3.986	0	:	:	I	:	:	:	2.5
1171	24.0	0.0	4.020	0	:	:	I	:	:	:	2.6
1172	24.0	0.0	4.053	0	:	:	I	:	:	:	2.6
1173	24.0	0.0	4.086	0	:	:	I	:	:	:	2.6
1174	24.0	0.0	4.119	0	:	:	I	:	:	:	2.6
1175	25.0	0.0	4.153	0	:	:	I	:	\	:	2.6
1176	25.0	0.0	4.188	0	:	:	I	:	:	:	2.6
1177	24.0	0.0	4.221	0	:	:	I	:	:	:	2.7
1178	24.0	0.0	4.254	0	:	:	I	:	:	:	2.7
1179	23.0	0.0	4.286	0	:	:	I	:	:	:	2.7
1180	22.0	0.0	4.316	0	:	:	I	:	:	:	2.7
1181	21.0	0.0	4.345	0	:	:	I	:	:	:	2.7
1182	20.0	0.0	4.373	0	:	:	I	:	:	:	2.7
1183	19.0	0.0	4.400	0	:	:	I	:	:	:	2.7
1184	18.0	0.0	4.424	0	:	:	I	:	:	:	2.7
1185	17.0	0.0	4.448	0	:	:	I	:	:	:	2.8
1186	16.0	0.0	4.470	0	:	:	I	:	:	:	2.8
1187	15.0	0.0	4.491	0	:	:	I	:	:	:	2.8
1188	15.0	0.0	4.512	0	:	:	I	:	:	:	2.8
1189	14.0	0.0	4.531	0	:	:	I	:	:	:	2.8
1190	13.0	0.0	4.549	0	:	I	:	:	:	:	2.8
1191	12.0	0.0	4.565	0	:	I	:	:	:	:	2.8
1192	12.0	0.0	4.582	0	:	I	:	:	:	:	2.8
1193	11.0	0.0	4.597	0	:	I	:	:	:	:	2.8
1194	11.0	0.0	4.612	0	:	I	:	:	:	:	2.8
1195	10.0	0.0	4.626	0	:	I	:	:	:	:	2.8
1196	10.0	0.0	4.640	0	:	I	:	:	:	:	2.8
1197	9.0	0.0	4.653	0	:	I	:	:	:	:	2.8
1198	9.0	0.0	4.665	0	:	I	:	:	:	:	2.9
1199	8.0	0.0	4.676	0	:	I	:	:	:	:	2.9
1200	8.0	0.0	4.687	0	:	I	:	:	:	:	2.9
1201	7.0	0.0	4.697	0	:	I	:	:	:	:	2.9
1202	7.0	0.0	4.707	0	:	I	:	:	:	:	2.9
1203	6.0	0.0	4.715	0	:	I	:	:	:	:	2.9
1204	6.0	0.0	4.723	0	:	I	:	:	:	:	2.9
1205	6.0	0.0	4.731	0	:	I	:	:	:	:	2.9
1206	6.0	0.0	4.740	0	:	I	:	:	:	:	2.9
1207	5.0	0.0	4.747	0	:	I	:	:	:	:	2.9
1208	5.0	0.0	4.754	0	:	I	:	:	:	:	2.9
1209	5.0	0.0	4.761	0	:	I	:	:	:	:	2.9
1210	5.0	0.0	4.768	0	:	I	:	:	:	:	2.9
1211	4.0	0.0	4.773	0	I	:	:	:	:	:	2.9
1212	4.0	0.0	4.779	0	I	:	:	:	:	:	2.9
1213	4.0	0.0	4.784	0	I	:	:	:	:	:	2.9
1214	4.0	0.0	4.790	0	I	:	:	:	:	:	2.9
1215	4.0	0.0	4.795	0	I	:	:	:	:	:	2.9
1216	4.0	0.0	4.801	0	I	:	:	:	:	:	2.9
1217	3.0	0.0	4.806	0	I	:	:	:	:	:	2.9
1218	3.0	0.0	4.810	0	I	:	:	:	:	:	2.9
1219	3.0	0.0	4.814	0	I	:	:	:	:	:	2.9
1220	3.0	0.0	4.818	0	I	:	:	:	:	:	2.9
1221	3.0	0.0	4.822	0	I	:	:	:	:	:	2.9
1222	3.0	0.0	4.826	0	I	:	:	:	:	:	2.9
1223	3.0	0.0	4.830	0	I	:	:	:	:	:	2.9
1224	3.0	0.0	4.835	0	I	:	:	:	:	:	2.9
1225	3.0	0.0	4.839	0	I	:	:	:	:	:	2.9
1226	3.0	0.0	4.843	0	I	:	:	:	:	:	2.9
1227	3.0	0.0	4.847	0	I	:	:	:	:	:	2.9
1228	3.0	0.0	4.851	0	I	:	:	:	:	:	2.9

1232	2.0	0.0	4.365	0I					2.9
1233	2.0	0.0	4.368	0I					2.9
1234	2.0	0.0	4.370	0I					2.9
1235	2.0	0.0	4.373	0I					2.9
1236	2.0	0.0	4.376	0I					2.9
1237	2.0	0.0	4.379	0I					3.0
1238	2.0	0.0	4.381	0I					3.0
1239	2.0	0.0	4.384	0I					3.0
1240	2.0	0.0	4.387	0I					3.0
1241	2.0	0.0	4.390	0I					3.0
1242	2.0	0.0	4.392	0I					3.0
1243	2.0	0.0	4.395	0I					3.0
1244	2.0	0.0	4.398	0I					3.0
1245	2.0	0.0	4.401	0I					3.0
1246	2.0	0.0	4.403	0I					3.0
1247	2.0	0.0	4.406	0I					3.0
1248	2.0	0.0	4.409	0I					3.0
1249	2.0	0.0	4.412	0I					3.0
1250	2.0	0.0	4.414	0I					3.0
1251	2.0	0.0	4.417	0I					3.0
1252	2.0	0.0	4.420	0I					3.0
1253	2.0	0.0	4.423	0I					3.0
1254	2.0	0.0	4.425	0I					3.0
1255	2.0	0.0	4.428	0I					3.0
1256	2.0	0.0	4.431	0I					3.0
1257	2.0	0.0	4.434	0I					3.0
1258	2.0	0.0	4.436	0I					3.0
1259	2.0	0.0	4.439	0I					3.0
1260	2.0	0.0	4.442	0I					3.0
1261	2.0	0.0	4.445	0I					3.0
1262	2.0	0.0	4.447	0I					3.0
1263	2.0	0.0	4.450	0I					3.0
1264	2.0	0.0	4.453	0I					3.0
1265	2.0	0.0	4.456	0I					3.0
1266	2.0	0.0	4.458	0I					3.0
1267	2.0	0.0	4.461	0I					3.0
1268	2.0	0.0	4.464	0I					3.0
1269	2.0	0.0	4.467	0I					3.0
1270	2.0	0.0	4.469	0I					3.0
1271	2.0	0.0	4.472	0I					3.0
1272	2.0	0.0	4.475	0I					3.0
1273	2.0	0.0	4.478	0I					3.0
1274	2.0	0.0	4.481	0I					3.0
1275	2.0	0.0	4.483	0I					3.0
1276	2.0	0.0	4.486	0I					3.0
1277	2.0	0.0	4.489	0I					3.0
1278	2.0	0.0	4.492	0I					3.0
1279	2.0	0.0	4.494	0I					3.0
1280	2.0	0.0	4.497	0I					3.0
1281	2.0	0.0	5.000	0I					3.0
1282	2.0	0.0	5.003	0I					3.0
1283	2.0	0.0	5.005	0I					3.0
1284	2.0	0.0	5.008	0I					3.0
1285	2.0	0.0	5.011	0I					3.0
1286	2.0	0.0	5.014	0I					3.0
1287	2.0	0.0	5.016	0I					3.0
1288	2.0	0.0	5.019	0I					3.0
1289	2.0	0.0	5.022	0I					3.0
1290	2.0	0.0	5.025	0I					3.0
1291	2.0	0.0	5.027	0I					3.0
1292	2.0	0.0	5.030	0I					3.0
1293	2.0	0.0	5.033	0I					3.0
1294	2.0	0.0	5.036	0I					3.0

1299	2.0	0.0	5.049	OI	:	:	:	:	3.0
1300	2.0	0.0	5.052	OI	:	:	:	:	3.0
1310	2.0	0.0	5.080	OI	:	:	:	:	3.0
1320	2.0	0.0	5.107	OI	:	:	:	:	3.1
1330	2.0	0.0	5.135	OI	:	:	:	:	3.1
1340	2.0	0.0	5.162	OI	:	:	:	:	3.1
1350	2.0	0.0	5.190	OI	:	:	:	:	3.1
1360	2.0	0.0	5.217	OI	:	:	:	:	3.1
1370	2.0	0.0	5.245	OI	:	:	:	:	3.1
1380	2.0	0.0	5.273	OI	:	:	:	:	3.1
1390	2.0	0.0	5.300	OI	:	:	:	:	3.1
1400	2.0	0.0	5.328	OI	:	:	:	:	3.1
1420	2.0	0.0	5.383	OI	:	:	:	:	3.2
1440	2.0	0.0	5.438	OI	:	:	:	:	3.2
1460	2.0	0.0	5.493	OI	:	:	:	:	3.2
1500	2.0	0.0	5.600	OI	:	:	:	:	3.2

Remaining water in basin = 5.60 (Ac.Ft)
Peak flow out of basin = 0.00(CFS)
Peak flow time = 0 Min.. time interval # = 69
Maximum depth in basin = 3.22(Ft.)

∴ WATER CONTRIBUTES TO THIS DEPRESSION WILL BE STORED 100%.

ON-SITE HYDROLOGY CALCULATION

- AREA "C" -

SUMMARY TABLE
TIME OF CONCENTRATION CALCULATION

Based on : Time of Concentration Nomograph for Initial Area (Figure V.4)

Land Use : Undeveloped condition - File : 20NSITE.SUM

Location No.	Area (Ac)	Top El. (ft)	Bot. El. (ft)	H (ft)	Lenght (ft)	Tc (min) Nomograph	Used
1A	3.9	2538.8	2531.3	7.5	650	17.0	17
2B	4.4	2542.0	2535.5	6.5	1000	23.0	23
3A	9.2	2536.7	2525.0	11.7	1000	20.0	20
4B	10.0	2536.0	2523.2	12.8	1000	19.8	20
5B	2.4	2526.5	2520.0	6.5	750	19.0	19
6C	6.0	2536.8	2525.6	11.2	1000	20.0	20
7C	9.1	2532.0	2520.0	12.0	1000	20.0	20
9B	8.1	2526.4	2516.0	10.4	950	20.0	20
10B	9.0	2524.1	2512.4	11.7	1000	20.0	20
11D	9.6	2532.5	2519.6	12.9	1000	19.6	20
12D	4.0	2528.0	2518.0	10.0	1000	20.5	20
16E	9.4	2523.0	2512.4	10.6	1000	20.0	20
18B	5.0	2518.5	2509.8	8.7	800	18.6	19
19B	10.0	2517.0	2506.1	10.9	1000	20.0	20
21F	5.3	2518.6	2506.2	12.4	1000	19.8	20
22F	5.7	2512.0	2501.0	11.0	1000	20.0	20
24B	8.9	2505.0	2491.0	14.0	1000	19.5	20
25C	4.5	2530.0	2520.0	10.0	1000	20.5	21
26C	3.5	2526.5	2519.0	7.5	1000	22.0	22
27C	7.5	2525.0	2512.0	13.0	1000	19.6	20
28C	6.4	2522.0	2511.3	10.7	1000	20.0	20
29C	6.9	2520.5	2506.8	13.7	1000	19.6	20
30C	8.3	2513.0	2503.0	10.0	1000	20.0	20
31D	7.1	2520.0	2506.0	14.0	1000	19.5	20
34C	1.8	2506.2	2502.3	3.9	440	15.5	15
35E	5.6	2513.0	2503.2	9.8	1000	20.5	20
38C	7.7	2510.5	2498.5	12.0	1000	20.0	20
39C	9.2	2506.0	2495.3	10.7	1000	20.0	20
40F	7.2	2518.5	2507.6	10.9	1000	20.5	20

41F	9.7	2508.2	2499.7	8.5	1000	21.5	21
44D	10.1	2517.1	2508.5	8.6	930	20.5	20
45D	9.7	2511.5	2506.0	6.5	770	19.5	20
46D	5.2	2512.1	2502.0	10.1	1000	20.0	20
50E	3.3	2509.0	2499.7	9.3	1000	21.0	21
52D	8.0	2504.0	2498.3	5.7	1000	23.3	23
55C	9.5	2502.1	2492.6	9.5	1000	20.5	20
56C	8.9	2505.0	2491.0	14.0	1000	19.5	20
58B	5.7	2504.2	2489.8	14.4	1000	19.5	20
59B	5.8	2499.0	2486.2	12.8	1000	19.6	20
60D	2.7	2517.1	2505.8	11.3	1000	20.0	20
61D	3.6	2508.0	2498.8	9.2	1000	21.0	21
62D	3.2	2502.1	2492.3	9.8	1000	21.0	21
63D	1.7	2494.5	2487.9	6.6	400	13.5	14
67E	6.6	2513.0	2502.9	10.1	1000	20.5	20
68E	5.7	2507.0	2497.0	10.0	1000	20.0	20
69E	10.2	2500.5	2486.2	14.3	1000	19.5	20
72F	8.1	2512.3	2500.0	12.3	900	18.7	19
73F	7.2	2505.0	2497.0	8.0	750	18.3	18
74F	6.3	2504.0	2491.0	13.0	1000	19.6	20

SUMMARY TABLE

ON-SITE HYDROLOGY CALCULATION

- UNDEVELOPED CONDITION -

Location No.	Area (Ac)	Total Area (Ac)	Total Q50 (cfs)	Remarks	Location No.	Area (Ac)	Total Area (Ac)	Total Q50 (cfs)	Remarks
1A	4	4	4	Begin & End	38C	8	60	41	
2B	4	4	3	Begin	39C	9	69	41	
3B	9	13	10		40F	7	7	7	Begin
4B	10	23	18		41F	10	17	12	End
5B	2	25	19	End	42D	-	32	27	From Off-site
6C	6	6	6	Begin	43D	-	32	27	
7C	9	15	12	End	44D	10	42	33	
88C	-	40	31	Confluenced	45D	10	52	40	
9B	8	48	36		46D	5	57	44	
10B	9	57	39	End	47D	-	57	44	
11D	10	10	9	Begin	480F	-	74	56	Confluenced
12D	4	14	12		49D	-	74	54	
13D	-	14	11	End	50E	3	3	3	Begin & End
14BD	-	71	51	Confluenced	51DE	-	77	54	Confluenced
15B	-	71	48		52D	8	85	59	
16E	9	9	8	Begin & End	53D	-	85	58	
17BE	-	80	49	Confluenced	54CD	-	154	97	Confluenced
18B	5	85	48		55C	10	164	96	
19B	10	95	48		56C	-	164	96	
20B	-	95	46		57BC	-	279	130	Confluenced
21F	5	5	5	Begin	58B	6	285	130	
22F	6	11	9	End	59B	6	291	128	
23BF	-	106	47	Confluenced	60D	3	3	3	Begin
24B	9	115	46		61D	4	7	5	
25C	5	5	4	Begin	62D	3	10	5	
26C	3	8	7		63D	2	12	6	
27C	8	16	13		64D	-	12	5	
28C	6	22	18		65BD	-	303	132	Confluenced

29C	7	29	23		66B	-	303	132	
30C	8	37	29	End	67E	7	7	7	Begin
31D	7	7	7	Begin	68E	6	13	11	
32D	-	7	6	End	69E	10	23	17	End
33CD	-	44	34	Confluenced	70BE	-	326	136	
34C	2	46	34		71B	-	326	136	
35E	6	6	6	Begin	72F	8	8	8	Begin
36E	-	6	5	End	73F	7	15	14	
37CE	-	52	39	Confluenced	74F	6	21	18	
					75F	-	21	17	End
					76BF	-	347	142	Confluenced
					77B	-	347	142	

FILE: INPUTHYD.HYZ

```
7     3   42D      32.1131227      27.200  4
8  5   0.       0. 100.      4. 200.      4. 300.      4. 400.      4.
8 10 500.       4. 600.      4. 700.      5. 800.      5. 900.      5.
8 151000.       5.1050.      6.1100.      6.1110.      6.1120.      6.
8 201130.       7.1131.      7.1132.      7.1133.      7.1134.      7.
8 251135.       7.1136.      7.1137.      7.1138.      7.1139.      7.
8 301140.       7.1141.      7.1142.      7.1143.      7.1144.      7.
8 351145.       7.1146.      7.1147.      9.1148.      9.1149.      9.
8 401150.      10.1151.     12.1152.     15.1153.     18.1154.     20.
8 451155.      21.1156.     22.1157.     22.1158.     23.1159.     23.
8 501160.      23.1161.     23.1162.     24.1163.     24.1164.     24.
8 551165.      25.1166.     25.1167.     24.1168.     24.1169.     24.
8 601170.      23.1171.     22.1172.     22.1173.     23.1174.     24.
8 651175.      24.1176.     24.1177.     24.1178.     24.1179.     24.
8 701180.      23.1181.     23.1182.     23.1183.     23.1184.     24.
8 751185.      24.1186.     24.1187.     24.1188.     24.1189.     24.
8 801190.      24.1191.     24.1192.     24.1193.     25.1194.     25.
8 851195.      25.1196.     25.1197.     25.1198.     25.1199.     25.
8 901200.      25.1201.     25.1202.     25.1203.     25.1204.     25.
8 951205.      25.1206.     25.1207.     25.1208.     26.1209.     26.
81001210.      26.1211.     26.1212.     26.1213.     26.1214.     26.
81051215.      26.1216.     26.1217.     26.1218.     26.1219.     26.
81101220.      26.1221.     26.1222.     26.1223.     27.1224.     27.
81151225.      27.1226.     27.1227.     27.1228.     26.1229.     26.
81201230.      26.1231.     26.1232.     25.1233.     25.1234.     25.
81251235.      25.1236.     25.1237.     25.1238.     25.1239.     25.
81301240.      25.1241.     25.1242.     25.1243.     25.1244.     25.
81351245.      25.1246.     25.1247.     25.1248.     24.1249.     24.
81401250.      24.1251.     24.1252.     24.1253.     24.1254.     24.
81451255.      23.1256.     23.1257.     23.1258.     23.1259.     23.
81501260.      22.1261.     22.1262.     22.1263.     22.1264.     22.
81551265.      22.1266.     22.1267.     22.1268.     22.1269.     22.
81601270.      22.1271.     22.1272.     22.1273.     22.1274.     22.
81651275.      21.1276.     20.1277.     20.1278.     20.1279.     20.
81701280.      20.1281.     20.1282.     20.1283.     20.1284.     20.
81751285.      20.1286.     20.1287.     20.1288.     20.1289.     20.
81801290.      20.1291.     20.1292.     20.1293.     20.1294.     20.
81851295.      20.1296.     19.1297.     19.1298.     19.1299.     19.
81901300.      18.1310.     18.1320.     17.1330.     10.1340.      6.
81951350.       5.1360.      5.1370.      5.1380.      5.1390.      5.
82001400.       5.1420.      4.1440.      4.1460.      4.1500.      4.
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MODIFIED RATIONAL METHOD HYDROLOGY

BUSINESS PARK CENTER - LOCHEED - FILE : LOCHED4 STORM DAY 4

	LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
*	3	1A	4.	4.	4.	4.	0	0.	.00000	.00	.00	0.	103	17	150	.00
	3	2B	4.	3.	4.	3.	2	980.	.01070	.00	.00	0.	103	23	150	.00
	3	3B	9.	8.	13.	10.	2	210.	.00860	.00	.00	0.	103	20	150	.00
	3	4B	10.	9.	23.	18.	2	470.	.00880	.00	.00	0.	103	20	150	.00
	3	5B	2.	2.	25.	19.	0	0.	.00000	.00	.00	0.	103	19	150	.00
	3	6C	6.	6.	6.	6.	2	780.	.00720	.00	.00	0.	103	20	150	.00
	3	7C	9.	8.	15.	12.	0	0.	.00000	.00	.00	0.	103	20	150	.00

CONFLUENCE Q'S

3 8B TB 1166 QB 19. QBC 31. QC 12. 3 8C TC 1165 QC 12. QC8 31. QB 19.

3 8BC TBC 1166 QBC 31. QB 19. QC 12.

	LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
	3	8BC	15.	12.	40.	31.	2	510.	.00780	.00	.00	0.	103	0	150	.00
	3	9B	8.	7.	48.	36.	2	530.	.00680	.00	.00	0.	103	20	150	.00
	3	10B	9.	8.	57.	39.	0	0.	.00000	.00	.00	0.	103	20	150	.00
	3	11D	10.	9.	10.	9.	2	430.	.00370	.00	.00	0.	103	20	150	.00
	3	12D	4.	4.	14.	12.	2	500.	.01120	.00	.00	0.	103	20	150	.00
	3	13D	0.	0.	14.	11.	0	0.	.00000	.00	.00	0.	103	20	150	.00

CONFLUENCE Q'S

3 14B TB 1170 QB 39. QBD 51. QD 11. 3 14D TD 1170 QD 11. QD8 51. QB 39.

3 14BD TBD 1170 QBD 51. QB 39. QD 11.

	LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
	3	14BD	14.	11.	71.	51.	2	500.	.00510	.00	.00	0.	103	0	150	.00
	3	15B	0.	0.	71.	48.	0	0.	.00000	.00	.00	0.	103	20	150	.00
	3	16E	9.	8.	9.	8.	0	0.	.00000	.00	.00	0.	103	20	150	.00

CONFLUENCE Q'S

3 17B TB 1174 QB 48. QBE 49. QE 0. 3 17E TE 1155 QE 8. QE8 13. QB 5.

3 17BE TBE 1171 QBE 49. QB 45. QE 4.

	LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
	3	17BE	9.	8.	80.	49.	2	510.	.00510	.00	.00	0.	103	0	150	.00
	3	18B	5.	5.	85.	48.	2	430.	.00860	.00	.00	0.	103	19	150	.00
**	3	19B	10.	9.	95.	48.	2	850.	.01010	.00	.00	0.	103	20	150	.00
	3	20B	0.	0.	95.	46.	0	0.	.00000	.00	.00	0.	103	20	150	.00
	3	21F	5.	5.	5.	5.	2	600.	.00870	.00	.00	0.	103	20	150	.00
	3	22F	6.	6.	11.	9.	0	0.	.00000	.00	.00	0.	103	20	150	.00

* INPUT HYDROGRAPH (FILE: PLANE.HYD) FOR FLOOD ROUTING FOR DEPRESSION AREA N° 2 (se page N° 4 ci- for detailed calculation)

** INPUT HYDROGRAPH (FILE PLANE.HYD) FOR FLOOD ROUTING FOR DEPRESSION AREA N° 3 (se page N° 4 for detailed Calculation)

MODIFIED RATIONAL METHOD HYDROLOGY

BUSINESS PAARK CENTER - LOCHEED - FILE : LOCHED4 STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
CONFLUENCE Q'S														
3 23B TB 1186 QB		46. QBB		47. QF		1.		3 23F TF 1163 QF			9. QFB		27. QB	18.
3 23BF TBF 1186 QBF				47. QB		46. QF		1.						
3	23BF	11.	9.	106.	47.	2	950.	.01050	.00	.00	0.	103	0	150	.00
3	24B	9.	8.	115.	46.	0	0.	.00000	.00	.00	0.	103	20	150	.00
3	25C	5.	4.	5.	4.	2	150.	.00670	.00	.00	0.	103	21	150	.00
3	26C	3.	3.	8.	7.	2	610.	.01150	.00	.00	0.	103	22	150	.00
3	27C	8.	7.	16.	13.	2	80.	.00880	.00	.00	0.	103	23	150	.00
3	28C	6.	6.	22.	18.	2	440.	.01020	.00	.00	0.	103	20	150	.00
3	29C	7.	7.	29.	23.	2	440.	.01020	.00	.00	0.	103	20	150	.00
3	30C	8.	7.	37.	29.	0	0.	.00000	.00	.00	0.	103	20	150	.00
3	31D	7.	7.	7.	7.	2	570.	.00530	.00	.00	0.	103	20	150	.00
3	32D	0.	0.	7.	6.	0	0.	.00000	.00	.00	0.	103	20	150	.00
CONFLUENCE Q'S														
3 33C TC 1168 QC		29. QCD		34. QD		6.		3 33D TD 1169 QD			6. QDC		34. QC	28.
3 33CD TCD 1168 QCD				34. QC		29. QD		6.						
3	33CD	7.	6.	44.	34.	2	250.	.00280	.00	.00	0.	103	0	150	.00
3	34C	2.	3.	46.	34.	0	0.	.00000	.00	.00	0.	103	15	150	.00
3	35E	6.	6.	6.	6.	2	190.	.00470	.00	.00	0.	103	20	150	.00
3	36E	0.	0.	6.	5.	0	0.	.00000	.00	.00	0.	103	20	150	.00
CONFLUENCE Q'S														
3 37C TC 1171 QC		34. QCE		38. QE		4.		3 37E TE 1162 QE			5. QEC		29. QC	23.
3 37CE TCE 1170 QCE				39. QC		34. QE		5.						
3	37CE	6.	5.	52.	39.	2	480.	.00790	.00	.00	0.	103	0	150	.00
3	38C	8.	7.	60.	41.	2	480.	.00670	.00	.00	0.	103	20	150	.00
3	39C	9.	8.	69.	41.	0	0.	.00000	.00	.00	0.	103	20	150	.00
3	40F	7.	7.	7.	7.	2	990.	.00800	.00	.00	0.	103	20	150	.00
3	41F	10.	9.	17.	12.	0	0.	.00000	.00	.00	0.	103	21	150	.00
* 3	42D	32.	27.	32.	27.	0	0.	.00000	.00	.00	0.	103	0	150	.00
3	43D	0.	0.	32.	27.	3	350.	.01000	.00	.00	0.	103	50	150	.00
3	44D	10.	9.	42.	33.	2	450.	.00780	.00	.00	0.	103	20	150	.00
3	45D	10.	9.	52.	40.	2	280.	.01070	.00	.00	0.	103	20	150	.00
3	46D	5.	5.	57.	44.	2	370.	.00620	.00	.00	0.	103	20	150	.00
3	47D	0.	0.	57.	44.	0	0.	.00000	.00	.00	0.	103	20	150	.00

* INPUT HYDROGRAPH FROM OFF-SITE AREA. FILE: INPUTHYD.HYD
(See page no. for detailed calculation)

MODIFIED RATIONAL METHOD HYDROLOGY

BUSINESS PARK CENTER - LOCKHEED - FILE : LOCKHD4 STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
CONFLUENCE Q'S														
3 48D TO 1169 QD	44. QDF	56. QE	12.	3 48F TO 1166 QE	12. QED	54. QD	42.							
3 48DF TOF 1169 QDF	56. QD	44. QE	12.											
3	48DF	17.	12.	74.	56.	2	530.	.00520	.00	.00	0.	103	0	150	.00
3	49D	0.	0.	74.	54.	0	0.	.00000	.00	.00	0.	103	20	150	.00
3	50E	3.	3.	3.	3.	0	0.	.00000	.00	.00	0.	103	21	150	.00
CONFLUENCE Q'S														
3 51D TO 1174 QD	54. QDE	54. QE	0.	3 51E TE 1155 QE	3. QED	13. QD	10.							
3 51DE TDE 1172 QDE	54. QD	53. QE	1.											
3	51DE	3.	3.	77.	54.	0	0.	.00000	.00	.00	0.	103	0	150	.00
3	52D	8.	6.	85.	59.	2	400.	.00680	.00	.00	0.	103	23	150	.00
3	53D	0.	0.	85.	58.	0	0.	.00000	.00	.00	0.	103	20	150	.00
CONFLUENCE Q'S														
3 54C TC 1171 QC	41. QCD	93. QD	52.	3 54D TD 1175 QD	58. QDC	97. QC	39.							
3 54CD TCD 1174 QCD	97. QC	40. QD	57.											
3	54CD	85.	58.	154.	97.	2	470.	.00570	.00	.00	0.	103	0	150	.00
3	55C	10.	9.	164.	96.	2	250.	.00640	.00	.00	0.	103	20	150	.00
3	56C	0.	0.	164.	96.	0	0.	.00000	.00	.00	0.	103	20	150	.00
CONFLUENCE Q'S														
3 57B TB 1191 QB	46. QBC	111. QC	65.	3 57C TC 1179 QC	96. QCB	130. QB	34.							
3 57BC TBC 1180 QBC	130. QB	35. QC	95.											
3	57BC	164.	96.	279.	130.	2	260.	.00460	.00	.00	0.	103	0	150	.00
3	58B	6.	6.	285.	130.	2	770.	.00470	.00	.00	0.	103	20	150	.00
3	59B	6.	6.	291.	128.	0	0.	.00000	.00	.00	0.	103	20	150	.00
3	60D	3.	3.	3.	3.	2	1000.	.00700	.00	.00	0.	103	20	150	.00
3	61D	4.	4.	7.	5.	2	1000.	.00650	.00	.00	0.	103	21	150	.00
3	62D	3.	3.	10.	5.	2	360.	.01220	.00	.00	0.	103	21	150	.00
3	63D	2.	3.	12.	6.	2	560.	.00300	.00	.00	0.	103	14	150	.00
3	64D	0.	0.	12.	5.	0	0.	.00000	.00	.00	0.	103	14	150	.00

MODIFIED RATIONAL METHOD HYDROLOGY

BUSINESS PARK CENTER - LOCHEED - FILE : LOCHED4 STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV L	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

CONFLUENCE Q'S

3 65B TB 1188 QB 129. QBD 132. QD 4. 3 65D TD 1180 QD 5. QDB 115. QB 110.

3 65BD TBD 1188 QBD 132. QB 128. QD 4.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV L	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
3 6580	12.	5.	303.	132.	0	0.	.00000	.00	.00	0.	103	0	150	.00
3 66B	0.	0.	303.	132.	0	0.	.00000	.00	.00	0.	103	20	150	.00
3 67E	7.	7.	7.	7.	2	650.	.00910	.00	.00	0.	103	20	150	.00
3 68E	6.	6.	13.	11.	2	870.	.01240	.00	.00	0.	103	20	150	.00
3 69E	10.	9.	23.	17.	0	0.	.00000	.00	.00	0.	103	20	150	.00
3 70BE	23.	17.	326.	136.	0	0.	.00000	.00	.00	0.	103	0	150	.00
3 718	0.	0.	326.	136.	0	0.	.00000	.00	.00	0.	103	20	150	.00
3 72F	8.	8.	8.	8.	2	450.	.00670	.00	.00	0.	103	19	150	.00
3 73F	7.	7.	15.	14.	2	550.	.01090	.00	.00	0.	103	18	150	.00
3 74F	6.	6.	21.	18.	2	580.	.00830	.00	.00	0.	103	20	150	.00
3 75F	0.	0.	21.	17.	0	0.	.00000	.00	.00	0.	103	20	150	.00

CONFLUENCE Q'S

3 76B TB 1187 QB 136. QBF 142. QF 5. 3 76F TF 1171 QF 17. QFB 104. QB 86.

3 76BF TBF 1186 QBF 142. QB 136. QF 6.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV L	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
3 76BF	21.	17.	347.	142.	0	0.	.00000	.00	.00	0.	103	0	150	.00
3 77B	0.	0.	347.	142.	0	0.	.00000	.00	.00	0.	103	20	150	.00

7	3	LA	4. 411155	4.200	4	
8	5	0.	0. 100.	0. 200.	0. 300.	0. 400.	0.
8	10	500.	0. 600.	0. 700.	0. 800.	0. 900.	0.
8	151000.		0.1050.	0.1100.	0.1110.	0.1120.	0.
8	201130.		0.1131.	0.1132.	0.1133.	0.1134.	0.
8	251135.		0.1136.	0.1137.	0.1138.	0.1139.	0.
8	301140.		0.1141.	0.1142.	0.1143.	0.1144.	0.
8	351145.		0.1146.	0.1147.	1.1148.	1.1149.	1.
8	401150.		1.1151.	2.1152.	4.1153.	4.1154.	4.
8	451155.		4.1156.	4.1157.	4.1158.	4.1159.	4.
8	501160.		4.1161.	4.1162.	4.1163.	4.1164.	4.
8	551165.		4.1166.	3.1167.	3.1168.	2.1169.	1.
8	601170.		0.1171.	0.1172.	0.1173.	0.1174.	0.
8	651175.		0.1176.	0.1177.	0.1178.	0.1179.	0.
8	701180.		0.1181.	0.1182.	0.1183.	0.1184.	0.
8	751185.		0.1186.	0.1187.	0.1188.	0.1189.	0.
8	801190.		0.1191.	0.1192.	0.1193.	0.1194.	0.
8	851195.		0.1196.	0.1197.	0.1198.	0.1199.	0.
8	901200.		0.1201.	0.1202.	0.1203.	0.1204.	0.
8	951205.		0.1206.	0.1207.	0.1208.	0.1209.	0.
81001210.			0.1211.	0.1212.	0.1213.	0.1214.	0.
81051215.			0.1216.	0.1217.	0.1218.	0.1219.	0.
81101220.			0.1221.	0.1222.	0.1223.	0.1224.	0.
81151225.			0.1226.	0.1227.	0.1228.	0.1229.	0.
81201230.			0.1231.	0.1232.	0.1233.	0.1234.	0.
81251235.			0.1236.	0.1237.	0.1238.	0.1239.	0.
81301240.			0.1241.	0.1242.	0.1243.	0.1244.	0.
81351245.			0.1246.	0.1247.	0.1248.	0.1249.	0.
81401250.			0.1251.	0.1252.	0.1253.	0.1254.	0.
81451255.			0.1256.	0.1257.	0.1258.	0.1259.	0.
81501260.			0.1261.	0.1262.	0.1263.	0.1264.	0.
81551265.			0.1266.	0.1267.	0.1268.	0.1269.	0.
81601270.			0.1271.	0.1272.	0.1273.	0.1274.	0.
81651275.			0.1276.	0.1277.	0.1278.	0.1279.	0.
81701280.			0.1281.	0.1282.	0.1283.	0.1284.	0.
81751285.			0.1286.	0.1287.	0.1288.	0.1289.	0.
81801290.			0.1291.	0.1292.	0.1293.	0.1294.	0.
81851295.			0.1296.	0.1297.	0.1298.	0.1299.	0.
81901300.			0.1310.	0.1320.	0.1330.	0.1340.	0.
81951350.			0.1360.	0.1370.	0.1380.	0.1390.	0.
82001400.			0.1420.	0.1440.	0.1460.	0.1500.	0.

FILE : PLANS. HYD
FOR
DEPRESSION AREA N° 2

AREA : 4.0 Ac.
VOLUME : .1 Ac.ft.

```
 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1991   Version 2.0
-------------------------------------------------------------------
Study Date : 12/16/92 Input hydrograph file name : PLAN5.HYD
Output hydrograph file name: PLAN5.rtd
CHECK CAPCITY OF DEPRESSION AREA NO. 2 AT BUSINESS PARK CENTER
EXISTING CONDITION - 50 YEAR STORM
FILE : PLAN5  - INPUT HYDROGRAPH : LOCRET.HY2

-------------------------------------------------------------------
Church Engineering, 2301 Alton Ave., Irvine, CA - S/N   602

Program computation of outflow v. depth

*****************************************************************
CALCULATED OUTFLOW DATA AT DEPTH =    0.70(Ft.)
*****************************************************************
Total outflow at this depth =      0.00(CFS)


*****************************************************************
CALCULATED OUTFLOW DATA AT DEPTH =    1.00(Ft.)
*****************************************************************
Total outflow at this depth =      0.00(CFS)


*****************************************************************
CALCULATED OUTFLOW DATA AT DEPTH =    1.20(Ft.)
*****************************************************************

Weir capacity using equation Q = CLH^Exp(Using Feet as units)
Weir Length =  30.00Ft.)   C value =   3.00   Exp =   1.50
Weir flow:     Depth = H =    0.20(Ft.)   Flow =      8.05 (CFS)

Total outflow at this depth =      8.05(CFS)

-------------------------------------------------------------------
Hydrograph time unit varies
Initial depth in storage basin =   0.48(Ft.)
-------------------------------------------------------------------
-------------------------------------------------------------------
Initial basin depth =   0.48 (Ft.)
Initial basin storage =      0.10 (Ac.Ft)
Initial basin outflow =   0.00 (CFS)
-------------------------------------------------------------------
-------------------------------------------------------------------
Depth vs. Storage and Depth vs. Discharge data @ 1 Min. Intervals:
 Basin Depth  Storage    Outflow   (S-O*dt/2)   (S+O*dt/2)
    (Ft.)    (Ac.Ft)    (CFS)     (Ac.Ft)     (Ac.Ft)
-------------------------------------------------------------------
  0.000      0.000      0.000      0.000        0.000
  0.700      0.140      0.000      0.140        0.140
  1.000      0.292      0.000      0.292        0.292
  1.200      0.426      8.050      0.420        0.432
-------------------------------------------------------------------
                Hydrograph Detention Basin Routing
Hydrograph at 3 1 A Storm Day: 4 Drainage Area =     4.00
Total flood hydrograph volume this storm day =    0.10 Ac. Ft
```

Time (Min)	Inflow (CFS)	Outflow (CFS)	Storage (Ac.Ft)	.0	1.0	2.0	3.0	4.0	Depth (Ft.)
0	0.0	0.0	0.096	0	:	:	:	:	0.5
100	0.0	0.0	0.096	0	:	:	:	:	0.5
200	0.0	0.0	0.096	0	:	:	:	:	0.5
300	0.0	0.0	0.096	0	:	:	:	:	0.5
400	0.0	0.0	0.096	0	:	:	:	:	0.5
500	0.0	0.0	0.096	0	:	:	:	:	0.5
600	0.0	0.0	0.096	0	:	:	:	:	0.5
700	0.0	0.0	0.096	0	:	:	:	:	0.5
800	0.0	0.0	0.096	0	:	:	:	:	0.5
900	0.0	0.0	0.096	0	:	:	:	:	0.5
1000	0.0	0.0	0.096	0	:	:	:	:	0.5
1050	0.0	0.0	0.096	0	:	:	:	:	0.5
1100	0.0	0.0	0.096	0	:	:	:	:	0.5
1110	0.0	0.0	0.096	0	:	:	:	:	0.5
1120	0.0	0.0	0.096	0	:	:	:	:	0.5
1130	0.0	0.0	0.096	0	:	:	:	:	0.5
1131	0.0	0.0	0.096	0	:	:	:	:	0.5
1132	0.0	0.0	0.096	0	:	:	:	:	0.5
1133	0.0	0.0	0.096	0	:	:	:	:	0.5
1134	0.0	0.0	0.096	0	:	:	:	:	0.5
1135	0.0	0.0	0.096	0	:	:	:	:	0.5
1136	0.0	0.0	0.096	0	:	:	:	:	0.5
1137	0.0	0.0	0.096	0	:	:	:	:	0.5
1138	0.0	0.0	0.096	0	:	:	:	:	0.5
1139	0.0	0.0	0.096	0	:	:	:	:	0.5
1140	0.0	0.0	0.096	0	:	:	:	:	0.5
1141	0.0	0.0	0.096	0	:	:	:	:	0.5
1142	0.0	0.0	0.096	0	:	:	:	:	0.5
1143	0.0	0.0	0.096	0	:	:	:	:	0.5
1144	0.0	0.0	0.096	0	:	:	:	:	0.5
1145	0.0	0.0	0.096	0	:	:	:	:	0.5
1146	0.0	0.0	0.096	0	:	:	:	:	0.5
1147	1.0	0.0	0.097	0	I	:	:	:	0.5
1148	1.0	0.0	0.098	0	I	:	:	:	0.5
1149	1.0	0.0	0.099	0	I	:	:	:	0.5
1150	1.0	0.0	0.101	0	I	:	:	:	0.5
1151	2.0	0.0	0.104	0	:	I	:	:	0.5
1152	4.0	0.0	0.108	0	:	:	:	I	0.5
1153	4.0	0.0	0.113	0	:	:	:	I	0.6
1154	4.0	0.0	0.119	0	:	:	:	I	0.6
1155	4.0	0.0	0.124	0	:	:	:	I	0.6
1156	4.0	0.0	0.130	0	:	:	:	I	0.6
1157	4.0	0.0	0.135	0	:	:	:	I	0.7
1158	4.0	0.0	0.141	0	:	:	:	I	0.7
1159	4.0	0.0	0.146	0	:	:	:	I	0.7
1160	4.0	0.0	0.152	0	:	:	:	I	0.7
1161	4.0	0.0	0.157	0	:	:	:	I	0.7
1162	4.0	0.0	0.163	0	:	:	:	I	0.7
1163	4.0	0.0	0.169	0	:	:	:	I	0.8
1164	4.0	0.0	0.174	0	:	:	:	I	0.8
1165	4.0	0.0	0.180	0	:	:	:	I	0.8
1166	3.0	0.0	0.184	0	:	:	I	:	0.8
1167	3.0	0.0	0.188	0	:	:	I	:	0.8
1168	2.0	0.0	0.191	0	:	I	:	:	0.8
1169	1.0	0.0	0.192	0	I	:	:	:	0.8
1170	0.0	0.0	0.192	0	:	:	:	:	0.8
1171	0.0	0.0	0.192	0	:	:	:	:	0.8
1172	0.0	0.0	0.192	0	:	:	:	:	0.8
1173	0.0	0.0	0.192	0	:	:	:	:	0.8

1178	0.0	0.0	0.192	0					0.8
1179	0.0	0.0	0.192	0					0.8
1180	0.0	0.0	0.192	0					0.8
1181	0.0	0.0	0.192	0					0.8
1182	0.0	0.0	0.192	0					0.8
1183	0.0	0.0	0.192	0					0.8
1184	0.0	0.0	0.192	0					0.8
1185	0.0	0.0	0.192	0					0.8
1186	0.0	0.0	0.192	0					0.8
1187	0.0	0.0	0.192	0					0.8
1188	0.0	0.0	0.192	0					0.8
1189	0.0	0.0	0.192	0					0.8
1190	0.0	0.0	0.192	0					0.8
1191	0.0	0.0	0.192	0					0.8
1192	0.0	0.0	0.192	0					0.8
1193	0.0	0.0	0.192	0					0.8
1194	0.0	0.0	0.192	0					0.8
1195	0.0	0.0	0.192	0					0.8
1196	0.0	0.0	0.192	0					0.8
1197	0.0	0.0	0.192	0					0.8
1198	0.0	0.0	0.192	0					0.8
1199	0.0	0.0	0.192	0					0.8
1200	0.0	0.0	0.192	0					0.8
1201	0.0	0.0	0.192	0					0.8
1202	0.0	0.0	0.192	0					0.8
1203	0.0	0.0	0.192	0					0.8
1204	0.0	0.0	0.192	0					0.8
1205	0.0	0.0	0.192	0					0.8
1206	0.0	0.0	0.192	0					0.8
1207	0.0	0.0	0.192	0					0.8
1208	0.0	0.0	0.192	0					0.8
1209	0.0	0.0	0.192	0					0.8
1210	0.0	0.0	0.192	0					0.8
1211	0.0	0.0	0.192	0					0.8
1212	0.0	0.0	0.192	0					0.8
1213	0.0	0.0	0.192	0					0.8
1214	0.0	0.0	0.192	0					0.8
1215	0.0	0.0	0.192	0					0.8
1216	0.0	0.0	0.192	0					0.8
1217	0.0	0.0	0.192	0					0.8
1218	0.0	0.0	0.192	0					0.8
1219	0.0	0.0	0.192	0					0.8
1220	0.0	0.0	0.192	0					0.8
1221	0.0	0.0	0.192	0					0.8
1222	0.0	0.0	0.192	0					0.8
1223	0.0	0.0	0.192	0					0.8
1224	0.0	0.0	0.192	0					0.8
1225	0.0	0.0	0.192	0					0.8
1226	0.0	0.0	0.192	0					0.8
1227	0.0	0.0	0.192	0					0.8
1228	0.0	0.0	0.192	0					0.8
1229	0.0	0.0	0.192	0					0.8
1230	0.0	0.0	0.192	0					0.8
1231	0.0	0.0	0.192	0					0.8
1232	0.0	0.0	0.192	0					0.8
1233	0.0	0.0	0.192	0					0.8
1234	0.0	0.0	0.192	0					0.8
1235	0.0	0.0	0.192	0					0.8
1236	0.0	0.0	0.192	0					0.8
1237	0.0	0.0	0.192	0					0.8
1238	0.0	0.0	0.192	0					0.8
1239	0.0	0.0	0.192	0					0.8

1244	0.0	0.0	0.192	0					0.3
1245	0.0	0.0	0.192	0					0.3
1246	0.0	0.0	0.192	0					0.3
1247	0.0	0.0	0.192	0					0.3
1248	0.0	0.0	0.192	0					0.3
1249	0.0	0.0	0.192	0					0.3
1250	0.0	0.0	0.192	0					0.3
1251	0.0	0.0	0.192	0					0.3
1252	0.0	0.0	0.192	0					0.3
1253	0.0	0.0	0.192	0					0.3
1254	0.0	0.0	0.192	0					0.3
1255	0.0	0.0	0.192	0					0.3
1256	0.0	0.0	0.192	0					0.3
1257	0.0	0.0	0.192	0					0.3
1258	0.0	0.0	0.192	0					0.3
1259	0.0	0.0	0.192	0					0.3
1260	0.0	0.0	0.192	0					0.3
1261	0.0	0.0	0.192	0					0.3
1262	0.0	0.0	0.192	0					0.3
1263	0.0	0.0	0.192	0					0.3
1264	0.0	0.0	0.192	0					0.3
1265	0.0	0.0	0.192	0					0.3
1266	0.0	0.0	0.192	0					0.3
1267	0.0	0.0	0.192	0					0.3
1268	0.0	0.0	0.192	0					0.3
1269	0.0	0.0	0.192	0					0.3
1270	0.0	0.0	0.192	0					0.3
1271	0.0	0.0	0.192	0					0.3
1272	0.0	0.0	0.192	0					0.3
1273	0.0	0.0	0.192	0					0.3
1274	0.0	0.0	0.192	0					0.3
1275	0.0	0.0	0.192	0					0.3
1276	0.0	0.0	0.192	0					0.3
1277	0.0	0.0	0.192	0					0.3
1278	0.0	0.0	0.192	0					0.3
1279	0.0	0.0	0.192	0					0.3
1280	0.0	0.0	0.192	0					0.3
1281	0.0	0.0	0.192	0					0.3
1282	0.0	0.0	0.192	0					0.3
1283	0.0	0.0	0.192	0					0.3
1284	0.0	0.0	0.192	0					0.3
1285	0.0	0.0	0.192	0					0.3
1286	0.0	0.0	0.192	0					0.3
1287	0.0	0.0	0.192	0					0.3
1288	0.0	0.0	0.192	0					0.3
1289	0.0	0.0	0.192	0					0.3
1290	0.0	0.0	0.192	0					0.3
1291	0.0	0.0	0.192	0					0.3
1292	0.0	0.0	0.192	0					0.3
1293	0.0	0.0	0.192	0					0.3
1294	0.0	0.0	0.192	0					0.3
1295	0.0	0.0	0.192	0					0.3
1296	0.0	0.0	0.192	0					0.3
1297	0.0	0.0	0.192	0					0.3
1298	0.0	0.0	0.192	0					0.3
1299	0.0	0.0	0.192	0					0.3
1300	0.0	0.0	0.192	0					0.3
1310	0.0	0.0	0.192	0					0.3
1320	0.0	0.0	0.192	0					0.3
1330	0.0	0.0	0.192	0					0.3
1340	0.0	0.0	0.192	0					0.3
1350	0.0	0.0	0.192	0					0.3

1400	0.0	0.0	0.192	0	:	:	:	:	0.3
1420	0.0	0.0	0.192	0	:	:	:	:	0.3
1440	0.0	0.0	0.192	0	:	:	:	:	0.3
1460	0.0	0.0	0.192	0	:	:	:	:	0.3
1500	0.0	0.0	0.192	0	:	:	:	:	0.3

Remaining water in basin = 0.19 (Ac.Ft)
Peak flow out of basin = 0.00(CFS)
Peak flow time = 0 Min.. time interval # = 41
Maximum depth in basin = 0.30(Ft.)

∴ WATER CONTRIBUTED TO THIS DETENTION AREA WILL BE STORED 100%

7	3	19B	95. 671181	48.200	4	
8	5	0.	0. 100.	2. 200.	2. 300.	2. 400.	2.
8	10	500.	2. 600.	2. 700.	2. 800.	2. 900.	2.
8	151000.		3.1050.	3.1100.	3.1110.	3.1120.	3.
8	201130.		3.1131.	4.1132.	4.1133.	4.1134.	4.
8	251135.		4.1136.	4.1137.	4.1138.	4.1139.	4.
8	301140.		4.1141.	4.1142.	4.1143.	4.1144.	4.
8	351145.		4.1146.	4.1147.	5.1148.	5.1149.	6.
8	401150.		6.1151.	8.1152.	11.1153.	13.1154.	14.
8	451155.		15.1156.	16.1157.	17.1158.	18.1159.	19.
8	501160.		20.1161.	21.1162.	23.1163.	24.1164.	25.
8	551165.		26.1166.	28.1167.	29.1168.	31.1169.	33.
8	601170.		34.1171.	35.1172.	34.1173.	36.1174.	38.
8	651175.		41.1176.	43.1177.	45.1178.	46.1179.	47.
8	701180.		47.1181.	48.1182.	47.1183.	47.1184.	46.
8	751185.		44.1186.	43.1187.	42.1188.	40.1189.	38.
8	801190.		37.1191.	35.1192.	33.1193.	32.1194.	30.
8	851195.		28.1196.	27.1197.	25.1198.	24.1199.	23.
8	901200.		21.1201.	20.1202.	19.1203.	18.1204.	17.
8	951205.		16.1206.	15.1207.	14.1208.	13.1209.	13.
81001210.			12.1211.	12.1212.	11.1213.	10.1214.	10.
81051215.			10.1216.	9.1217.	9.1218.	8.1219.	8.
81101220.			8.1221.	7.1222.	7.1223.	7.1224.	7.
81151225.			6.1226.	6.1227.	6.1228.	6.1229.	5.
81201230.			5.1231.	5.1232.	5.1233.	5.1234.	5.
81251235.			5.1236.	4.1237.	4.1238.	4.1239.	4.
81301240.			4.1241.	4.1242.	4.1243.	4.1244.	4.
81401250.			3.1251.	3.1252.	3.1253.	3.1254.	3.
81451255.			3.1256.	3.1257.	3.1258.	3.1259.	3.
81501260.			3.1261.	3.1262.	3.1263.	3.1264.	3.
81551265.			3.1266.	3.1267.	3.1268.	3.1269.	3.
81601270.			3.1271.	3.1272.	3.1273.	3.1274.	3.
81651275.			3.1276.	2.1277.	2.1278.	2.1279.	2.
81701280.			2.1281.	2.1282.	2.1283.	2.1284.	2.
81751285.			2.1286.	2.1287.	2.1288.	2.1289.	2.
81801290.			2.1291.	2.1292.	2.1293.	2.1294.	2.
81851295.			2.1296.	2.1297.	2.1298.	2.1299.	2.
81901300.			2.1310.	2.1320.	2.1330.	2.1340.	2.
81951350.			2.1360.	2.1370.	2.1380.	2.1390.	2.
82001400.			2.1420.	2.1440.	2.1460.	2.1500.	2.

PLANG. HYD FOR DEPRESSION AREA N.

AREA: 95.0 Ac.
VOLUME: 6.95 Ac.Ft.

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1991 Version 2.0

Study Date : 12/21/92 Input hydrograph file name : PLAN6.HYD
Output hydrograph file name: DEPRN3.rtd
CHECK CAPACITY OF DEPRESSION AREA NO. 3 AT BUSINESS PARK CENTER
50 YEAR STORM AT EXISTING CONDITION
FILE : PLAN6 INPUT HYDROGRAPH : PLAN6.HYD

Church Engineering, 2501 Alton Ave., Irvine, CA - S/H 602

Program computation of outflow v. depth

****
CALCULATED OUTFLOW DATA AT DEPTH = 1.90(Ft.)
****
Total outflow at this depth = 0.00(CFS)

****
CALCULATED OUTFLOW DATA AT DEPTH = 3.50(Ft.)
****
Total outflow at this depth = 0.00(CFS)

****
CALCULATED OUTFLOW DATA AT DEPTH = 3.90(Ft.)
****

Weir capacity using equation Q = CLH^Exp(Using Feet as units)
Weir Length = 90.00(Ft.) C value = 3.00 Exp = 1.50
Weir flow: Depth = H = 0.40(Ft.) Flow = 68.31 (CFS)

Total outflow at this depth = 68.31(CFS)

Hydrograph time unit varies
Initial depth in storage basin = 0.00(Ft.)

Initial basin depth = 0.00 (Ft.)
Initial basin storage = 0.00 (Ac.Ft)
Initial basin outflow = 0.00 (CFS)

Depth vs. Storage and Depth vs. Discharge data @ 1 Min. Intervals:

Basin Depth (Ft.)	Storage (Ac.Ft)	Outflow (CFS)	(S-O*dt/2) (Ac.Ft)	(S+O*dt/2) (Ac.Ft)
0.000	0.000	0.000	0.000	0.000
1.900	0.866	0.000	0.866	0.866
3.500	3.109	0.000	3.109	3.109
3.900	3.997	68.305	3.950	4.044

Graph values: 'I'= unit inflow; 'O'=outflow at time shown

Time (Min)	Inflow (CFS)	Outflow (CFS)	Storage (Ac.Ft)	.0	12.0	24.0	36.0	48.0	Depth (Ft.)
0	0.0	0.0	0.000	O	|	|	|	|	0.0
100	2.0	0.0	0.139	OI	|	|	|	|	0.3
200	2.0	0.0	0.415	OI	|	|	|	|	0.9
300	2.0	0.0	0.690	OI	|	|	|	|	1.5
400	2.0	0.0	0.966	OI	|	|	|	|	2.0
500	2.0	0.0	1.241	OI	|	|	|	|	2.2
600	2.0	0.0	1.517	OI	|	|	|	|	2.4
700	2.0	0.0	1.792	OI	|	|	|	|	2.6
800	2.0	0.0	2.067	OI	|	|	|	|	2.8
900	2.0	0.0	2.343	OI	|	|	|	|	3.0
1000	3.0	0.0	2.688	O I	|	|	|	|	3.2
1050	3.0	0.0	2.895	O I	|	|	|	|	3.3
1100	3.0	0.0	3.101	O I	|	|	|	|	3.5
1110	3.0	1.7	3.131	|OI	|	|	|	|	3.5
1120	3.0	2.6	3.142	|OI	|	|	|	|	3.5
1130	3.0	2.8	3.146	|OI	|	|	|	|	3.5
1131	4.0	3.0	3.148	|OI	|	|	|	|	3.5
1132	4.0	3.1	3.149	| O	|	|	|	|	3.5
1133	4.0	3.2	3.150	| O	|	|	|	|	3.5
1134	4.0	3.2	3.151	| O	|	|	|	|	3.5
1135	4.0	3.3	3.152	| O	|	|	|	|	3.5
1136	4.0	3.4	3.153	| O	|	|	|	|	3.5
1137	4.0	3.5	3.154	| O	|	|	|	|	3.5
1138	4.0	3.5	3.155	| O	|	|	|	|	3.5
1139	4.0	3.6	3.155	| O	|	|	|	|	3.5
1140	4.0	3.6	3.156	| O	|	|	|	|	3.5
1141	4.0	3.6	3.156	| O	|	|	|	|	3.5
1142	4.0	3.7	3.157	| O	|	|	|	|	3.5
1143	4.0	3.7	3.157	| O	|	|	|	|	3.5
1144	4.0	3.7	3.158	| O	|	|	|	|	3.5
1145	4.0	3.8	3.158	| O	|	|	|	|	3.5
1146	4.0	3.8	3.158	| O	|	|	|	|	3.5
1147	5.0	3.9	3.160	| OI	|	|	|	|	3.5
1148	5.0	4.0	3.161	| OI	|	|	|	|	3.5
1149	6.0	4.2	3.164	| O I	|	|	|	|	3.5
1150	6.0	4.4	3.166	| O I	|	|	|	|	3.5
1151	8.0	4.8	3.171	| O I	|	|	|	|	3.5
1152	11.0	5.4	3.179	| O I|	|	|	|	|	3.5
1153	13.0	6.2	3.189	| O I	|	|	|	|	3.5
1154	14.0	6.9	3.199	| O |I	|	|	|	|	3.5
1155	15.0	7.8	3.210	| O | I	|	|	|	|	3.5
1156	16.0	8.6	3.221	| O | I	|	|	|	|	3.6
1157	17.0	9.4	3.232	| O | I	|	|	|	|	3.6
1158	18.0	10.3	3.243	| O | I	|	|	|	|	3.6
1159	19.0	11.2	3.254	| O| I	|	|	|	|	3.6
1160	20.0	12.1	3.266	| O I	|	|	|	|	3.6
1161	21.0	13.0	3.277	| O I	|	|	|	|	3.6
1162	23.0	14.0	3.291	| |O I|	|	|	|	|	3.6
1163	24.0	15.0	3.304	| |O I	|	|	|	|	3.6
1164	25.0	16.0	3.317	| | O I	|	|	|	|	3.6
1165	26.0	17.0	3.330	| | O |I	|	|	|	|	3.6
1166	28.0	18.1	3.344	| | O | I	|	|	|	|	3.6
1167	29.0	19.2	3.359	| | O | I	|	|	|	|	3.6
1168	31.0	20.4	3.374	| | O | I	|	|	|	|	3.6
1169	33.0	21.7	3.391	| | O | I	|	|	|	|	3.6
1170	34.0	22.9	3.407	| | O| I	|	|	|	|	3.6

174	38.0	27.4	3.465	|	|	| O	|I	|	3.7
175	41.0	28.8	3.483	|	|	| O	| I	|	3.7
176	43.0	30.2	3.502	|	|	| O	| I	|	3.7
177	45.0	31.7	3.521	|	|	| O	| I |		3.7
178	46.0	33.1	3.540	|	|	| O |	I |		3.7
179	47.0	34.5	3.558	|	|	| O|	I|		3.7
180	47.0	35.8	3.574	|	|	| O|	I|		3.7
181	48.0	37.0	3.590	|	|	| O	I		3.7
182	47.0	38.0	3.603	|	|	| |O	I|		3.7
183	47.0	38.9	3.615	|	|	| |O	I|		3.7
184	46.0	39.6	3.624	|	|	| | O	I |		3.7
185	44.0	40.1	3.630	|	|	| | O	I |		3.7
186	43.0	40.4	3.634	|	|	| | O	I |		3.7
187	42.0	40.5	3.636	|	|	| | O	I |		3.7
188	40.0	40.5	3.635	|	|	| | O	|		3.7
189	38.0	40.2	3.632	|	|	| |IO	|		3.7
190	37.0	39.9	3.628	|	|	| I O	|		3.7
191	35.0	39.4	3.621	|	|	| I| O	|		3.7
192	33.0	38.8	3.613	|	|	| I |O	|		3.7
193	32.0	38.1	3.604	|	|	| I |O	|		3.7
194	30.0	37.3	3.594	|	|	| I O	|		3.7
195	28.0	36.3	3.581	|	|	| I O	|		3.7
196	27.0	35.4	3.569	|	|	| I O|	|		3.7
197	25.0	34.4	3.556	|	|	I O |	|		3.7
198	24.0	33.3	3.542	|	|	I O |	|		3.7
199	23.0	32.3	3.529	|	|	I| O |	|		3.7
200	21.0	31.1	3.514	|	|	I | O	|		3.7
201	20.0	30.0	3.499	|	|	I | O	|		3.7
202	19.0	28.9	3.485	|	|	I | O	|		3.7
203	18.0	27.8	3.471	|	|	I | O	|		3.7
204	17.0	26.7	3.456	|	|	I |O	|		3.7
205	16.0	25.6	3.442	|	|	I |O	|		3.7
206	15.0	24.6	3.428	|	|	I O	|		3.6
207	14.0	23.5	3.415	|	|I	O|	|		3.6
208	13.0	22.5	3.401	|	I	O |	|		3.6
209	13.0	21.5	3.389	|	I	O |	|		3.6
210	12.0	20.5	3.376	|	I	O |	|		3.6
211	12.0	19.7	3.365	|	I	O |	|		3.6
212	11.0	18.8	3.354	|	I|	O |	|		3.6
213	10.0	17.9	3.342	|	I |	O |	|		3.6
214	10.0	17.1	3.332	|	I |	O |	|		3.6
215	10.0	16.4	3.322	|	I |	O |	|		3.6
216	9.0	15.7	3.313	|	I |	O |	|		3.6
217	9.0	15.0	3.304	|	I |	O |	|		3.6
218	8.0	14.3	3.295	|	I |	O |	|		3.6
219	8.0	13.7	3.287	|	I |	O |	|		3.6
220	8.0	13.1	3.279	|	I |	O |	|		3.6
221	7.0	12.5	3.271	|	I |	O |	|		3.6
222	7.0	11.9	3.264	|	I |	O|	|		3.6
223	7.0	11.4	3.258	|	I |	O|	|		3.6
224	7.0	11.0	3.252	|	I |	O|	|		3.6
225	6.0	10.5	3.245	|	I |	O |	|		3.6
226	6.0	10.0	3.239	|	I |	O |	|		3.6
227	6.0	9.6	3.234	|	I |	O |	|		3.6
228	6.0	9.3	3.229	|	I |	O |	|		3.6
229	5.0	8.8	3.224	|	I |	O |	|		3.6
230	5.0	8.4	3.219	|	I |	O |	|		3.5
231	5.0	8.1	3.214	|	I |	O |	|		3.5
232	5.0	7.8	3.210	|	I |	O |	|		3.5
233	5.0	7.5	3.207	|	I |	O |	|		3.5
234	5.0	7.3	3.203	|	I |	O |	|		3.5

1238	4.0	6.2	3.190	I O					3.5
1239	4.0	6.0	3.187	IO					3.5
1240	4.0	5.8	3.184	IO					3.5
1241	4.0	5.6	3.182	IO					3.5
1242	4.0	5.4	3.180	IO					3.5
1243	4.0	5.3	3.178	IO					3.5
1244	4.0	5.2	3.176	IO					3.5
1245	4.0	5.0	3.175	IO					3.5
1246	4.0	4.9	3.173	IO					3.5
1247	3.0	4.7	3.171	IO					3.5
1248	3.0	4.6	3.168	IO					3.5
1249	3.0	4.4	3.166	0					3.5
1250	3.0	4.3	3.165	0					3.5
1251	3.0	4.1	3.163	0					3.5
1252	3.0	4.0	3.161	0					3.5
1253	3.0	3.9	3.160	0					3.5
1254	3.0	3.8	3.159	0					3.5
1255	3.0	3.7	3.158	0					3.5
1256	3.0	3.7	3.157	0					3.5
1257	3.0	3.6	3.156	0					3.5
1258	3.0	3.5	3.155	0					3.5
1259	3.0	3.5	3.154	0					3.5
1260	3.0	3.4	3.154	0					3.5
1261	3.0	3.4	3.153	0					3.5
1262	3.0	3.4	3.153	0					3.5
1263	3.0	3.3	3.152	0					3.5
1264	3.0	3.3	3.152	0					3.5
1265	3.0	3.3	3.151	0					3.5
1266	3.0	3.2	3.151	0					3.5
1267	3.0	3.2	3.151	0					3.5
1268	3.0	3.2	3.150	0					3.5
1269	3.0	3.2	3.150	0					3.5
1270	3.0	3.2	3.150	0					3.5
1271	3.0	3.1	3.150	0					3.5
1272	3.0	3.1	3.150	0					3.5
1273	3.0	3.1	3.149	0					3.5
1274	3.0	3.1	3.149	0					3.5
1275	3.0	3.1	3.149	0					3.5
1276	2.0	3.0	3.148	0					3.5
1277	2.0	2.9	3.146	0					3.5
1278	2.0	2.8	3.145	0					3.5
1279	2.0	2.7	3.144	0					3.5
1280	2.0	2.6	3.143	0					3.5
1281	2.0	2.6	3.142	0					3.5
1282	2.0	2.5	3.142	0					3.5
1283	2.0	2.5	3.141	0					3.5
1284	2.0	2.4	3.140	0					3.5
1285	2.0	2.4	3.140	0					3.5
1286	2.0	2.3	3.139	0					3.5
1287	2.0	2.3	3.139	0					3.5
1288	2.0	2.3	3.139	0					3.5
1289	2.0	2.2	3.138	0					3.5
1290	2.0	2.2	3.138	0					3.5
1291	2.0	2.2	3.138	0					3.5
1292	2.0	2.2	3.137	0					3.5
1293	2.0	2.2	3.137	0					3.5
1294	2.0	2.1	3.137	0					3.5
1295	2.0	2.1	3.137	0					3.5
1296	2.0	2.1	3.137	0					3.5
1297	2.0	2.1	3.136	0					3.5
1298	2.0	2.1	3.136	0					3.5

1320	2.0	2.0	3.135	0					3.5
1330	2.0	2.0	3.135	0					3.5
1340	2.0	2.0	3.135	0					3.5
1350	2.0	2.0	3.135	0					3.5
1360	2.0	2.0	3.135	0					3.5
1370	2.0	2.0	3.135	0					3.5
1380	2.0	2.0	3.135	0					3.5
1390	2.0	2.0	3.135	0					3.5
1400	2.0	2.0	3.135	0					3.5
1420	2.0	2.0	3.135	0					3.5
1440	2.0	2.0	3.135	0					3.5
1460	2.0	2.0	3.135	0					3.5
1500	2.0	1.8	3.132	0					3.5

Remaining water in basin = 3.13 (Ac.Ft)
Peak flow out of basin = 40.53(CFS)
Peak flow time = 1187 Min., time interval # = 73
Maximum depth in basin = 3.74(Ft.)

BECAUSE:

$Q_{IN} = 48$ cfs $\quad Q_{OUT} = 40.5$ cfs.

THEREFORE, TO BE CONSERVATIVE, IGNORE THIS DEPRESSION AND ASSUME ALL WATER WILL FLOW DOWNSTREAM.

V. DEVELOPED CONDITIONS

A) Design Frequency

Per the City of Palmdale Drainage Management Plan all master plan and local drainage facilities will be generally designed so that the peak run-off for the 10-year storm will be contained at or below the street curbs and the peak run-off from a 25 year storm will be contained within the street right of way. For purposes of providing a conservative drainage system design and to meet the City clear lane requirements, the proposed on-site drainage facilities have been designed to contain the 25-year storm event.

The proposed master plan storm drains, earthen swales, and related culvert facilities, have been designed to convey the 50-year storm event (Capital Flood). The proposed finish floor elevation of all habitable structures shall be designed to be a minimum of one foot above the maximum water level resulting from the Capital Flood.

B) Design Standards and Method of Analysis

1. Off-Site Master Plan Analysis

Generally, the analysis of the off-site hydrology has been prepared based upon the modifications to the City of Palmdale Master Plan of Drainage as presented in the Anaverde Creek Basin Hydrology Study Antelope Valley Freeway to Air Force Plant 42 Basins (ACBHS), as prepared by AKM Consulting Engineering in July 1992. However, due to proposed modifications to the regional facilities we have utilized only those portions of the ACBHS which remain applicable.

The following is a discussion of the assumptions and criteria which were utilized to analyze the off-site master planned run-off and facilities:

a) **Southeast Corner/RCB - Unlined Channel**

This project proposes to realign the master planned drainage system in Sierra Highway by routing the run-off within the 12.5'X6' RCB through the project using an unlined, low velocity, earthen channel facility. In the current ACBHS report the 50-year run-off in the proposed 12.5'X6' RCB is 1,026 cfs at Node 264CD. We have assumed that this 1,026 cfs will enter the project site, through a culvert under the Southern Pacific Railroad, near the southwest corner of the site. This run-off value, as presented in the ACBHS report, is based upon the Modified Rational Method.

b) Northwest Corner/Revised Confluence

Since the capital flood flows within the Sierra Highway RCB will be re-routed into the development the resultant run-off at Avenue M and Sierra Highway will be greatly reduced. In order to compute the revised run-off for this new watershed we have combined the flows at Nodes 269D, 265C, and 266C of the ACBHS report. The resultant combined 50-year flow at this location, designated as Node 270CD, has been computed to be 335 cfs.

c) Northeast Corner/Anaverde Creek at Avenue M

The Capital Flood run-off at Node 279AC, which represents the total flow tributary to the Plant 42 Basin from the west, in Avenue M, is not identified within the ACBHS report. In order to establish the run-off which is tributary westerly to Node 279AC the following procedures has been utilized:

i) To differentiate these hydrologic calculations from the ACBHS and the Master Plan of Drainage we have assigned new Node designations as follows:

- Node 270CD, at Avenue M and Sierra Highway, has been changed to Node 1A.
- Nodes 273E, 274E, 275CE, 276F, 277F, 278CF, 196D, 197D, 195A, 199A, and 200A have been changed to Nodes 4B, 5B, 6AB, 8C, 9C, 10AC, 12D, 13D, 14D, 15D, and 16D, respectfully.
- Node 279AC, at Avenue M and 15th Street East, has been changed to Node 17AD.
- These revised node numbers are illustrated on Exhibit V-2.

ii) The drainage area and hydrologic data in the ACBHS report have been utilized to compute the 50-year run-off at Node 279AC (17AD).

The 50-year storm run-off has been computed to be 1669 cfs. The supporting calculations are provided on Page V-14.

The flow of 1669 cfs was utilized to evaluate the confluence at the westerly limits of the Plant 42 Basin, Node 279AC, as described below:

The ACBHS report shows a major confluence at Node 279AC where the Anaverde Creek and the Avenue M facilities confluence with the proposed expansion of the Plant 42 Retention Basin. The ACBHS report has indicated that run-off from the east side of the Plant 42 Basin, from Nodes 229BE to 270BE will also confluence at this point. Our review of the topography for this area does not support this assumption. Therefore we have re-evaluated the total run-off for node 279AC to consist only of the tributary areas from the west, Nodes 195, 196, 197, 199, 200, 273, 274, 276, and 277, and from the south in the Anaverde Creek facilities, being Node 194CD. Other flows are tributary to the Plant 42 Basin, however, the confluence points are at other locations.

Our analysis indicates the resultant 50-year run-off at Node 279AC to be 3981 cfs. This run-off will enter the Plant 42 Retention Basin at this point. The supporting calculations are shown on Pages V-17 through V-27 and the Node designations are illustrated on Exhibit V-3.

2. <u>On-Site Drainage Facility</u>

The ultimate development of the Palmdale Business Park Center will provide for the parcelization of the major planning areas into smaller developments. This parcelizations will most likely result in a final grading which is somewhat different that the mass grading indicated on the Developed Hydrology Map, Exhibit V-1. In order to provide for the developed run-off for this project we have utilized the following procedure to compute the run-off for the developed condition:

a) The ACBHS report was prepared utilizing the Modified Rational Method. This report identifies 3 drainage areas within the proposed development of the site with confluence points at Avenue M indicated as Nodes 275CD, 278CF, and 200A. The average run-off per acre for these three areas ranged from 0.85 cfs/acre to 0.96 cfs/acre from the 25-year storm. To calculate the on-site developed run-off for the 25 year storm a conservative factor of 1.0 cfs/acre was utilized for all on-site drainage areas.

b) The on-site storm drain system, which has been designed to convey the 25-year storm, confluences with the proposed master planned facilities at several locations. The master planned facilities are designed to convey the 50-year storm. In order to convert the on-site run-off to the 50-year event, we have assumed a conversion factor of 1.3. This factor is conservative

ON-SITE DRAINAGE FACILITY - CONTINUED

and is greater that the Q50=1.114 (Q2)5 relationship which is used by the Corps of Engineers and City of Los Angeles.

Upon development of this project, and the actual design of all drainage facilities, a final hydrologic/hydraulic report shall be prepared using the Modified Rational Method and the actual grading design for each sub-planning area.

C) Master Plan of Drainage Improvements

As noted above, all proposed Master Plan of Drainage regional facilities shall be designed to convey the capital Flood.

The Palmdale Business Center drainage Plan proposes modifications to the City of Palmdale Master Plan of Drainage. Our discussion of these proposed modifications will reference the facilities and computations which are presented in the Anaverde Creek Basin Hydrology Study Antelope Valley Freeway to Air Force Plant 42 (ACBHS) as prepared by AKM Consulting Engineering in July 1992.

The following is a discussion of the regional facilities proposed for this development and their relationship to the facilities identified in the ACBHS. The proposed regional facilities are shown on the Hydrology map for the Developed Condition, Exhibit V-1, and the hydrologic data is shown on Table V-1.

1. Sierra Highway RCB

a) Master Plan Facilities

The Master Plan of Drainage and the ACBHS provide for the construction of a reinforced concrete box (RCB) in Sierra Highway from Avenue N northerly to Avenue M. The ACBHS identifies this facility as a 12.5'x6' RCB. Most of the run-off which is to be conveyed by this facility enters the system upstream, south of Avenue N.

b) Proposed Master Plan Facilities

The drainage plan for this development proposes to re-route the flows from the Maser Plan RCB into the development near the southwest corner of the site. this will be accomplished by terminating the RCB at this location, construction of a culvert system under the Southern Pacific Railroad, and construction of an unlined trapezoidal channel through the golf course portion of the project to Avenue M. This system will eliminate the need to construct the proposed 12.5'x6' RCB northerly to Avenue M.

The RCB from Avenue N to the railroad culvert is not proposed to be constructed as a part of this project. Therefore, until this system is constructed in the future by others, the regional flows will not enter the project into the proposed unlined Channel. However, all proposed regional facilities downstream of the railroad culvert will be designed and constructed to safely convey the 50-year run-off which has been computed in the ACBHS to the 1026 cfs.

2. Sierra Highway at Avenue M

a) Master Plan and Proposed Facilities

The re-routing of the major regional flows from the 12.5'X6' RCB into the site, as described above, will greatly reduce the flows which are tributary to Avenue M at La Sierra. A regional drainage system will still be necessary to intercept and convey 50-year run-off from the westerly areas which are tributary to Node 269D and from the south from drainage areas designated by Nodes 265C and 266C.

The total resultant 50-year run-off at Avenue M and Sierra Highway has been computed to be 335 cfs.

Construction of the storm drain facilities to intercept and convey these flows is not proposed as part of the Palmdale Business Park Center development.

3. Unlined On-Site Channel

The re-routing of the regional flows from the proposed 12.5'X6' RCB is Sierra Highway will be accomplished through the construction of an unlined,low velocity, trapezoidal channel facility within the golf course portion of the development. This facility shall convey the regional flows from the proposed culvert system at the Southern Pacific Railroad to Avenue M.

Culvert systems shall be constructed at roadway crossings of the proposed unlined channel to convey the 50-year run-off.

This unlined channel system will be designed to provide for the safe and adequate conveyance of the tributary regional flows. The design will also minimize maintenance needs.

Typical cross sections for this proposed facility are indicated on the Hydrology Map for the Developed Condition, Exhibit V-1.

This proposed regional drainage facility combined with the proposed storm drain in Avenue M are proposed to replace a portion of the 12.5'X6' RCB in Sierra Highway and the lined trapezoidal channel along Avenue M which are identified in the current Drainage Master Plan and the ACBHS report.

4. Avenue M

a) Master Plan Facilities

The Master Plan of Drainage and the ACBHS report provide for the construction of a lined trapezoidal channel facility along Avenue M from Sierra Highway to the west end of the proposed Plant 42 Retention Basin at 15

Street East. The ACBHS report identifies this lined trapezoidal channel system as a 9'X8' channel from Sierra Highway to 10th Street East and an 11'X8' channel from 10th Street East to 15th Street East. Construction of this channel system, as proposed, would severely limit access to the proposed development by creating an open channel barrier across the entire frontage with Avenue M which is the sole source of access to the development.

b) Proposed Master Plan Facilities

The construction of the proposed unlined trapezoidal channel through the golf course portion of the project results in a significant reduction in peak flows which are tributary to Avenue M. Considering this reduction in peak flow, the need for adequate access to Avenue M, and construction constraints at the existing reservoir site between 5th and 6th Streets East an underground storm drain has been proposed in Avenue M from 3rd Street East to the confluence with the unlined channel at Planning Area GC-1.

The proposed storm drain in Avenue M will consist of an 84" to a 90" RCP with a maximum 50-year flow of 555 cfs.

At the confluence of this storm drain and the on-site unlined trapezoidal channel another unlined trapezoidal channel shall be constructed along the south side of Avenue M. This master plan facility will convey the regional flows to a proposed RCB which will discharge into the proposed expansion of the Plant 42 Basin.

The total 50-year run-off from this entire watershed has been computed to be 1669 cfs. This flow will confluence with the Anaverde Creek at the west end of the Plant 42 Retention Basin.

5. Expansion of the Plant 42 Retention Basin

All of the master planned regional facilities described above are ultimately tributary to the Plant 42 Retention Basin. The existing Plant 42 Basin facilities do not have the capacity to provide for the proposed run-off which will be conveyed by these drainage facilities. Therefore, the Plant 42 Basin will need to expanded to provide for the ultimate capacity.

The proposed expansion of this basin is described in the ACBHS report.

EXPANSION OF PLANT 42 RETENTION BASIN - CONTINUED

In order to facilitate the increased run-off which is generated by the development of the Palmdale Business Park Center we propose to construct a temporary on-site detention facility, in accordance with City design requirements, or to construct an incremental expansion of the Plant 42 Retention Basin immediately easterly of Avenue 15 Street East. This incremental expansion shall be performed to the ultimate design of the Plant 42 Basin.

D. PROPOSED ON-SITE DRAINAGE IMPROVEMENTS

In addition to the proposed regional drainage improvements an on-site drainage system shall be constructed to convey run-off from the internal street system into the regional facilities. This storm drain system will consist of catch basins and reinforced concrete pipe systems.

These on-site improvements are shown on the Hydrology Map for the Developed Condition, Exhibit V-1.

As noted previously, the pipe sizes indicated in Exhibit V-1 represent a conservative design in that the 25-year storm has been utilized in these preliminary calculations. Further computations, during the final design stage of the project, may provide for downsizing of these facilities.

All of the proposed on-site drainage facilities have been designed to ultimately discharge into the regional drainage facilities.

All proposed on-site drainage facilities shall be constructed within the street right-of-way or within easements dedicated to the City of Palmdale for drainage purposes.

The hydrologic data for the on-site proposed storm drain system is summarized in Table V-2.

The proposed golf course consists of a total area of approximately 236.4 acres. Approximately one half of this area, 118 acres, will be utilized to provide on-site retention of storm flows. This on-site retention shall consist of localized depressions, located between the tees, fairways and greens of this golf course. The design of these depressions shall be such that the maximum ponding shall be limited to a maximum of 2 feet. Percolation tests performed over this site indicated a minimum percolation rate of 20 gal/sf/day can be conservatively anticipated. This percolation rate will provide for the total elimination of standing water within a one day period, well below the City's standard requirement for detention facilities.

TABLE V-2

PROPOSED STORM DRAIN
FOR
LOCKHEED BUSINESS PARK CENTER

NOTES : 1. Q25 = 1.0 cfs (Conservative)
(Estimated from A.K.M Master Drainage Study).
2. Q's & Pipe sizes will be revised at final engineering.

Line No.	Area (Ac)	Q25 (cfs)	Pipe Size (in)
A	8.4	8.0	18
B	3.4	3.5	18
C	9.7	10.0	18
D	36.9	37.0	27
E	29.7	30.0	27
F	3.6	3.5	18
G	32.1	32.0	27
H	9.3	9.0	18
I	9.0	9.0	18
J	15.2	15.0	18
K	14.4	14.5	18
L	171.0	171.0	66
L1	84.6	84.5	48
L2	33.9	34.0	27
M	40.1	40.0	30

E) Floodway and Floodplain Management

Flood Hazard Zones have been delinated by the Federal Emergency Management Agency (FEMA) for the Anaverde and Amargosa Creeks. These Flood Hazard Zones, within the City of Palmdale, are shown on the Flood Insurance Rate Map (FIRM) Community Panel Number 060144 0010 C, Figure V-1. The vast majority of the proposed development is classified as Zone X which refers to areas which are determined to be outside of the 500-year floodplain. A small portion of the site, at the most northwesterly corner, is identified as Zone AO (depth 1) which refers to an area which is subject to flooding during the 100-year flood event to an average depth of approximately 1 foot. The flood hazard zone at the northwest corner is due to a breakout of the Amargosa Creek near Interstate 14 at Avenue P. Construction of regional drainage facilities, pursuant to the City of Palmdale Master Plan of Drainage, will provide of interception of these flows along Sierra Highway and will eliminate flooding within this area of the project.

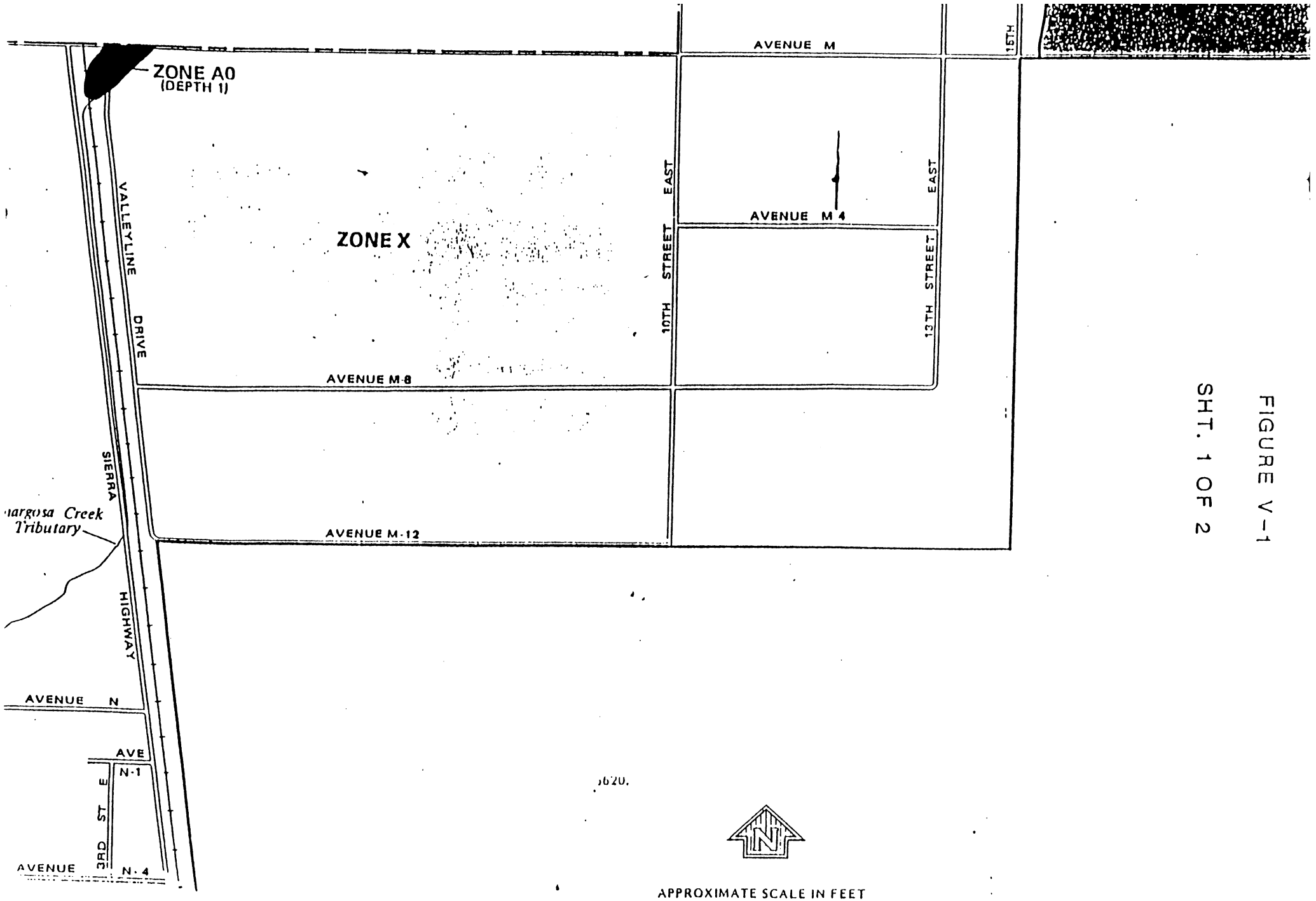
The Palmdale Business Park Center has been designed so as to avoid development within this floodplain area until such time as these regional facilities have been constructed. An interim drainage easement is proposed at this location which affects Planning Areas GC-5 and CC-1. Upon completion of these regional facilities a Letter of Map Revision (LOMR) shall be processed and approved by FEMA in order to remove this area from the flood hazard zone classifications. Once the LOMR is complete the interim drainage easement shall be quitclaimed and then grading and development can occur within that portion of CC-1.

F. Facility Maintenance

All of the proposed drainage facilities shall be constructed in accordance with the City of Palmdale Drainage Management Plan. The system shall be designed and constructed to provide a system with minimum maintenance requirements wherever possible.

Maintenance of all proposed regional drainage facilities and infrastructure drainage facilities shall be the responsibility of the City of Palmdale.

All proposed regional drainage facilities and infrastructure drainage facilities shall be constructed within the public street right-of-way or within drainage easements which are dedicated to the City of Palmdale.



FEMA MAP

FIGURE V-1

SHT. 1 OF 2

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A	No base flood elevations determined.
ZONE AE	Base flood elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE A99	To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.
ZONE V	Coastal flood with velocity hazard (wave action); no base flood elevations determined.
ZONE VE	Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X	Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X	Areas determined to be outside 500-year flood plain.
ZONE D	Areas in which flood hazards are undetermined.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

~~~~ 513 ~~~~ Base Flood Elevation Line; Elevation in Feet*

(D) —— (D) Cross Section Line

(EL 987) Base Flood Elevation in Feet Where Uniform Within Zone*

BM7 X Elevation Reference Mark

*Referenced to the National Geodetic Vertical Datum of 1929

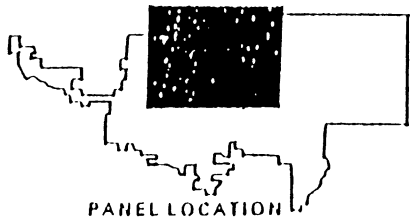
FEMA MAP

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

CITY OF
PALMDALE,
CALIFORNIA
LOS ANGELES COUNTY

PANEL 10 OF 25
(SEE MAP INDEX FOR PANELS NOT PRINTED)



COMMUNITY-PANEL NUMBER
060144 0010 C

MAP REVISED:
JUNE 10, 1987

Federal Emergency Management Agency

SHT. 2 OF 2

FIGURE V-1
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G. Developed Hydrology Calculations

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT FILE : BASIN42 INPUT HYDROGRAPH : PALM50.HY2

STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1	1A	1571.	1305.	1571.	1305.	0	0.	.00000	.00	.00	0.	103	0	ISO	.00
1	2A	0.	0.	1571.	1305.	5	2800.	.00400	14.00	.00	0.	103	50	ISO	.00
1	3A	0.	0.	1571.	1276.	0	0.	.00000	.00	.00	0.	103	99	ISO	.00
1	4B	75.	99.	75.	99.	4	1200.	.00800	3.75	.00	0.	103	21	ISO	.90
1	5B	79.	104.	154.	201.	0	0.	.00000	.00	.00	0.	103	22	ISO	.90

* CONFLUENCE Q'S *

* 1 6A TA 1176 QA 1276. QAB 1352. QB 76. 1 6B TB 1160 QB 201. QBA 808. QA 608. *

* 1 6AB TAB 1173 QAB 1372. QA 1225. QB 147. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1	6AB	154.	201.	1725.	1372.	5	2000.	.00400	14.00	.00	0.	103	0	ISO	.00
1	7A	0.	0.	1725.	1353.	0	0.	.00000	.00	.00	0.	103	99	ISO	.00
1	8C	62.	88.	62.	88.	4	1200.	.00800	3.50	.00	0.	103	20	ISO	.90
1	9C	60.	85.	122.	171.	0	0.	.00000	.00	.00	0.	103	20	ISO	.90

* CONFLUENCE Q'S *

* 1 10A TA 1177 QA 1353. QAC 1391. QC 38. 1 10C TC 1160 QC 171. QCA 841. QA 670. *

* 1 10AC TAC 1177 QAC 1391. QA 1353. QC 38. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1	10AC	122.	171.	1847.	1391.	5	2800.	.00700	13.00	.00	0.	103	0	ISO	.00
1	11A	0.	0.	1847.	1380.	0	0.	.00000	.00	.00	0.	103	99	ISO	.00
1	12D	73.	100.	73.	100.	4	2150.	.00800	3.75	.00	0.	103	21	ISO	.90
1	13D	64.	98.	137.	187.	4	2150.	.00400	5.25	.00	0.	103	18	ISO	.90
1	14D	92.	113.	229.	287.	4	1300.	.00600	5.75	.00	0.	103	24	ISO	.90
1	15D	90.	118.	319.	388.	4	1200.	.00600	6.25	.00	0.	103	22	ISO	.90
1	16D	87.	114.	406.	481.	0	0.	.00000	.00	.00	0.	103	22	ISO	.90

* CONFLUENCE Q'S *

* 1 17A TA 1181 QA 1380. QAD 1610. QD 231. 1 17D TD 1169 QD 481. QDA 1514. QA 1033. *

* 1 17AD TAD 1176 QAD 1669. QA 1310. QD 359. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
1	17AD	406.	481.	2253.	1669.	0	0.	.00000	.00	.00	0.	103	0	ISO	.00

Exhibit V-2

DEVELOPED Q50 AT NE. CORNER OF THE PROJECT SITE

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 4ZBASIN STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	21A	58.	89.	58.	89.	0	0.	.00000	.00	.00	0.	103	14	I50	.35
9	22A	47.	75.	105.	164.	4	1000.	.02400	3.50	.00	0.	103	13	I50	.32
9	23A	61.	95.	166.	256.	4	1700.	.02400	4.25	.00	0.	103	14	I50	.40
9	24A	81.	120.	247.	364.	0	0.	.00000	.00	.00	0.	103	15	I50	.40
9	25B	36.	62.	36.	62.	3	900.	.08000	.00	.00	0.	103	12	I50	.33
9	26B	51.	82.	87.	140.	0	0.	.00000	.00	.00	0.	103	13	I50	.33
9	27B	49.	79.	136.	218.	4	1900.	.04400	3.50	.00	0.	103	13	I50	.33
9	28B	28.	44.	164.	255.	4	820.	.04400	3.75	.00	0.	103	14	I50	.40

CONFLUENCE Q'S

9 29A TA 1159 QA 364. QAB 617. QB 254. 9 29B TB 1160 QB 254. QBA 615. QA 361.

9 29AB TAB 1159 QAB 617. QA 364. QB 254.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	29AB	164.	254.	411.	617.	4	1400.	.02000	6.00	.00	0.	103	0	I50	.00
9	30A	82.	128.	493.	731.	4	1300.	.01600	6.75	.00	0.	103	16	I50	.67
9	31A	32.	66.	525.	774.	4	1350.	.01400	7.00	.00	0.	103	12	I50	.90
9	32A	50.	93.	575.	837.	0	0.	.00000	.00	.00	0.	103	14	I50	.90
9	33B	57.	97.	57.	97.	3	1000.	.02000	.00	.00	0.	103	12	I50	.33
9	34B	45.	72.	102.	159.	4	1600.	.02700	3.50	.00	0.	103	13	I50	.33
9	35B	44.	62.	146.	214.	4	1300.	.02700	4.00	.00	0.	103	16	I50	.40
9	36B	68.	95.	214.	297.	4	1500.	.02000	4.50	.00	0.	103	16	I50	.40
9	37B	40.	53.	254.	339.	0	0.	.00000	.00	.00	0.	103	17	I50	.40
9	38B	0.	0.	254.	339.	0	0.	.00000	.00	.00	0.	103	99	I50	.00
9	39C	10343.	313.	10343.	313.	4	2100.	.01500	5.00	.00	0.	103	0	I50	.00
9	40C	56.	74.	10399.	372.	4	1200.	.01500	5.25	.00	0.	103	17	I50	.40

CONFLUENCE Q'S

9 41B TB 1164 QB 339. QBC 706. QC 367. 9 41C TC 1158 QC 371. QCB 653. QB 282.

9 41BC TBC 1163 QBC 706. QB 338. QC 368.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	41BC	10399.	371.	10653.	706.	4	1300.	.01500	6.75	.00	0.	103	0	I50	.00
9	42D	61.	100.	61.	100.	3	1500.	.01500	.00	.00	0.	103	16	I50	.80
9	43D	40.	62.	101.	149.	0	0.	.00000	.00	.00	0.	103	18	I50	.90

CONFLUENCE Q'S

9 44B TB 1165 QB 705. QBD 851. QD 146. 9 44D TD 1162 QD 149. QDB 835. QB 686.

9 44BD TBD 1165 QBD 851. QB 705. QD 146.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	44BD	101.	149.	10754.	851.	4	1200.	.01500	7.25	.00	0.	103	0	I50	.00

E:

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 4ZBASIN STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

CONFLUENCE Q'S

9 45A TA 1167 QA 837. QAB 1667. QB 836. 9 45B TB 1166 QB 862. QBA 1618. QA 762.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	45AB	10754.	849.	11329.	1674.	5	2750.	.01500	12.00	.00	0.	103	0	I50	.00
9	46A	30.	48.	11359.	1689.	0	0.	.00000	.00	.00	0.	103	17	I50	.90
9	47B	60.	56.	60.	56.	4	1300.	.01600	2.75	.00	0.	103	27	I50	.52
9	48B	45.	84.	105.	135.	4	1200.	.01600	3.50	.00	0.	103	14	I50	.90
9	49B	52.	97.	157.	223.	4	1700.	.00800	5.00	.00	0.	103	14	I50	.90
9	50B	45.	76.	202.	286.	4	700.	.01000	5.25	.00	0.	103	16	I50	.90
9	51C	95.	78.	95.	78.	4	1400.	.01300	3.00	.00	0.	103	30	I50	.43
9	52C	63.	101.	158.	174.	4	1050.	.01300	4.00	.00	0.	103	17	I50	.90
9	53C	37.	69.	195.	235.	4	1500.	.01300	4.50	.00	0.	103	14	I50	.90
9	54C	37.	69.	232.	289.	0	0.	.00000	.00	.00	0.	103	14	I50	.90

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* CONFLUENCE Q'S

* 9 55B TB 1164 QB 285. QBC 568. QC 282. 9 55C TC 1162 QC 289. QCB 571. QB 281.

* 9 55BC TBC 1163 QBC 572. QB 284. QC 288.

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LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	55BC	232.	289.	434.	572.	0	0.	.00000	.00	.00	0.	103	0	I50	.00

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* CONFLUENCE Q'S

* 9 56A TA 1166 QA 1689. QAB 2215. QB 526. 9 56B TB 1163 QB 572. QBA 2134. QA 1562.

* 9 56AB TAB 1165 QAB 2225. QA 1669. QB 557.

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LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	56AB	434.	572.	11793.	2225.	5	1900.	.00600	15.00	.00	0.	103	0	I50	.00
9	57A	0.	0.	11793.	2197.	0	0.	.00000	.00	.00	0.	103	99	I50	.00
9	58A	0.	0.	11793.	2197.	0	0.	.00000	.00	.00	0.	103	99	I50	.00
9	59A	0.	0.	11793.	2197.	0	0.	.00000	.00	.00	0.	103	99	I50	.00
9	60D	28.	45.	28.	45.	4	1600.	.00800	2.75	.00	0.	103	17	I50	.87
9	61D	57.	81.	85.	121.	0	0.	.00000	.00	.00	0.	103	20	I50	.90
9	62E	43.	61.	43.	61.	2	1400.	.00800	.00	.00	0.	103	20	I50	.90

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* CONFLUENCE Q'S

* 9 63D TD 1160 QD 121. QDE 160. QE 38. 9 63E TE 1170 QE 55. QED 150. QD 95.

* 9 63DE TDE 1165 QDE 169. QD 116. QE 52.

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LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 42BASIN STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	63DE	43.	55.	128.	169.	4	2500.	.00600	4.75	.00	0.	103	0	I50	.00
9	64D	56.	86.	184.	226.	4	500.	.00600	5.25	.00	0.	103	18	I50	.90
9	65D	56.	100.	240.	292.	0	0.	.00000	.00	.00	0.	103	15	I50	.90

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* CONFLUENCE Q'S

* 9 66A TA 1168 QA 2197. QAD 2441. QD 244. 9 66D TD 1164 QD 292. QDA 2270. QA 1978.

* 9 66AD TAD 1167 QAD 2446. QA 2190. QD 256.

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LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	66AD	240.	292.	12033.	2446.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
9	67F	40.	70.	40.	70.	4	1300.	.00600	3.50	.00	0.	103	15	I50	.83
9	68F	45.	80.	85.	141.	4	800.	.00600	4.50	.00	0.	103	15	I50	.90

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* 9 69AF TAF 1167 QAF 2566. QA 2446. QF 120. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	69AF	85.	140.	12118.	2566.	5	1400.	.00600	16.00	.00	0.	103	0	I50	.00
9	70A	43.	54.	12161.	2597.	0	0.	.00000	.00	.00	0.	103	22	I50	.80
9	71D	39.	43.	39.	43.	4	1300.	.00600	2.75	.00	0.	103	21	I50	.40
9	72D	40.	45.	79.	85.	4	950.	.00600	3.75	.00	0.	103	21	I50	.45
9	73D	37.	43.	116.	125.	0	0.	.00000	.00	.00	0.	103	20	I50	.45

* CONFLUENCE Q'S *

* 9 74A TA 1169 QA 2597. QAD 2713. QD 116. 9 74D TD 1163 QD 125. QDA 2193. QA 2068. *

* 9 74AD TAD 1168 QAD 2715. QA 2596. QD 119. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	74AD	116.	125.	12277.	2715.	5	1550.	.00600	17.00	.00	0.	103	0	I50	.00
9	75A	44.	74.	12321.	2712.	0	0.	.00000	.00	.00	0.	103	16	I50	.90
9	76B	41.	59.	41.	59.	3	800.	.02400	.00	.00	0.	103	14	I50	.20
9	77B	36.	54.	77.	108.	4	1850.	.02400	3.00	.00	0.	103	15	I50	.40
9	78B	38.	74.	115.	168.	4	2700.	.01800	3.75	.00	0.	103	12	I50	.73
9	79B	61.	114.	176.	248.	4	600.	.01300	4.75	.00	0.	103	14	I50	.90
9	80C	60.	88.	60.	88.	4	1200.	.01500	3.25	.00	0.	103	15	I50	.37
9	81C	32.	38.	92.	124.	4	1400.	.01300	3.75	.00	0.	103	19	I50	.40
9	82C	43.	52.	135.	172.	0	0.	.00000	.00	.00	0.	103	20	I50	.50
9	83D	36.	48.	36.	48.	3	1250.	.01500	.00	.00	0.	103	17	I50	.40

TE: PAGE 5

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MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 42BASIN STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

* CONFLUENCE Q'S *

* 9 84C TC 1161 QC 172. QCD 215. QD 43. 9 84D TD 1164 QD 44. QDC 211. QC 167. *

* 9 84CD TCD 1161 QCD 215. QC 172. QD 43. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	84CD	36.	44.	171.	215.	4	1300.	.01300	4.50	.00	0.	103	0	I50	.00
9	85C	37.	55.	208.	262.	0	0.	.00000	.00	.00	0.	103	17	I50	.70
9	86E	51.	78.	51.	78.	3	1350.	.02800	.00	.00	0.	103	14	I50	.35
9	87E	42.	59.	93.	127.	0	0.	.00000	.00	.00	0.	103	16	I50	.40
9	88F	39.	57.	39.	57.	3	750.	.02700	.00	.00	0.	103	14	I50	.25
9	89F	33.	48.	72.	101.	3	1400.	.02700	.00	.00	0.	103	15	I50	.35
9	90F	47.	66.	119.	155.	0	0.	.00000	.00	.00	0.	103	16	I50	.40

* CONFLUENCE Q'S *

* 9 91E TE 1160 QE 127. QEF 280. QF 152. 9 91F TF 1162 QF 155. QFE 280. QE 125. *

* 9 91EF TEF 1161 QEF 282. QE 127. QF 155. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	91EF	119.	155.	212.	282.	4	1200.	.01500	4.75	.00	0.	103	0	I50	.00
9	92E	42.	56.	254.	329.	4	1300.	.01500	5.00	.00	0.	103	17	I50	.40
9	93E	36.	61.	290.	376.	0	0.	.00000	.00	.00	0.	103	16	I50	.90

* CONFLUENCE Q'S *

* 9 94C TC 1164 QC 262. QCE 638. QE 376. 9 94E TE 1164 QE 376. QEC 638. QC 262. *

* 9 94CE TCE 1164 QCE 638. QC 262. QE 376. *

9	94CZ	290.	376.	498.	638.	4	1400.	.01300	6.50	.00	0.	103	0	I50	.00

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CONFLUENCE Q'S

* 9 95B TB 1164 QB 247. QBC 861. QC 614. 9 95C TC 1167 QC 631. QCB 825. QB 194.

* 9 95BC TBC 1165 QBC 866. QB 241. QC 625.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 95BC	498.	631.	674.	866.	5	1400.	.00600	11.00	.00	0.	103	0	I50	.00
9 96B	45.	70.	719.	907.	5	1100.	.00600	11.00	.00	0.	103	17	I50	.80
9 97B	40.	70.	759.	913.	0	0.	.00000	.00	.00	0.	103	15	I50	.83
9 98C	67.	74.	67.	74.	4	1000.	.00600	3.50	.00	0.	103	21	I50	.40
9 99C	55.	63.	122.	135.	4	650.	.00400	4.75	.00	0.	103	20	I50	.40
9 100C	152.	184.	274.	316.	4	1100.	.00600	6.00	.00	0.	103	22	I50	.70

ATE:

TIME:

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUTS0.HYD INPUT FILE : 42BASIN

STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

*

CONFLUENCE Q'S

* 9 101B TB 1168 QB 913. QBC 1216. QC 303. 9 101C TC 1164 QC 314. QCB 1149. QB 834.

* 9 101BC TBC 1167 QBC 1218. QB 911. QC 307.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 101BC	274.	314.	1033.	1218.	5	2800.	.00600	12.00	.00	0.	103	0	I50	.00
9 102D	40.	70.	40.	70.	4	1100.	.01300	3.00	.00	0.	103	15	I50	.83
9 103D	37.	64.	77.	130.	4	1000.	.00300	4.75	.00	0.	103	15	I50	.83
9 104D	53.	47.	130.	172.	4	1000.	.00300	5.25	.00	0.	103	27	I50	.40
9 105D	55.	48.	185.	217.	4	700.	.00300	5.75	.00	0.	103	27	I50	.40
9 106D	42.	46.	227.	258.	4	650.	.00300	6.25	.00	0.	103	24	I50	.64
9 107D	35.	49.	262.	295.	0	0.	.00000	.00	.00	0.	103	20	I50	.86

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CONFLUENCE Q'S

* 9 108B TB 1171 QB 1191. QBD 1478. QD 287. 9 108D TD 1168 QD 295. QDB 1411. QB 1116.

* 9 108BD TBD 1171 QBD 1478. QB 1191. QD 287.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 108BD	262.	295.	1295.	1478.	5	2600.	.00600	13.00	.00	0.	103	0	I50	.00
9 109B	159.	256.	1454.	1487.	5	1100.	.00600	13.00	.00	0.	103	17	I50	.90

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CONFLUENCE Q'S

* 9 110A TA 1170 QA 2712. QAB 3999. QB 1287. 9 110B TB 1176 QB 1483. QBA 3756. QA 2273.

* 9 110AB TAB 1172 QAB 4035. QA 2669. QB 1367.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 110AB	1454.	1483.	13775.	4035.	5	1750.	.00800	20.00	.00	0.	103	0	I50	.00
9 111A	46.	74.	13821.	4033.	5	1250.	.00800	20.00	.00	0.	103	17	I50	.90
9 112A	53.	82.	13874.	4037.	5	800.	.00400	26.00	.00	0.	103	18	I50	.90
9 113A	47.	72.	13921.	4041.	5	1350.	.00400	26.00	.00	0.	103	18	I50	.90
9 114C	51.	86.	51.	86.	4	1250.	.00800	3.50	.00	0.	103	16	I50	.90
9 115C	42.	71.	93.	151.	0	0.	.00000	.00	.00	0.	103	16	I50	.90

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CONFLUENCE Q'S

* 9 116A TA 1177 QA 4030. QAC 4055. QC 25. 9 116C TC 1159 QC 151. QCA 1625. QA 1474.

* 9 116AC TAC 1177 QAC 4055. QA 4030. QC 25.

9	116AC	93.	151.	14014.	4055.	5	1200.	.00400	26.00	.00	0.	103	0	I50	.00
9	117D	48.	81.	48.	81.	4	1250.	.00800	3.50	.00	0.	103	16	I50	.90
9	118D	40.	68.	88.	143.	0	0.	.00000	.00	.00	0.	103	16	I50	.90

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MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 4ZBASIN STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

* CONFLUENCE Q'S *

* 9 119A TA 1179 QA 4042. QAD 4064. QD 22. 9 119D TD 1159 QD 143. QDA 1635. QA 1492. *

* 9 119AD TAD 1179 QAD 4064. QA 4042. QD 22. *

9	119AD	88.	143.	14102.	4064.	5	1850.	.00700	21.00	.00	0.	103	0	I50	.00
9	120F	45.	64.	45.	64.	3	1600.	.00400	.00	.00	0.	103	20	I50	.90
9	121F	46.	65.	91.	112.	0	0.	.00000	.00	.00	0.	103	20	I50	.90

* CONFLUENCE Q'S *

* 9 122A TA 1181 QA 4048. QAF 4095. QF 47. 9 122F TF 1167 QF 112. QFA 2318. QA 2206. *

* 9 122AF TAF 1180 QAF 4098. QA 4046. QF 51. *

9	122AF	91.	112.	14193.	4098.	5	1200.	.00700	22.00	.00	0.	103	0	I50	.00
9	123A	0.	0.	14193.	4089.	0	0.	.00000	.00	.00	0.	103	99	I50	.00
9	124B	30.	43.	30.	43.	4	1000.	.00600	2.75	.00	0.	103	15	I50	.30
9	125B	73.	100.	103.	136.	4	800.	.01000	4.00	.00	0.	103	16	I50	.35
9	126B	20.	30.	123.	163.	0	0.	.00000	.00	.00	0.	103	14	I50	.30
9	127C	63.	85.	63.	85.	3	500.	.01000	.00	.00	0.	103	17	I50	.43
9	128C	45.	60.	108.	143.	3	1100.	.01500	.00	.00	0.	103	17	I50	.43

* CONFLUENCE Q'S *

* 9 129B TB 1159 QB 163. QBC 290. QC 126. 9 129C TC 1163 QC 138. QCB 294. QB 155. *

* 9 129BC TBC 1161 QBC 299. QB 162. QC 137. *

9	129BC	108.	138.	231.	299.	0	0.	.00000	.00	.00	0.	103	0	I50	.00
9	130D	73.	78.	73.	78.	0	0.	.00000	.00	.00	0.	103	20	I50	.25

* CONFLUENCE Q'S *

* 9 131B TB 1161 QB 299. QBD 374. QD 76. 9 131D TD 1155 QD 78. QDB 280. QB 202. *

* 9 131BD TBD 1161 QBD 374. QB 299. QD 76. *

9	131BD	73.	78.	304.	374.	4	1000.	.01500	5.25	.00	0.	103	0	I50	.00
9	132B	43.	51.	347.	418.	4	1500.	.01500	5.50	.00	0.	103	18	I50	.25
9	133B	71.	78.	418.	487.	4	1250.	.01500	5.75	.00	0.	103	21	I50	.40
9	134B	58.	59.	476.	539.	0	0.	.00000	.00	.00	0.	103	23	I50	.40
9	135C	37.	39.	37.	39.	3	350.	.00600	.00	.00	0.	103	22	I50	.40
9	136D	46.	63.	46.	63.	4	1200.	.01500	2.75	.00	0.	103	16	I50	.33

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MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 4ZBASIN STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

9	138D	77.	124.	170.	240.	4	1000.	.00600	5.25	.00	0.	103	17	I50	.90
9	139D	58.	57.	228.	293.	4	1600.	.00600	5.75	.00	0.	103	24	I50	.40

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CONFLUENCE Q'S

* 9 140B TB 1167 QB 539. QBC 575. QC 37. 9 140C TC 1160 QC 39. QCB 487. QB 448.

* 9 140BC TBC 1166 QBC 576. QB 538. QC 37.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 140BC	37.	39.	513.	576.	4	500.	.00600	7.25	.00	0.	103	0	I50	.00

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CONFLUENCE Q'S

* 9 141B TB 1168 QB 574. QBD 862. QD 288. 9 141D TD 1169 QD 289. QDB 861. QB 572.

* 9 141BD TBD 1168 QBD 862. QB 574. QD 288.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 141BD	228.	289.	741.	862.	5	1200.	.00600	11.00	.00	0.	103	0	I50	.00
9 142B	60.	78.	801.	912.	5	1250.	.00600	11.00	.00	0.	103	19	I50	.58
9 143B	72.	98.	873.	967.	0	0.	.00000	.00	.00	0.	103	19	I50	.70
9 144C	50.	78.	50.	78.	3	1250.	.00600	.00	.00	0.	103	17	I50	.80
9 145C	53.	77.	103.	141.	4	1300.	.00700	4.25	.00	0.	103	19	I50	.85
9 146D	39.	54.	39.	54.	4	1350.	.00600	3.00	.00	0.	103	19	I50	.73
9 147D	55.	78.	94.	125.	0	0.	.00000	.00	.00	0.	103	17	I50	.57

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CONFLUENCE Q'S

* 9 148C TC 1167 QC 140. QCD 246. QD 106. 9 148D TD 1160 QD 125. QDC 242. QC 117.

* 9 148CD TCD 1164 QCD 257. QC 136. QD 121.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 148CD	94.	125.	197.	257.	4	1300.	.00700	5.25	.00	0.	103	0	I50	.00

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CONFLUENCE Q'S

* 9 149B TB 1169 QB 967. QBC 1217. QC 250. 9 149C TC 1167 QC 254. QCB 1192. QB 938.

* 9 149BC TBC 1169 QBC 1217. QB 967. QC 250.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 149BC	197.	254.	1070.	1217.	5	1900.	.00500	13.00	.00	0.	103	0	I50	.00
9 150B	45.	56.	1115.	1240.	5	850.	.00500	13.00	.00	0.	103	22	I50	.78
9 151B	56.	48.	1171.	1279.	0	0.	.00000	.00	.00	0.	103	30	I50	.52
9 152C	62.	88.	62.	88.	4	700.	.00500	3.75	.00	0.	103	20	I50	.90
9 153C	43.	51.	105.	138.	4	700.	.00500	4.50	.00	0.	103	24	I50	.82
9 154C	40.	45.	145.	182.	4	700.	.00500	5.00	.00	0.	103	24	I50	.70

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 42BASIN STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 155C	43.	48.	188.	230.	4	1200.	.00500	5.50	.00	0.	103	24	I50	.70

*

CONFLUENCE Q'S

* 9 156B TB 1173 QB 1279. QBC 1495. QC 216. 9 156C TC 1167 QC 228. QCB 1287. QB 1059.

* 9 156BC TBC 1172 QBC 1497. QB 1277. QC 220.

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 156BC	188.	228.	1359.	1497.	5	1250.	.00500	14.00	.00	0.	103	0	I50	.00
9 157B	54.	82.	1413.	1506.	5	1300.	.00500	14.00	.00	0.	103	18	I50	.80

9	160C	48.	77.	85.	115.	4	1000.	.00500	4.25	.00	0.	103	17	ISO .90
9	161C	66.	87.	151.	193.	4	1000.	.00500	5.00	.00	0.	103	22	ISO .90
9	162C	65.	85.	216.	269.	4	1200.	.00500	5.75	.00	0.	103	22	ISO .90

* CONFLUENCE Q'S *

* 9 163B TB 1176 QB 1507. QBC 1716. QC 209. 9 163C TC 1170 QC 268. QC3 1564. QB 1296. *

* 9 163BC TBC 1175 QBC 1734. QB 1499. QC 235. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	163BC	216.	268.	1687.	1734.	5	1400.	.00500	15.00	.00	0.	103	0	ISO	.00
9	164B	62.	90.	1749.	1734.	0	0.	.00000	.00	.00	0.	103	17	ISO	.63
9	165C	48.	77.	48.	77.	4	1300.	.00500	3.75	.00	0.	103	17	ISO	.90

* CONFLUENCE Q'S *

* 9 166B TB 1177 QB 1734. QBC 1750. QC 16. 9 166C TC 1161 QC 75. QC3 948. QB 874. *

* 9 166BC TBC 1177 QBC 1750. QB 1734. QC 16. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	166BC	48.	75.	1797.	1750.	5	1300.	.00500	15.00	.00	0.	103	0	ISO	.00
9	167B	65.	73.	1862.	1756.	0	0.	.00000	.00	.00	0.	103	24	ISO	.70
9	168D	38.	58.	38.	58.	4	700.	.00500	3.25	.00	0.	103	18	ISO	.90

* CONFLUENCE Q'S *

* 9 169B TB 1178 QB 1756. QBD 1766. QD 10. 9 169D TD 1160 QD 58. QDB 911. QB 853. *

* 9 169BD TBD 1178 QBD 1766. QB 1756. QD 10. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	169BD	38.	58.	1900.	1766.	5	1300.	.00400	15.00	.00	0.	103	0	ISO	.00
9	170B	47.	76.	1947.	1771.	5	1600.	.00400	15.00	.00	0.	103	17	ISO	.90
9	171B	41.	63.	1988.	1769.	0	0.	.00000	.00	.00	0.	103	18	ISO	.90

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 42BASIN STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

* CONFLUENCE Q'S *

* 9 172A TA 1182 QA 4089. QAB 5858. QB 1769. 9 172B TB 1182 QB 1769. QBA 5858. QA 4089. *

* 9 172AB TAB 1182 QAB 5858. QA 4089. QB 1769. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	172AB	1988.	1769.	16181.	5858.	5	700.	.00400	35.00	.00	0.	103	0	ISO	.00
9	173C	76.	108.	76.	108.	3	2600.	.00700	.00	.00	0.	103	20	ISO	.90
9	174C	55.	78.	131.	154.	0	0.	.00000	.00	.00	0.	103	20	ISO	.90

* CONFLUENCE Q'S *

* 9 175A TA 1183 QA 5848. QAC 5918. QC 70. 9 175C TC 1168 QC 154. QCA 3467. QA 3313. *

* 9 175AC TAC 1182 QAC 5918. QA 5842. QC 76. *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	175AC	131.	154.	16312.	5918.	5	1600.	.00400	36.00	.00	0.	103	0	ISO	.00
9	176D	110.	131.	110.	131.	3	2600.	.00800	.00	.00	0.	103	25	ISO	.90
9	177D	79.	104.	189.	208.	0	0.	.00000	.00	.00	0.	103	22	ISO	.90

* CONFLUENCE Q'S *

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	178AD	189.	208.	16501.	6017.	5	1300.	.00400	36.00	.00	0.	103	0	I50	.00
9	179F	103.	123.	103.	123.	3	2600.	.00600	.00	.00	0.	103	25	I50	.90
9	180F	71.	93.	174.	186.	0	0.	.00000	.00	.00	0.	103	22	I50	.90

* CONFLUENCE Q'S

* 9 181A TA 1185 QA 5997. QAF 6103. QF 106. 9 181F TF 1169 QF 186. QFA 3422. QA 3236.

* 9 181AF TAF 1185 QAF 6103. QA 5997. QF 106.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	181AF	174.	186.	16675.	6103.	5	1300.	.00600	31.00	.00	0.	103	0	I50	.00

* CONFLUENCE Q'S

* 9 182A TA 1187 QA 6088. QAE 1400. QE 4688. 9 182E TE 1187 QE 4688. QEA 1400. QA 6088.

* 9 182AE TAE 1100 QAE 1400. QA 1416. QE 16.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	182AE	0.	4688.	16675.	1400.	0	0.	.00000	.00	.00	1400.	103	0	I50	.00

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUTS0.HY2 INPUT FILE : 4ZBASIN STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	183A	0.	0.	16675.	1400.	0	0.	.00000	.00	.00	0.	103	99	I50	.90
9	184A	0.	0.	16675.	1400.	0	0.	.00000	.00	.00	0.	103	99	I50	.90
9	185A	112.	147.	16787.	1547.	5	1300.	.00600	14.00	.00	0.	103	22	I50	.90
9	186A	93.	122.	16880.	1669.	5	1200.	.00600	14.00	.00	0.	103	22	I50	.90
9	187A	68.	89.	16948.	1757.	0	0.	.00000	.00	.00	0.	103	22	I50	.90
9	188B	85.	116.	85.	116.	3	1400.	.01000	.00	.00	0.	103	21	I50	.90
9	189B	100.	131.	185.	238.	4	1000.	.01000	4.75	.00	0.	103	22	I50	.90
9	190B	112.	159.	297.	384.	4	2750.	.00500	6.50	.00	0.	103	20	I50	.90

* CONFLUENCE Q'S

* 9 191A TA 1160 QA 1757. QAB 2038. QB 281. 9 191B TB 1171 QB 375. QBA 2085. QA 1710.

* 9 191AB TAB 1167 QAB 2104. QA 1739. QB 365.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	191AB	297.	375.	17245.	2104.	5	1300.	.00600	15.00	.00	0.	103	0	I50	.00
9	192A	79.	100.	17324.	2194.	0	0.	.00000	.00	.00	0.	103	23	I50	.90
9	193C	117.	172.	117.	172.	4	3200.	.00400	5.00	.00	0.	103	19	I50	.90

* CONFLUENCE Q'S

* 9 194A TA 1168 QA 2194. QAC 2352. QC 158. 9 194C TC 1169 QC 158. QCA 2351. QA 2193.

* 9 194AC TAC 1168 QAC 2352. QA 2194. QC 158.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	194AC	117.	158.	17441.	2352.	5	1400.	.00600	16.00	.00	0.	103	0	I50	.00
9	195A	92.	113.	17533.	2453.	0	0.	.00000	.00	.00	0.	103	24	I50	.90
9	196D	73.	100.	73.	100.	3	2150.	.00800	.00	.00	0.	103	21	I50	.90
9	197D	64.	98.	137.	170.	4	2150.	.00400	5.00	.00	0.	103	18	I50	.90

* CONFLUENCE Q'S

* 9 198A TA 1169 QA 2453. QAD 2613. QD 160. 9 198D TD 1171 QD 164. QDA 2612. QA 2448.

* 9 198AD TAD 1170 QAD 2615. QA 2457. QD 163.

LOCATION		AREA	Q	AREA	Q	TYPE	LNGTH	SLOPE	SIZE	Z	Q	NAME	TC	ZONE	IMPV
9	198AD	137.	164.	17670.	2615.	5	1300.	.00600	16.00	.00	0.	103	0	I50	.00
9	199A	90.	118.	17760.	2708.	5	1200.	.00600	16.00	.00	0.	103	22	I50	.90
9	200A	87.	114.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	22	I50	.90
9	201A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	202A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	203A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	204A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	205A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	206A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	207A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00

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MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 42BASIN

STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	208A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	209A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	210A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	211A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	212A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	213A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	214A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	215A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	216A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	217A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	218A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	219A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	220A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	221A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	222A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	223A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	224A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	225A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	226A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	227A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	228A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	229A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	230A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	231A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	232A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	233A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	234A	0.	0.	17847.	2796.	0	0.	.00000	.00	.00	0.	103	50	I50	.00
9	235C	41.	52.	41.	52.	4	1750.	.00400	3.25	.00	0.	103	23	I50	.90
9	236C	36.	59.	77.	100.	4	800.	.00400	4.25	.00	0.	103	16	I50	.80
9	237C	57.	60.	134.	157.	0	0.	.00000	.00	.00	0.	103	23	I50	.46
9	238D	86.	76.	86.	76.	4	1900.	.00700	3.50	.00	0.	103	27	I50	.40
9	239E	65.	50.	65.	50.	3	1200.	.01200	.00	.00	0.	103	27	I50	.18

****

* CONFLUENCE Q'S *

* 9 240C TC 1164 QC 157. QCD 231. QD 74. 9 240D TD 1167 QD 74. QDC 227. QC 152. *

* 9 240CD TCD 1164 QCD 231. QC 157. QD 74. *

****

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9	240CD	86.	74.	220.	231.	0	0.	.00000	.00	.00	0.	103	0	I50	.00

****

* CONFLUENCE Q'S *

* 9 241C TC 1164 QC 231. QCE 279. QE 48. 9 241E TE 1169 QE 49. QEC 263. QC 214. *

* 9 241CE TCE 1165 QCE 279. QC 231. QE 48. *

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUTS0.HY2 INPUT FILE : 42BASIN

STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 241CE	65.	49.	285.	279.	4	1400.	.00600	5.50	.00	0.	103	0	I50	.00
9 242D	49.	54.	49.	54.	3	400.	.01200	.00	.00	0.	103	20	I50	.33

****

* CONFLUENCE Q'S

* 9 243C TC 1169 QC 275. QCD 322. QD 46. 9 243D TD 1158 QD 54. QDC 228. QC 174.

* 9 243CD TCD 1168 QCD 323. QC 275. QD 48.

****

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 243CD	49.	54.	334.	323.	4	1300.	.00500	6.25	.00	0.	103	0	I50	.00
9 244C	64.	81.	398.	386.	0	0.	.00000	.00	.00	0.	103	21	I50	.72
9 245E	53.	87.	53.	87.	3	1250.	.01200	.00	.00	0.	103	15	I50	.65

****

* CONFLUENCE Q'S

* 9 246C TC 1169 QC 386. QCE 451. QE 65. 9 246E TE 1163 QE 79. QEC 424. QC 344.

* 9 246CE TCE 1167 QCE 456. QC 382. QE 74.

****

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 246CE	53.	79.	451.	456.	4	1910.	.00400	7.25	.00	0.	103	0	I50	.00
9 247C	82.	110.	533.	526.	4	1800.	.00500	7.25	.00	0.	103	21	I50	.85
9 248D	57.	92.	57.	92.	3	1200.	.01600	.00	.00	0.	103	17	I50	.90
9 249C	49.	83.	582.	527.	0	0.	.00000	.00	.00	0.	103	16	I50	.90

****

* CONFLUENCE Q'S

* 9 250C TC 1174 QC 527. QCD 563. QD 36. 9 250D TD 1162 QD 88. QDC 465. QC 377.

* 9 250CD TCD 1171 QCD 574. QC 510. QD 65.

****

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 250CD	57.	88.	639.	574.	4	2200.	.00800	7.00	.00	0.	103	0	I50	.00
9 251E	69.	106.	69.	106.	3	1300.	.00600	.00	.00	0.	103	18	I50	.90
9 252E	76.	122.	145.	208.	0	0.	.00000	.00	.00	0.	103	17	I50	.90

****

* CONFLUENCE Q'S

* 9 253C TC 1175 QC 569. QCE 650. QE 82. 9 253E TE 1162 QE 208. QEC 595. QC 387.

* 9 253CE TCE 1168 QCE 689. QC 516. QE 173.

****

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 253CE	145.	208.	784.	689.	5	800.	.00600	10.00	.00	0.	103	0	I50	.00
9 254C	0.	0.	784.	683.	0	0.	.00000	.00	.00	0.	103	99	I50	.00
9 255C	0.	0.	784.	683.	0	0.	.00000	.00	.00	0.	103	99	I50	.00
9 256D	68.	83.	68.	83.	2	1400.	.00600	.00	.00	0.	103	22	I50	.73
9 257D	84.	115.	152.	177.	2	1200.	.00600	.00	.00	0.	103	21	I50	.90
9 258D	67.	94.	219.	245.	2	1400.	.00600	.00	.00	0.	103	20	I50	.88

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUTS0.HY2 INPUT FILE : 42BASIN

STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 259D	60.	78.	279.	289.	4	2300.	.00600	5.75	.00	0.	103	22	I50	.88

9	262D	34.	63.	427.	346.	4	1350.	.00600	6.00	.00	0.	103	14	ISO	.90
9	263D	30.	56.	457.	369.	0	0.	.00000	.00	.00	0.	103	14	ISO	.90

* CONFLUENCE Q'S *

* 9 264C TC 1169 QC 683. QCD 1025. QD 342. 9 264D TD 1165 QD 369. QDC 997. QC 629. *

* 9 264CD TCD 1168 QCD 1026. QC 678. QD 348. *

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 264CD	457.	369.	1241.	1026.	5	3350.	.00700	11.00	.00	0.	103	0	ISO	.00
9 265C	48.	63.	1289.	1049.	5	1900.	.00700	11.00	.00	0.	103	22	ISO	.90
9 266C	23.	35.	1312.	1045.	0	0.	.00000	.00	.00	0.	103	18	ISO	.90
9 267D	95.	125.	95.	125.	4	1650.	.00700	4.00	.00	0.	103	22	ISO	.90
9 268D	78.	110.	173.	229.	4	1900.	.00700	5.00	.00	0.	103	20	ISO	.90
9 269D	86.	122.	259.	335.	4	400.	.00500	6.25	.00	0.	103	20	ISO	.90

* CONFLUENCE Q'S *

* 9 270C TC 1175 QC 1045. QCD 1260. QD 214. 9 270D TD 1166 QD 335. QDC 1146. QC 811. *

* 9 270CD TCD 1172 QCD 1305. QC 1018. QD 287. *

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 270CD	259.	335.	1571.	1305.	5	2800.	.00400	14.00	.00	0.	103	0	ISO	.00
9 271C	0.	0.	1571.	1276.	0	0.	.00000	.00	.00	0.	103	99	ISO	.00
9 272C	0.	0.	1571.	1276.	0	0.	.00000	.00	.00	0.	103	99	ISO	.00
9 273E	75.	99.	75.	99.	3	1200.	.00800	.00	.00	0.	103	22	ISO	.90
9 274E	79.	104.	154.	195.	0	0.	.00000	.00	.00	0.	103	22	ISO	.90

* CONFLUENCE Q'S *

* 9 275C TC 1176 QC 1276. QCE 1375. QE 99. 9 275E TE 1163 QE 195. QEC 926. QC 730. *

* 9 275CE TCE 1173 QCE 1378. QC 1225. QE 153. *

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 275CE	154.	195.	1725.	1378.	5	2000.	.00400	14.00	.00	0.	103	0	ISO	.00
9 276F	62.	88.	62.	88.	3	1200.	.00800	.00	.00	0.	103	20	ISO	.90
9 277F	60.	85.	122.	164.	0	0.	.00000	.00	.00	0.	103	20	ISO	.90

* CONFLUENCE Q'S *

* 9 278C TC 1178 QC 1368. QCF 1421. QF 54. 9 278F TF 1163 QF 164. QFC 935. QC 771. *

* 9 278CF TCF 1177 QCF 1424. QC 1363. QF 61. *

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV

MODIFIED RATIONAL METHOD HYDROLOGY

INPUT HYDROGRAPH : INPUT50.HY2 INPUT FILE : 42BASIN STORM DAY 4

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 278CF	122.	164.	1847.	1424.	5	2800.	.00700	13.00	.00	0.	103	0	ISO	.00

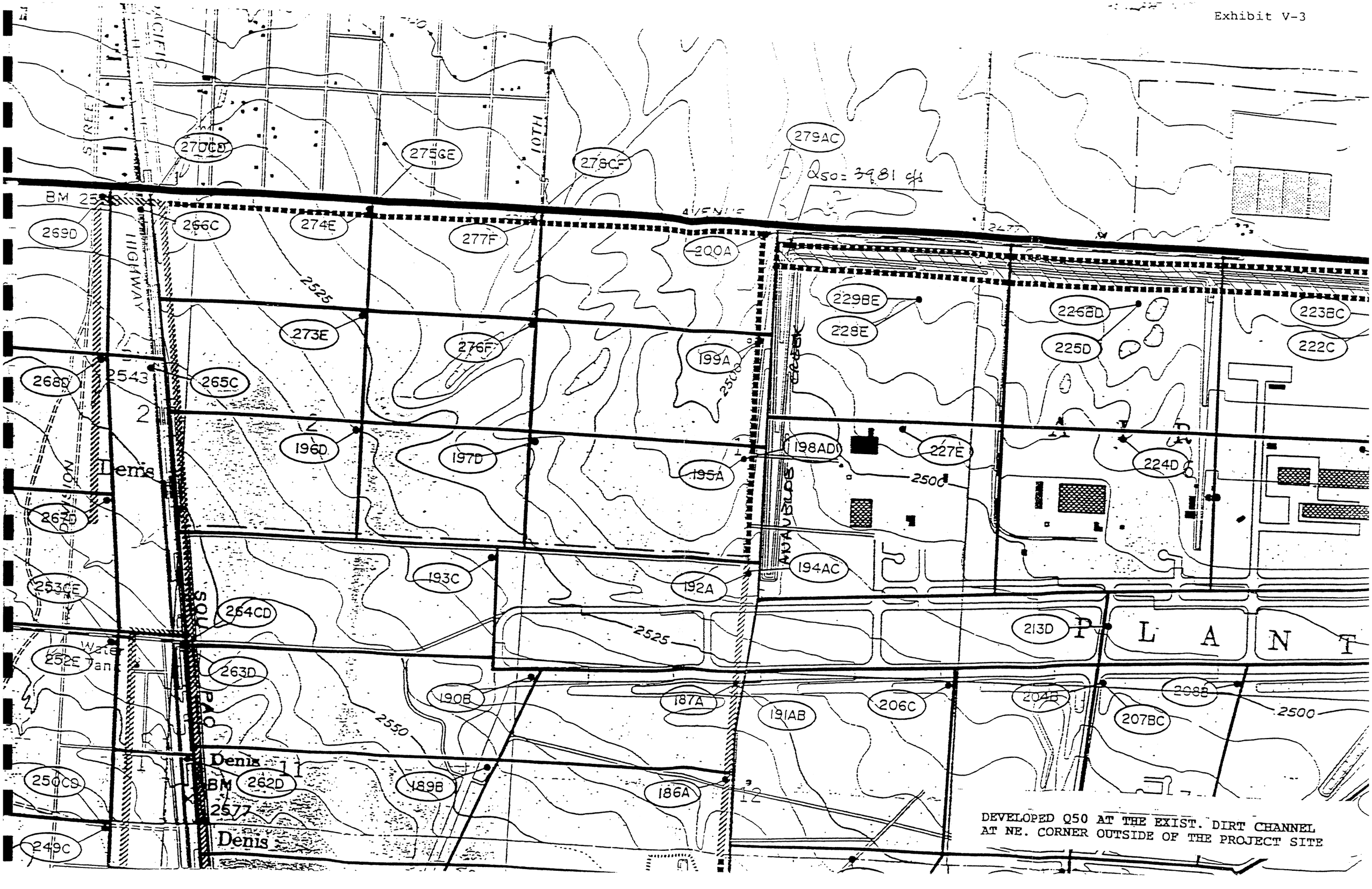
* CONFLUENCE Q'S *

* 9 279A TA 1171 QA 2796. QAC 3912. QC 1116. 9 279C TC 1181 QC 1412. QCA 3710. QA 2297. *

* 9 279AC TAC 1173 QAC 3981. QA 2772. QC 1209. *

LOCATION	SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
9 279AC	1847.	1412.	19694.	3981.	0	0.	.00000	.00	.00	0.	103	0	ISO	.00

Exhibit V-3



DEVELOPED Q50 AT THE EXIST. DIRT CHANNEL
AT NE. CORNER OUTSIDE OF THE PROJECT SITE

```
**************************************************************************
              HYDRAULIC ELEMENTS - I  PROGRAM PACKAGE
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          Ver. 2.7A  Release Date: 6/25/88  Serial # DE1724

                      Especially prepared for:

                      CHURCH ENGINEERING, INC.

--------------------------------------------------------------------------
  TIME/DATE OF STUDY: 17:09  28-DEC-92
==========================================================================


 ************************* DESCRIPTION OF STUDY *************************
* HYDRAULIC ELEMENTS CALCULATION                                         *
* DIRT TRAPEZOIDAL CHANNEL THRU GOLF COURSE                              *
* LOCKHEED BUSINESS PARK CENTER                                          *
 ************************************************************************

**************************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
--------------------------------------------------------------------------
    CHANNEL Z(HORIZONTAL/VERTICAL) =     4.00
    BASEWIDTH(FEET) =     30.00
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.006500
    UNIFORM FLOW(CFS) =      1110.00
    MANNINGS FRICTION FACTOR = 0.0300
==========================================================================
    NORMAL-DEPTH FLOW INFORMATION:
--------------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =    3.40
    FLOW TOP-WIDTH(FEET) =         57.24
    FLOW AREA(SQUARE FEET) =          148.50
    HYDRAULIC DEPTH(FEET) =      2.59
    FLOW AVERAGE VELOCITY(FEET/SEC.) =      7.47
    UNIFORM FROUDE NUMBER =     0.818
    PRESSURE + MOMENTUM(POUNDS) =         30211.15
    AVERAGED VELOCITY HEAD(FEET) =       0.868
    SPECIFIC ENERGY(FEET) =       4.272
==========================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
--------------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =         54.23
    CRITICAL FLOW AREA(SQUARE FEET) =           127.58
    CRITICAL FLOW HYDRAULIC DEPTH(FEET) =       2.35
    CRITICAL FLOW AVERAGE VELOCITY(FEET/SEC.) =      8.70
    CRITICAL DEPTH(FEET) =      3.03
    CRITICAL FLOW PRESSURE + MOMENTUM(POUNDS) =         29616.49
    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =       1.176
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =       4.205


**************************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
--------------------------------------------------------------------------
    CHANNEL Z(HORIZONTAL/VERTICAL) =     4.00
    BASEWIDTH(FEET) =     40.00
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.006500
    UNIFORM FLOW(CFS) =      1110.00
    MANNINGS FRICTION FACTOR = 0.0300
==========================================================================
    NORMAL-DEPTH FLOW INFORMATION:
--------------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =    2.99
    FLOW TOP-WIDTH(FEET) =         63.88
    FLOW AREA(SQUARE FEET) =          155.04
    HYDRAULIC DEPTH(FEET) =      2.43
    FLOW AVERAGE VELOCITY(FEET/SEC.) =      7.16
    UNIFORM FROUDE NUMBER =     0.810
    PRESSURE + MOMENTUM(POUNDS) =         28733.11
    AVERAGED VELOCITY HEAD(FEET) =       0.796
    SPECIFIC ENERGY(FEET) =       3.781
==========================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
--------------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =         61.01
    CRITICAL FLOW AREA(SQUARE FEET) =           132.63
    CRITICAL FLOW HYDRAULIC DEPTH(FEET) =       2.17
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    CRITICAL DEPTH(FEET) =      2.63
    CRITICAL FLOW PRESSURE + MOMENTUM(POUNDS) =         28116.07
    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =       1.088
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =       3.714


**********************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
----------------------------------------------------------------------
    CHANNEL Z(HORIZONTAL/VERTICAL) =     4.00
    BASEWIDTH(FEET) =     30.00
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.005000
    UNIFORM FLOW(CFS) =      1069.00
    MANNINGS FRICTION FACTOR = 0.0300
======================================================================
    NORMAL-DEPTH FLOW INFORMATION:
----------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =    3.58
    FLOW TOP-WIDTH(FEET) =         58.64
    FLOW AREA(SQUARE FEET) =          158.67
    HYDRAULIC DEPTH(FEET) =      2.71
    FLOW AVERAGE VELOCITY(FEET/SEC.) =      6.74
    UNIFORM FROUDE NUMBER =     0.722
    PRESSURE + MOMENTUM(POUNDS) =         29771.33
    AVERAGED VELOCITY HEAD(FEET) =       0.705
    SPECIFIC ENERGY(FEET) =       4.285
======================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
----------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =         53.70
    CRITICAL FLOW AREA(SQUARE FEET) =          123.97
    CRITICAL FLOW HYDRAULIC DEPTH(FEET) =      2.31
    CRITICAL FLOW AVERAGE VELOCITY(FEET/SEC.) =      8.62
    CRITICAL DEPTH(FEET) =      2.96
    CRITICAL FLOW PRESSURE + MOMENTUM(POUNDS) =         28239.93
    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =       1.155
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =       4.117


**********************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
----------------------------------------------------------------------
    CHANNEL Z(HORIZONTAL/VERTICAL) =     4.00
    BASEWIDTH(FEET) =     30.00
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.006000
    UNIFORM FLOW(CFS) =      1069.00
    MANNINGS FRICTION FACTOR = 0.0300
======================================================================
    NORMAL-DEPTH FLOW INFORMATION:
----------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =    3.41
    FLOW TOP-WIDTH(FEET) =         57.30
    FLOW AREA(SQUARE FEET) =          148.94
    HYDRAULIC DEPTH(FEET) =      2.60
    FLOW AVERAGE VELOCITY(FEET/SEC.) =      7.18
    UNIFORM FROUDE NUMBER =     0.785
    PRESSURE + MOMENTUM(POUNDS) =         29072.38
    AVERAGED VELOCITY HEAD(FEET) =       0.800
    SPECIFIC ENERGY(FEET) =       4.212
======================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
----------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =         53.70
    CRITICAL FLOW AREA(SQUARE FEET) =          123.97
    CRITICAL FLOW HYDRAULIC DEPTH(FEET) =      2.31
    CRITICAL FLOW AVERAGE VELOCITY(FEET/SEC.) =      8.62
    CRITICAL DEPTH(FEET) =      2.96
    CRITICAL FLOW PRESSURE + MOMENTUM(POUNDS) =         28239.93
    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =       1.155
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =       4.117


**********************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
----------------------------------------------------------------------
    CHANNEL Z(HORIZONTAL/VERTICAL) =     4.00
    BASEWIDTH(FEET) =     30.00
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.006000
```

```
    MANNINGS FRICTION FACTOR = 0.0300
================================================================================
    NORMAL-DEPTH FLOW INFORMATION:
--------------------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =    3.34
    FLOW TOP-WIDTH(FEET) =         56.75
    FLOW AREA(SQUARE FEET) =          145.03
    HYDRAULIC DEPTH(FEET) =      2.56
    FLOW AVERAGE VELOCITY(FEET/SEC.) =      7.11
    UNIFORM FROUDE NUMBER =     0.784
    PRESSURE + MOMENTUM(POUNDS) =        27777.74
    AVERAGED VELOCITY HEAD(FEET) =      0.785
    SPECIFIC ENERGY(FEET) =       4.128
================================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
--------------------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =         53.20
    CRITICAL FLOW AREA(SQUARE FEET) =          120.66
    CRITICAL FLOW HYDRAULIC DEPTH(FEET) =      2.27
    CRITICAL FLOW AVERAGE VELOCITY(FEET/SEC.) =      8.54
    CRITICAL DEPTH(FEET) =      2.90
    CRITICAL FLOW PRESSURE + MOMENTUM(POUNDS) =        26975.69
    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =       1.134
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =       4.034
================================================================================
```

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**********************************************************************
          HYDRAULIC ELEMENTS - I  PROGRAM PACKAGE
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      Ver. 2.7A  Release Date: 6/25/88  Serial # DE1724

                  Especially prepared for:

                  CHURCH ENGINEERING, INC.

----------------------------------------------------------------------
  TIME/DATE OF STUDY: 17:14  28-DEC-92
======================================================================


 ************************* DESCRIPTION OF STUDY *************************
* HYDRAULIC ELEMENTS CALCULATION                                        *
* CULVERT SYSTEM IN LOCKHEED BUSINESS PARK CENTER                       *
*                                                                       *
 ************************************************************************

**********************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
----------------------------------------------------------------------
    CHANNEL Z(HORIZONTAL/VERTICAL) =     0.00
    BASEWIDTH(FEET) =     12.00
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.005000
    UNIFORM FLOW(CFS) =      1031.00
    MANNINGS FRICTION FACTOR = 0.0140
======================================================================
    NORMAL-DEPTH FLOW INFORMATION:
----------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =    5.62
    FLOW TOP-WIDTH(FEET) =         12.00
    FLOW AREA(SQUARE FEET) =           67.50
    HYDRAULIC DEPTH(FEET) =      5.62
    FLOW AVERAGE VELOCITY(FEET/SEC.) =     15.27
    UNIFORM FROUDE NUMBER =     1.135
    PRESSURE + MOMENTUM(POUNDS) =         42363.56
    AVERAGED VELOCITY HEAD(FEET) =       3.623
    SPECIFIC ENERGY(FEET) =       9.248
======================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
----------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =         12.00
    CRITICAL FLOW AREA(SQUARE FEET) =           73.46
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    UNIFORM FLOW(CFS) =      1110.00
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    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =       3.215
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =       9.643
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APPENDIX L

GROUNDWATER RESOURCES STATUS REPORT

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STATUS REPORT
ON THE
GROUND WATER RESOURCES
NEAR THE
PALMDALE REGIONAL AIRPORT

John F. Mann, Jr.
Consulting Geologist and Hydrologist

June 30, 1989

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PALMDALE REGIONAL AIRPORT

SUMMARY

1. The Palmdale Regional Airport (PRA) overlies two subunits of the Antelope Valley ground water basin -- the Buttes subunit and the Lancaster subunit -- which are separated by a fault that acts as a ground water barrier. In the Buttes subunit the water-bearing materials are about 500 feet thick; recharge is good and water levels recover quickly in wet periods. In the western part of the PRA, which overlies the Lancaster subunit, the water-bearing materials are more than 1000 feet thick; recharge is slow and there has been a long history of declining water levels.

2. Recharge to the Antelope Valley ground water basin resulting from percolation of runoff from the surrounding mountains was estimated in 1947 to average 66,400 acre-feet per year (AF/YR). Later studies suggest that the average recharge is only 40,700 AF/YR.

3. Ground water pumping started on a small scale about 1900 and gradually rose to 170,000 AF/YR in 1930, and then dropped during the Depression to 95,000 AF/YR. This was followed by a rise to a peak pumping rate of 300,000 to 400,000 AF/YR in the early 1950s. Since then there has been a continuing decrease.

4. Water level trends in the Lancaster subunit have been in a dominant downward direction -- at a rate of as much as 8 feet per year in the late 1940s and early 1950s. Since about 1975 there has been a leveling off. In the 1980s, small recoveries have been observed in some areas of reduced agricultural pumpage. In other areas in the Lancaster subunit, more gradual downtrends have occurred in areas of increasing municipal pumpage.

5. As of 1972, it was estimated that 9 million acre-feet had been "mined" from the Lancaster subunit. As of 1975, it was also estimated that there was still 15 million acre-feet left in the ground. In the last 15 years the rate of mining has been much less than in the earlier years.

6. The perennial yield (or "safe" yield) of the Antelope Valley ground water basin has not been calculated. Conceptually, it should be equal to the average recharge (estimated as 40,700 AF/YR) plus the amount of delivered water which is able to return to the water table (which is unknown).

7. The amount of water that will be pumped in 1989 is estimated to be 70,850 acre-feet, somewhat in excess of the probable perennial yield. The basin is still probably in overdraft, but the magnitude of that overdraft is much less than it was in the earlier years.

8. Ground water quality under the PRA property is currently excellent, but there is some potential for degradation.

9. The PRA property lies within the Antelope Valley - East Kern Water Agency (AVEK), which has a maximum entitlement to water from the State Water Project (SWP) of 138,400 AF/YR. In 1988, AVEK took delivery of only 34,621 acre-feet. In the event of temporary shortage of SWP water, the ground waters of Antelope Valley can provide an ample standby supply.

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Introduction

This status report is primarily a review of published information (see References). For gaining a familiarity with Antelope Valley problems and for getting information on 1988 conditions, visits and contacts were made with the offices of the United States Geological Survey in San Diego, Sacramento, and Loma Linda, with the Department of Water Resources in Los Angeles, the Lahontan Regional Board in Victorville, the County Sanitation Districts of Los Angeles County in Whittier, the Los Angeles County Department of Public Works (Soils and Geology) and the Waterworks Districts in Alhambra, the County of Los Angeles Department of Regional Planning in Los Angeles, the University of California Farm Advisor and the County Agricultural Commissioner's office in Lancaster, Air Force Plant 42, the Antelope Valley - East Kern Water Agency in Quartz Hill, the Palmdale Water District, the Quartz Hill County Water District, the Littlerock Creek Irrigation District, and the Rosamond Community Services District. I would like to thank all of the above for their cooperation in this study. I would like to thank especially Mr. James E. Bort and Marcella Wyant of the office of the Palmdale Regional Airport for their generous assistance.

General Hydrogeology

The first study of the hydrogeology of Antelope Valley appears in U. S. Geological Survey Water Supply Paper 278 (Johnson, 1911). Flowing artesian wells had been drilled as early as 1881, and by 1890, about 23 of such wells are recorded. Up until 1900 all irrigation was supplied by flowing wells without the help of pumping equipment. By the time of Johnson's survey in Janaury 1909, about 353 artesian wells had been drilled. The maximum flow was about 900 gallons per minute (gpm) and the maximum head above ground surface was 22.5 feet. Johnson measured 60 wells flowing at rates of 9 to 135 gpm and calculated that these were wasting 2,721,600 gallons per day. Many of the wells had not been drilled in serious efforts to engage in irrigated agriculture but merely to obtain patents on government lands. Others may have involved futile attempts to irrigate on soils that were too alkaline. It was an unfortunate circumstance that in the very areas where irrigation water was available without pumping, there was upward seepage and evaporation of ground water which left salts in the soils and rendered them unfit for agriculture. To move to soils that were acceptable, it was necessary to move away from the areas of artesian wells to areas where the ground water had to be pumped. To minimize pumping lifts the moves were not far, and the irrigated areas formed a fringe around the artesian area centered at Rosamond dry lake. Johnson recorded the locations of all the known wells and outlined the area of flowing wells on his Plate VI. Farther south in Antelope Valley, near Palmdale, the wells were not artesian, and the water table was originally as much as 200 feet below the ground surface.

Prior to World War I, artesian areas were sought out because pumps were inefficient. For domestic supplies, cylinder or plunger (windmill-type pumps) could be used. For large supplies, air-lift pumps could be used but they were notoriously inefficient. The mainstay was the centrifugal pump, which had to be installed within suction lift (about 20 feet) of the pumping level. As water levels fell, the centrifugal pump had to be installed on platforms within a shaft at progressively lower levels. The deep-well turbine had been invented in 1908 but was not in widespread use until after World War I.

The second report on the hydrogeology of Antelope Valley was by David G. Thompson as part of a comprehensive study of the entire Mohave (sic) Desert Region, as reported in U. S. Geological Survey Water Supply Paper 578. He worked in Antelope Valley at various times between December 1918 and May 1921, but the paper was not published until 1929. In his Figure 11, the geologic conditions which produced the artesian flows are sketched -- recharge from the high winter flows originating in the San Gabriel Mountains percolate on the alluvial fans and move northerly through the sands and gravels beneath the clays of Rosamond dry lake.

Thompson estimated that the total annual runoff to Antelope Valley averaged 75,000 acre-feet per year (AF/YR), of which 50,000 AF/YR reached ground water. He stressed that this water originates in the local watersheds, and that contrary to speculations, which still persist, does not come from the Sierra Nevada. As of 1919, he estimated that deliveries for irrigation were about 7000 AF/YR of surface water and 31,000 AF/YR of ground water. He recognized that net draft on the ground water was less

because some of the delivered water percolated downward and returned to the water table. Some water level measurements, made by other members of the U. S. Geological Survey between 1920 and 1927, were made available to Thompson prior to publication. Although there were some declines, he did not believe the safe yield of the basin had been exceeded.

During the 1930s there were no hydrogeologic studies and only a few water level measurements. Because of severe economic conditions during the Depression, the number of wells in Antelope Valley dropped from 854 in 1930 to 607 in 1940 (Snyder, 1955). After World War II ended, there was a flurry of activity. In November 1945, measurements of static water levels were made in 140 wells as a joint project of the Los Angeles County Flood Control District and the U. S. Geological Survey. From a study of these water levels, Warren Thayer (1946) of the Flood Control District suggested that Antelope Valley was not a single large ground water basin, but should be divided into seven sub-basins. At about the same time, the Assembly of the State Legislature directed the Division of Water Resources (DWR) of the California Department of Public Works to submit a report on the water supplies of Antelope Valley, noting that there had been a progressive decline of ground water levels of about 3 feet per year in the areas of heavy pumping. The report was completed in May 1947. The sub-basins were reduced to four from the seven that had been delineated by Thayer. Runoff reaching the valley fill was estimated from short-term measurements as 66,400 AF/YR, of which 63,000 AF/YR was considered to have reached the water table. DWR did not consider that the declines during the dry years of the early 1930s as indicative of overdraft. These years were viewed

as a period of adjustment for reduction of outflow and waste. However, the continued decline during the 1938-44 wet period was considered evidence of overdraft. Using 1945 crop surveys by the Soil Conservation Service and the Los Angeles County Agricultural Commissioner, DWR estimated a consumptive use of irrigation water of 109,000 AF/YR and an overdraft of 46,000 AF/YR (109,000 minus 63,000). From changes in water levels and specific yields, the reduction in stored ground water was calculated as 41,000 AF/YR. With adjustments from 1945 to 1947, the overdraft in 1947 was considered to be between 57,000 and 62,000 AF/YR.

In October 1950, the U. S. Geological Survey commenced a detailed study of water supplies for Edwards Air Force Base. One of the first efforts was a canvass of all water wells in and near Antelope Valley, resulting in one U.S.G.S. Open-File Report (Dutcher, 1959) and two Bulletins published by the California Department of Water Resources (formerly the Division of Water Resources) (Dutcher, et al, 1961; Kunkel and Dutcher, 1961). The main report is by Dutcher and Worts (1963) which sets up the division of the valley fill in Antelope Valley into the principal and deep aquifers with an intermediate clay layer. This hydrogeologic picture is the one now in widespread use. Figure 3 of that report shows the clay layer dipping to the south and thinning; unfortunately, the cross-section does not extend under the Palmdale Regional Airport (PRA) as it ends at the south boundary of Township 7 North. However, at the north boundary of the PRA property, the principal aquifer extends to a depth of about 800 feet and the clay occurs between depths of 800 and 920 feet. Below the clay is the deep aquifer which had not been reached in that vicinity in the 1960s.

One of the main conclusions of the Dutcher and Worts report was that net draft in Antelope Valley had exceeded perennial supply since about 1930, and was about 170,000 AF/YR in 1951 -- at least three times the estimated yield.

The California Division of Water Resources made another study as part of a plan for supplying supplemental water to Antelope Valley (DWR, 1955). This was primarily an office study -- incorporating water level measurements which had been made since the 1947 report. The ground water sub-basins are the same as those delineated in the 1947 report. Water level hydrographs were extended into late 1954. Areas of irrigated crops were compiled for the period 1940-54 and sales of power (for agricultural and other uses) were compiled for the period 1927-54.

A somewhat different approach to overdraft in Antelope Valley was used by Snyder (1955), who reviewed the history of irrigated agriculture and water use through 1951. He adopted a safe yield figure of 40,000 AF/YR and concluded that overdraft had commenced in 1925. As an agricultural economist, he pointed out that "physically determined" safe yield does not include economic factors and that ground water "mining" has been undertaken because it is profitable. As of 1951, he calculated the cumulative overdraft as 1,860,000 acre-feet. The overdraft was accompanied by an increase in average pumping lift from 89 feet in 1924 to 197 feet in 1951.

The Antelope Valley - East Kern Water Agency (AVEK) was created in 1959. In May 1963, under a cooperative agreement with AVEK, the U. S. Geological Survey commenced a series of studies which resulted in numerous reports. The first was a

progress report (Weir, Crippen and Dutcher, 1965), recommending a test-drilling program to refine the hydrogeology of the western part of Antelope Valley. Another progress report by Bloyd (1966) reported on the results of that test-drilling program. A more comprehensive report was completed by Bloyd (1967), in which the Antelope Valley Basin was divided into six subunits -- Lancaster, Buttes, Pearland, Neenach, West Antelope, and Finger Buttes -- which are in general use at this time. Average annual recharge was re-evaluated and given as 58,000 AF/YR. Following Bloyd's basic report, the U.S.G.S. prepared annual reports until 1986. In cooperation with DWR, the U.S.G.S. during the 1960s had prepared additional basic data reports for all of Antelope Valley (Moyle, 1965; Koehler, 1966).

During the 1970s, a mathematical model was developed by the U.S.G.S. in a cooperative investigation with DWR (Durbin, 1978). As a result of overdraft, water levels had dropped by as much as 200 feet and it was estimated that about 9 million acre-feet had been removed from ground water storage. The model was developed to assist in water management plans involving the distribution of water from the State Water Project (SWP), reclamation of waste water, and improved utilization of flood waters.

Starting in the late 1970s, DWR began a study of water management in Antelope Valley which led to the planned utilization report (DWR, 1980). The background studies for this report are an unpublished series of Technical Information Records (TIRs) covering, among other subjects, ground water in storage, ground water quality, and potential spreading grounds.

Since the 1960s, monitoring of water levels and water quality has become more formalized. The U.S.G.S. (Duell, 1987) has

proposed an idealized monitoring well network throughout Antelope Valley. More recently, DWR (Pierotti, 1989) has proposed a network of key wells for monitoring both water levels and ground water quality.

The Los Angeles County Flood Control District (now part of the Los Angeles County Department of Public Works) has long had an interest in maximizing the conservation of flood waters that originate in the San Gabriel Mountains. The early hydrogeologic report of Thayer (1946) was followed by reports in 1967, water conservation requirements in 1970, geology and hydrology of the Big Rock Creek drainage area in 1983, and a preliminary report on spreading grounds in 1989.

Because of safety considerations, and possible revocation of the Certificate of Approval for Littlerock Dam, DWR prepared environmental impacts reports in 1977, 1979, and 1986, and a more general report on water management in the Littlerock Creek Irrigation District in 1988.

The Palmdale Regional Airport (PRA) property overlies the extreme southern portion of the Lancaster subunit and the western portion of the Buttes subunit (Figure 2). Geologic cross-section A-A' (a vertical slice) trends in a WNW-ESE direction across the PRA property (Figure 4). Note that the Buttes subunit is on an uplifted fault block where the alluvial deposits average less than 500 feet thick. These materials are very permeable and the Buttes subunit is recharged rather easily by the flows of Littlerock Creek. The western part of the PRA property overlies the Lancaster subunit, on a downdropped fault block. N-S geologic cross-section B-B' (Figure 5) shows the general three-fold division of the valley fill materials which prevails in the

central and eastern parts of Antelope Valley -- principal aquifer, lacustrine (lake) beds, and deep aquifer. The widespread lake clays were deposited in a large body of fresh water which covered all but but the western part of Antelope Valley during the Ice Age (Pleistocene). Such an ancient lake was originally suggested by Thompson (1929) and the lake has been named Lake Thompson in his honor. Recharge to the aquifers beneath the PRA property is by underflow from the Buttes subunit westerly across the fault which is only semi-permeable. Note that this underflow is depicted to move from the Buttes subunit and into the principal aquifer beneath the PRA property on top of the lake clays. The N-S geologic cross-section B-B' (Figure 5) shows the clay beds becoming deeper to the south, with question marks. Actually the southern limit of the clay beds is poorly known. In Figure 3, the clay beds are shown to extend to the south of the PRA property within the Lancaster subunit, and to be absent in the Buttes subunit. Little is known about the nature and thickness of the deep aquifer beneath the PRA property.

Generally speaking, wells in the eastern part of the PRA property in the Buttes subunit will be relatively shallow (about 500 feet) with lesser depths to water and good wet period recoveries, but with relatively small yields. In the western part of the PRA property, wells drilled to basement rock will be much deeper, and with great depths to water. Yields will be high but wet period recoveries will tend to be of small magnitude.

Recharge

The main source of recharge to Antelope Valley is the percolation of surface flows originating in the San Gabriel Mountains. It is generally agreed that rainfall in Antelope Valley is too low to permit recharge of rainfall through the soil zone of the valley floor.

Several attempts have been made to estimate the recharge to the Antelope Valley ground water basin. Runoff measurements were made on Rock Creek (now Big Rock Creek) and Littlerock Creek from 1896-99 and again from 1923-26. Using these short-term records, and calculations of runoff per square mile from ungaged drainages, Thompson (1929, p. 314) estimated the runoff to Antelope Valley to be about 75,000 acre-feet per year (AF/YR). With a longer record of measurements on Rock Creek and Littlerock Creek, and estimates of runoff from the ungaged areas, DWR in their first such study (DWR, 1947) estimated the average runoff to Antelope Valley to be 66,400 AF/YR. Except for small amounts that reached the dry lakes in very wet years, all of this runoff was assumed to become part of the stored ground water. In a later study (1955) DWR observed that almost half the runoff to Antelope Valley occurs in Big Rock and Littlerock Creeks. For the 30-year period 1923-53, the average seasonal runoff from the Big Rock drainage was 11,810 AF/YR, whereas from the Littlerock drainage for the period 1930-54, the average seasonal runoff was 14,130 AF/YR. No figure was given for the entire amount of runoff to Antelope Valley.

The U.S.G.S. (Durbin, 1978) in developing a mathematical model for the Antelope Valley ground water basin noted that only 20 per cent of the area tributary to Antelope Valley is gaged.

Average annual runoff from three gaging stations -- Big Rock Creek near Valyermo, Littlerock Creek near Littlerock, and Santiago Creek above Littlerock Creek -- was 24,300 acre-feet. The mean annual runoff from the other areas tributary to Antelope Valley was estimated by using a method based on the width and average depth of stream channels at bars and berms. The total annual runoff to Antelope Valley was estimated as 40,700 AF/YR. DWR (1980) seems to have accepted this estimate.

Historic Pumping

Many attempts have been made to reconstruct the historic pumping in Antelope Valley. Most pumping of ground water has been for the irrigation of crops (primarily alfalfa) and has not been metered. The estimates have been based on number of wells, acreage and unit (per acre) deliveries, or electrical power consumed. The estimates made for the same year by different investigators have been widely divergent. Durbin (1978) attempted to resolve these discrepancies during the development of the mathematical model. Durbin assumed no pumping as of 1915, then a rapid rise to about 55,000 AF/YR in 1924, reaching a peak of about 170,000 AF/YR in 1930. Following a sharp drop to about 95,000 AF/YR during the Depression of the early 1930s, there was a rise to about 300,000 to 400,000 AF/YR in 1951, and then a downtrend to about 200,000 AF/YR in 1972. The downtrend has continued to the present time.

A good index to the amount of pumping is the acreage under irrigation in any given year. Thompson (1929) indicated that ground water in 1919 was used to irrigate 8710 acres. As of 1945, about 43,300 acres were being irrigated (DWR, 1947). Plate 2 of that report shows the actual areas irrigated in 1947. The first land and water use survey by DWR was in the Fall of 1949 (DWR, 1955) when the total irrigated acreage in Antelope Valley was 73,600. The maximum irrigated acreage was probably a few years later. In the 1961 land and water use survey (DWR, 1965) subareas were used. As of 1961, the total acreage of irrigated agriculture in the Neenach, Buttes, Lancaster and Rock Creek subareas was 50,600. In the 1972

land and water use survey (DWR, 1974) within the "Antelope Valley Planning Area" there had been a reduction in irrigated acreage of 13,380 between 1961 and 1972.

Another land use survey was made by DWR in the Fall of 1987. This has not yet been published, but copies of the preliminary maps and print-outs were obtained. As of late 1987, only 15150 acres were being irrigated within Antelope Valley south of Rosamond. This included 8469 acres of pasture and alfalfa.

Water Level Trends

Falling water levels in Antelope Valley have been of concern for many decades. There was a reduction in the area of flowing artesian wells between the studies of Johnson (1911) and Thompson (1929). During the 1920s, there was only a modest lowering and Thompson didn't think that this was evidence of overdraft. The lowering continued during the 1930s, and by 1940 there was considerable local concern. On May 20, the First Antelope Valley Agricultural Program Building Conference was held. By the Second Conference, on April 16, 1941, there was a report by Lee Benson, Assistant Farm Advisor, which documented falling ground water levels since 1922. Average lowering had been 3 to 4 feet per year, but there was considerable variability, which was explained as due to "apparently unconnected bodies of water at different depths".

Following World War II, DWR, in response to a Legislative directive, prepared their 1947 report, which included hydrographs back to the 1920s. These steady downtrends are shown on Figure 6. In the 1955 report by DWR, hydrographs covering the 1941-54 period show an even steeper downtrend (Figure 7). Well 6N/11W-12A was on PRA property in the Lancaster subunit near the boundary with the Buttes subunit. (For an explanation of the standard system for numbering wells see Figure 1). In its 1980 report, DWR included hydrographs which suggest a leveling off in the late 1970s (Figure 8).

Print-outs were obtained from the U.S.G.S. for wells in and near the PRA property. There are few measurements prior to the early 1960s. Available measurements have been plotted on Figures 9 through 17. These hydrographs will be discussed individually.

Well 6N/10W-5H1 is in the Buttes subunit near Avenue M-8 and 100th St. East. The water level in 1982 was only a few feet lower than in 1952, indicating a complete recovery by recharge in the Buttes subunit. Well 6N/10W-17N1 is at Avenue P and 90th St. East. Following the wet years of the early 1980s, the water levels were as high as they had been in 1945. During the last few years of drought there has been a temporary downtrend. Well 6N/10W-22D1 is just east of the PRA property, near Avenue P-4 and 110th St. East, and is also in the Buttes subunit. It is farther from the recharge area along Littlerock Creek and shows a more subdued recovery than wells closer to the creek. Well 6N/11W-25C1, in the Buttes subunit at Avenue Q and 75th St. East and along the left bank of Littlerock Wash, shows a sharp rise of almost 100 feet related to the heavy storm flows of 1978.

Within the Lancaster subunit, Well 6N/11W-3E2 is located at about Avenue M-8 and 53rd St. East. It appears to have shared in the general downtrend from 1962 to 1981. The uptrend from 1981 to 1989 may have some relationship to recharge along Littlerock Creek but more likely associated with the easing of pumping in this part of the Lancaster subunit . Well 6N/11W-9P1 is on Avenue O at about 43rd St. East. The rise in the 1980s is related to a reduction of pumping, rather than to recharge. Well 6N/11W-11M1 is at about Avenue N-8 and 60th St. East. It has recoverd about to where it was in 1963 because of a reduction of pumping. Well 6N/11W-16J1 is at about Avenue O-8 and 50th St. East and the water level is higher than it was in 1965. This is explained as recovery due to a reduction of pumping. Well 6N/12W-12M1 is west of the PRA property and

about 1.4 miles northwest of the intersection of Avenue P and 15th St. East. It shows a continuing downtrend since 1982. Despite the general reduction in agricultural pumping, this well is more influenced by the increasing amounts of municipal pumpage in this area.

In the Buttes subunit, good recharge and complete recovery of water levels in wet periods is expected to continue. In the Lancaster subunit, the effects of recharge are muted by slow underflow through the fault separating it from the Buttes subunit. The primary influence on water levels in the Lancaster subunit is pumping. Where the dominant influence has been the reduction of agricultural pumping, water levels have shown a recovery in the 1980s. In areas of continued and increasing municipal pumping, the downtrend started by the earlier agricultural pumping will continue.

Reduction of Stored Ground Water

If the entire Antelope Valley ground water basin could be filled to within 20 feet of the ground surface, it would hold about 68 million acre-feet of water (DWR, 1980). This is a somewhat artificial assumption in that the water beneath the alluvial fans flanking Antelope Valley could not be kept that close to the ground surface. The fact of falling ground water levels since the early 1920s indicates very clearly that there is much less water stored beneath Antelope Valley than there was 60 or 70 years ago. Durbin (1978) estimated that by 1972, the cumulative overdraft was 9 million acre-feet, or, in other words, that is the amount by which the reserves in the ground have been reduced. Of more importance, however, is the amount of ground water which still remains in storage. As of the Fall of 1975, it was estimated that within the Lancaster subunit about 15 million acre-feet were still in ground water storage (DWR, November 1977b). Since that time, as suggested by the hydrographs, there may have been little further reduction of the volume stored in the ground.

Perennial Yield

The perennial yield (or safe yield) is the amount of water which can be pumped on an average annual basis over a period of representative rainfall without causing an undesirable result. Results considered undesirable are: (1) a progressive decline in water levels; (2) infringement of water rights, such as a basin outflow requirement; (3) intrusion of sea water or other inferior quality water; (4) excessive pumping lifts; and (5) land-surface subsidence. In Antelope Valley, the factor most often considered has been (1). Not all lowering of water levels can be considered undesirable. At least in the early stages of the development of a ground water basin, it might be advantageous to lower water levels to avoid waste from high water tables and unwanted spills.

No detailed study of the perennial yield of the Antelope Valley ground water basin has been made. It should be measured by pumpage -- the maximum average pumpage that can be sustained without permanent loss of ground water in storage. The ground water reserves are maintained by recharge -- not only by the percolation of storm flows but by the water which returns to the ground water basin after it has been delivered for use. The time required for the return water to reach the water table could be very long. Durbin (1978) believed that, as of 1955, after more than 40 years of irrigation activities, most of the return water had not yet reached the water table. As irrigation return water is higher in dissolved solids than the applied water, its presence should have been reflected by an increase in minerals in the ground water. As of the 1960s, however, he felt that the ground water was showing some effect of return water. The chief obstacles to the return water reaching the

water table are clay lenses, which prevent direct downward movement and require that the water take a slow, circuitous route.

The best methodology for determining perennial yield is to calculate pumpage as accurately as possible and adjust it for the change in ground water storage. Steady improvement in calculating perennial yield will come as municipal pumpage (which is customarily metered) replaces agricultural pumpage. Changes in storage are calculated from systematic water level measurements, especially in the Spring. The present water level measuring programs seems to be designed with this in mind.

Current Rate of Pumping

The current rate of pumping has been analyzed as of January 1, 1989. Population figures as of this date are available for the Cities of Palmdale (45,850) and Lancaster (82,200). No figures are as yet available for the unincorporated areas of Antelope Valley. Their population as of 1/1/88 was about 58,000. With a projected annual increase of 8 per cent, the population as of 1/1/89 is estimated as 62,670. That would make the total population of Antelope Valley as of 1/1/89 about 190,270.

Two large water districts -- Palmdale Water District and County Waterworks District No. 4 (plus No. 34) -- dominate retail deliveries in Antelope Valley. During 1988, the population of the Palmdale Water District averaged 55,930. Total water use was 13682 acre-feet, consisting of 4832 acre-feet of water from the State Water Project (SWP) and 8850 acre-feet of ground water. Water use averaged 215 gallons per capita per day (gcd). During 1988, water use by Districts #4-#34 was 25110 acre-feet of which 12780 AF was from the SWP and 12330 AF was ground water. The population can be estimated from the number of connections at the end of 1988 and the APPH (average persons per household):

20,346 X 2.75 = 55,950

Average annual water use was 400 gcd.

From six water purveyors in the unincorporated areas with a population of about 30,000 a weighted average of 263 gcd was obtained.

Water demands were than calculated under the assumption that the Palmdale Water District in 1989 would take 65 per cent from ground water and the remaining purveyors would take 50 per cent; miscellaneous industrial would take 100 per cent

from ground water, and the Rosamond Community Services District (in Kern County) would pump about 5 per cent more than in 1988.

Municipal and Industrial Demands as of 1/1/89

Item	Population	GCD	Total AF/YR	SWP	GW
Palmdale	45,850	215	11,042	3865	8850
Lancaster	82,200	400	36,830	18,415	18,415
Unincorp.	62,670	263	18.462	9231	9231
Industrial			395	45	350
Rosamond CSD			965	65	900
		Total from ground water			37,746 AF

As a basis for estimating water use for agriculture in 1989, preliminary results were obtained for a land and water use study made by DWR in the Fall of 1987. These results have not yet been published. The materials obtained consist of 38 overlays of topographic quadrangles and a print-out summary. The total irrigated acreage in Antelope Valley in the Fall of 1987 was 15,150. From those acreages, delivery demands have been estimated as follows:

Crop	Acres	AF/A Demand	AF/YR
Grain	1355	1.2	1626
Field crops	63	2.2	139
Alfalfa	8469	5.0	42,345
Truck	2545	2.1	5345
Decid. Fruits	2016	3.75	7560
Lawns	650	4.2	2730
Vineyards	34	3.75	128
		Total	59,873 AF

The above estimated delivery demand will have to be adjusted for the water which is delivered for use from sources other than ground water -- from the SWP, from Littlerock Dam, and from treated sewage.

1. Reduce the acreage of alfalfa by 1910 acres which have gone out of production since the time of the DWR survey.

   1910 X 5 = 9550 AF

2. Reduce by 12,114 AF for agricultural deliveries by AVEK
3. Reduce for the 600 acres of alfalfa, etc. on the Nebeker Ranch, which is irrigated with treated sewage.

   600 X 5 = 3000 AF

4. Reduce for deliveries of surface water and SWP in the Littlerock Creek Irrigation District.

   1224 (surface) + 273 (SWP) = 1497 AF

5. Reduce for deliveries by AVEK to the Antelope Valley Country Club - 605 AF.

59,873 - (9550 + 12,114 + 3000 + 1497 + 605) = 33,107 AF

Total demands for ground water in 1989

37,746 (M&I) + 33,107 (Ag) = 70,853 AF

Ground Water Quality

Under natural conditions, the excellent quality flood flows emanating from the San Gabriel Mountains percolated into the alluvial fans near the mountains and moved slowly underground in a northerly direction toward Rosamond, Buckhorn, and Rogers dry lakes. From deep sands and gravels beneath the clay layers the artesian waters moved upward toward the ground surface and produced seepage areas from which the water evaporated. The result was the production of saline and alkaline soils in the vicinity of the dry lakes.

Well waters in Antelope Valley are generally acceptable for all beneficial uses. However, in areas of present and former irrigation where there are shallow clay layers, the shallow waters may be of higher mineral content due to the effects of irrigation return waters. An area of high nitrates is present in the Littlerock area, where fertilizers from agricultural activities and septic tanks have degraded the relatively shallow ground waters in the Pearland subunit.

Antelope Valley is a closed basin with only a small amount of underground outflow to the Fremont Basin beneath Rogers dry lake. As a result of this condition, essentially all of the salts reaching Antelope Valley -- whether carried by surface runoff from the mountains or by imports via the State Water Project -- remain in the valley. As there is a substantial continuing contribution of salts and no exports, the salt balance is adverse. Fortunately, the deterioration can be expected to proceed very slowly, and the ground waters will, on the average, remain usable for many decades.

Numerous chemical analyses of well waters in Antelope Valley have been published in reports of the U.S.G.S. (Koehler, 1966; Moyle, 1965). More recent analyses from the ongoing monitoring programs are stored on U.S.G.S computers and are available as print-outs. Beneath the eastern part of the PRA property, in T6N, R10W, which is in the Buttes subunit, total dissolved solids show a range of 225 to 380 milligrams per liter (mg/l). In the western part of the PRA property, in T6N, R11W, which is in the Lancaster subunit, the well waters show a TDS range of 177 to 334 mg/l.

A few particular areas have a higher than normal potential for accelerated degradation. North of Lancaster there are large volumes of shallow perched waters with higher salinities due to natural or irrigation-induced conditions. Treated sewage usually has 250-300 mg/l higher TDS than the delivered water and ground waters beneath unlined ponds or in areas where treated sewage is used for irrigation should be monitored carefully.

County Sanitation District No. 14 (Lancaster) uses ponds for evaporation and percolation. In addition, the treated sewage is delivered to Apollo Park for lake level maintenance and landscape irrigation, as well as to the Nebeker Ranch for irrigation of alfalfa and other crops. Monitor wells have been installed near the District No.14 effluent ponds, the Nebeker Ranch and the Piute Ponds. Recent values of TDS in these monitor wells are in the range of 433 to 829 mg/l.

Monitor wells have also been installed near the ponds and disposal areas in the vicinity of the District No. 20 (Palmdale) sewage treatment plant. TDS values are still very low -- in the range of 128 to 207 mg/l. Because of the great depth to

water in this area, the higher salinity water may not yet have reached the water table.

Because of the extremely low concentrations (expressible in micrograms per liter, or parts per billion) at which drinking waters are rendered unacceptable by organic compounds such as solvents and petroleum products, industrial and new airport facilities should be designed and monitored very carefully to avoid pollution by such substances. The great depth to water and thick vadose zone (from the ground surface to the water table) may offer some protection against pollution but this can not be relied upon to prevent ultimate pollution if great care is not exercised.

Water Available Through AVEK

The entire PRA property lies within the boundaries of the Antelope Valley - East Kern Water Agency and is entitled to service from the AVEK facilities.

In 1991, under its contract for water from the State Water Project, AVEK will be contractually entitled to receive its maximum annual amount of 138,400 AF/YR. In 1988, AVEK delivered only 34,621 acre-feet, of which 12,114 acre-feet went directly to agriculture. Thus there is more than 100,000 AF/YR which has not yet been delivered.

There have been some questions raised, especially in droughts, about whether the State will have adequate water to meet contractor entitlements. Because of this uncertainty, the large volumes of water stored beneath Antelope Valley must be kept as a viable standby source.

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FIGURE 1

Well-Numbering System

Wells are numbered according to their location in the rectangular system for subdivision of public land. For example, in the well number 11N/9W-24B2S, that part of the number preceding the slash indicates the township (T. 11 N.); the number and letter following the slash indicate the range (R. 9 W.); the number following the hyphen indicates the section (sec. 24); the letter (B) following the section number indicates the 40-acre subdivision of the section; the final digit (2) is a serial number for wells in each 40-acre subdivision; and the final letter (S) indicates the San Bernardino or (M) Mount Diablo base line and meridian.

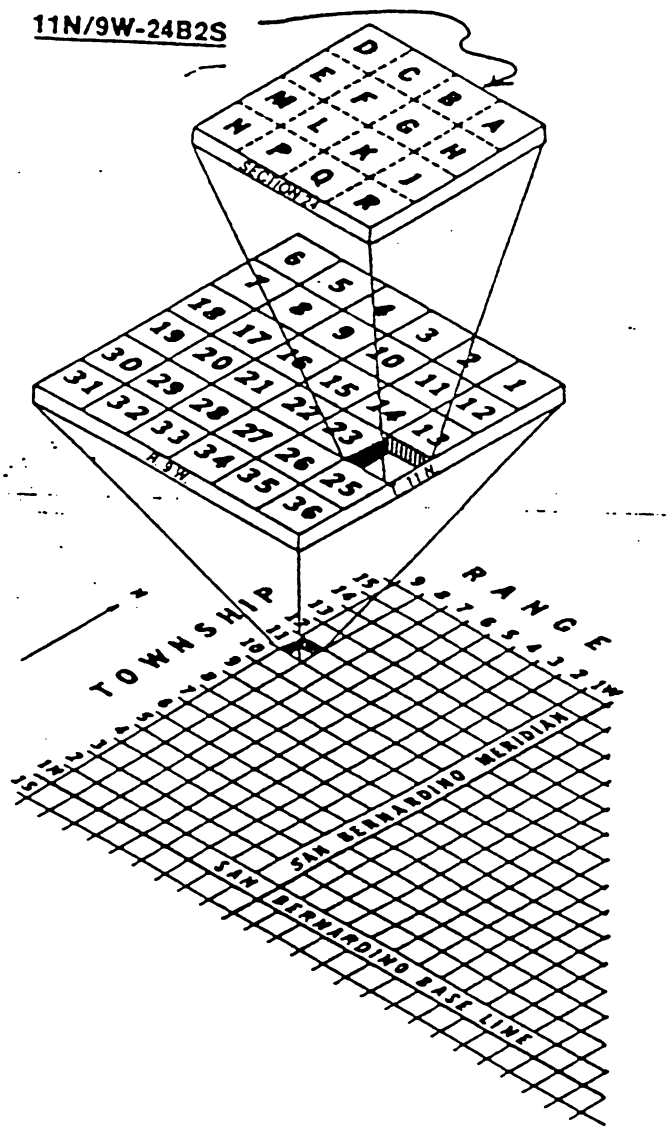
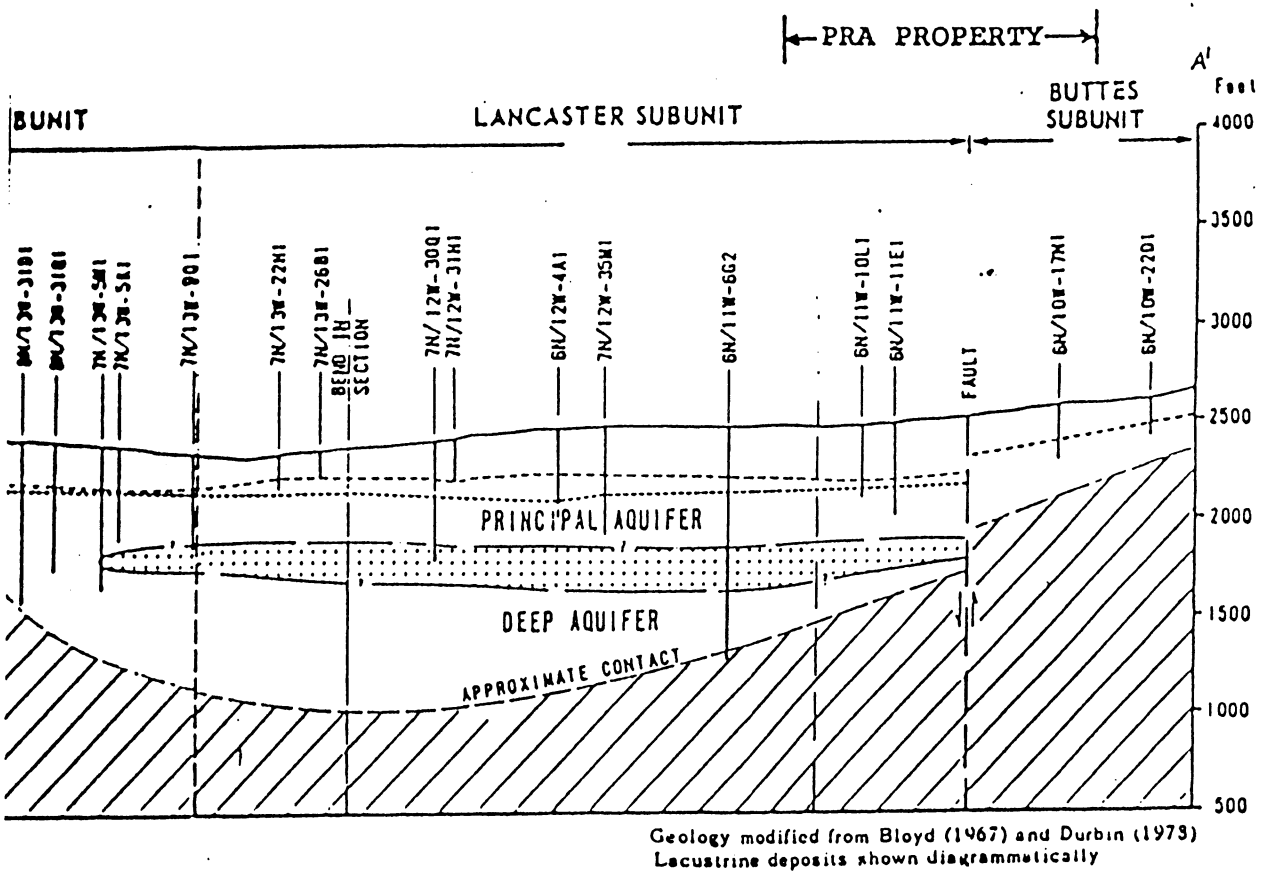


FIGURE 4



Geology modified from Bloyd (1967) and Durbin (1978)
Lacustrine deposits shown diagrammatically

EXPLANATION

ISITS

7 6N/15W-11A1

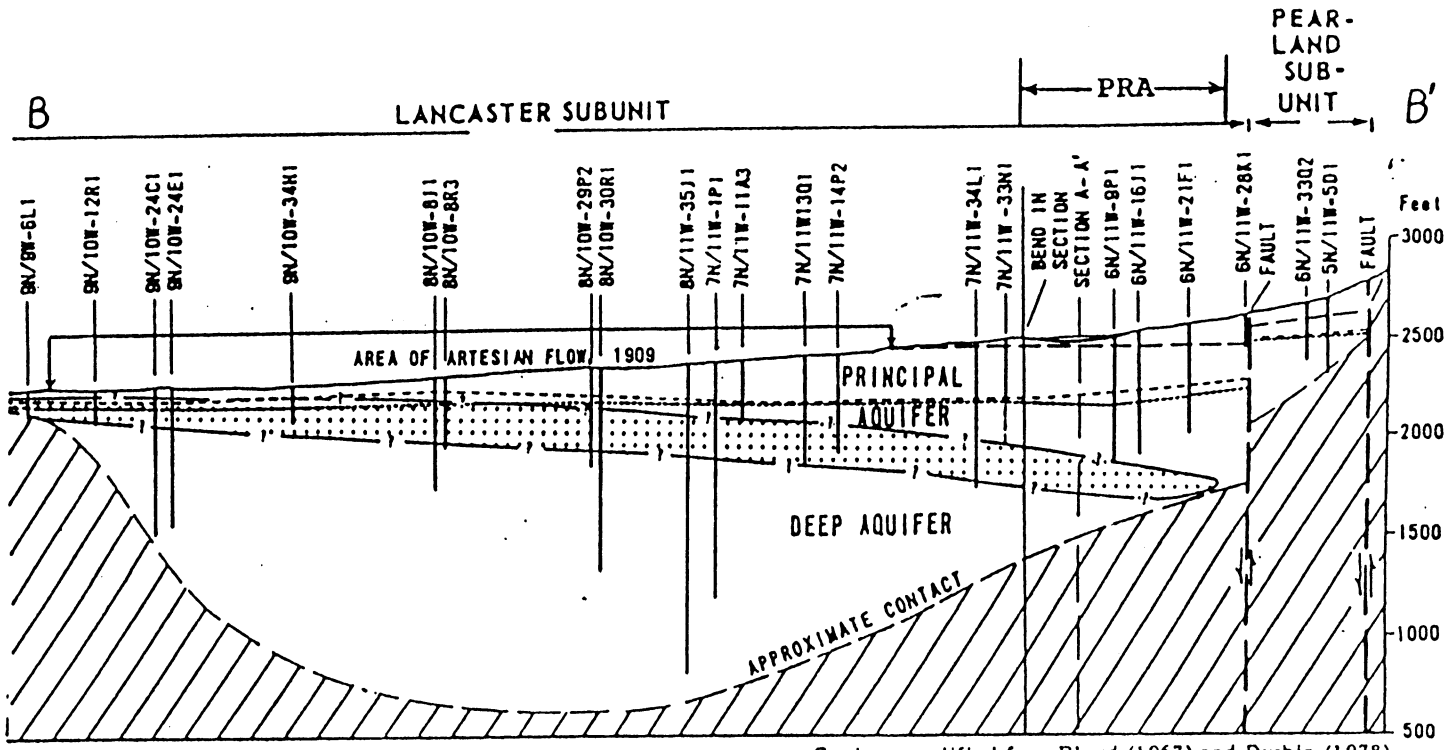
WELL--Dashed where perforated

WATER LEVEL, 1964

WATER LEVEL, 1982

cated; arrows
ive vertical

FIGURE 5



Geology modified from Bloyd (1967) and Durbin (1978).
Lacustrine deposits shown diagrammatically

EXPLANATION

UNCONSOLIDATED DEPOSITS

LACUSTRINE DEPOSITS

CONSOLIDATED ROCKS

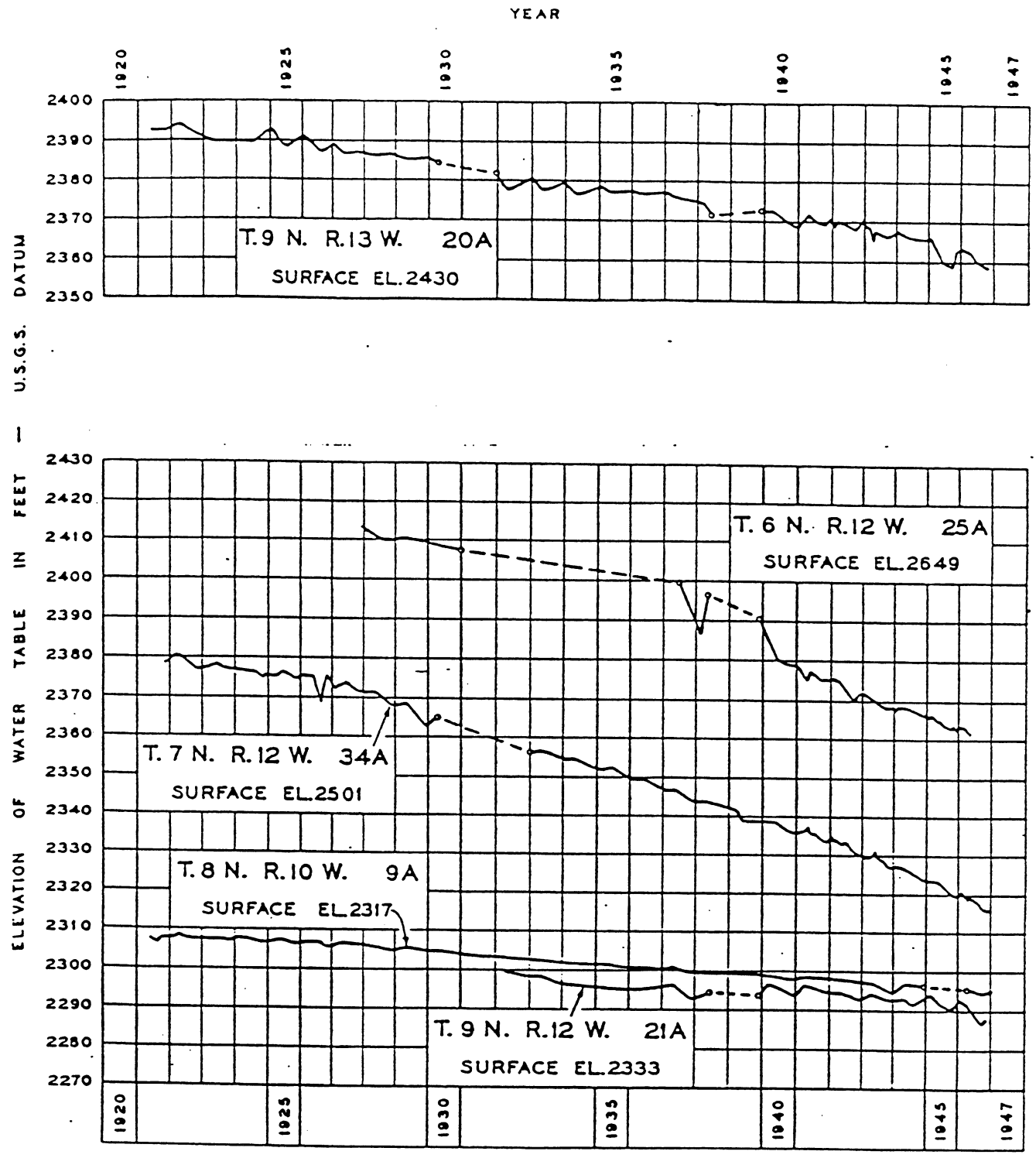
FAULT—Approximately located; arrows indicate direction of relative vertical movement

9N/15W-11K1 WELL--Dashed where perforated

WATER LEVEL, 1909

WATER LEVEL, 1964

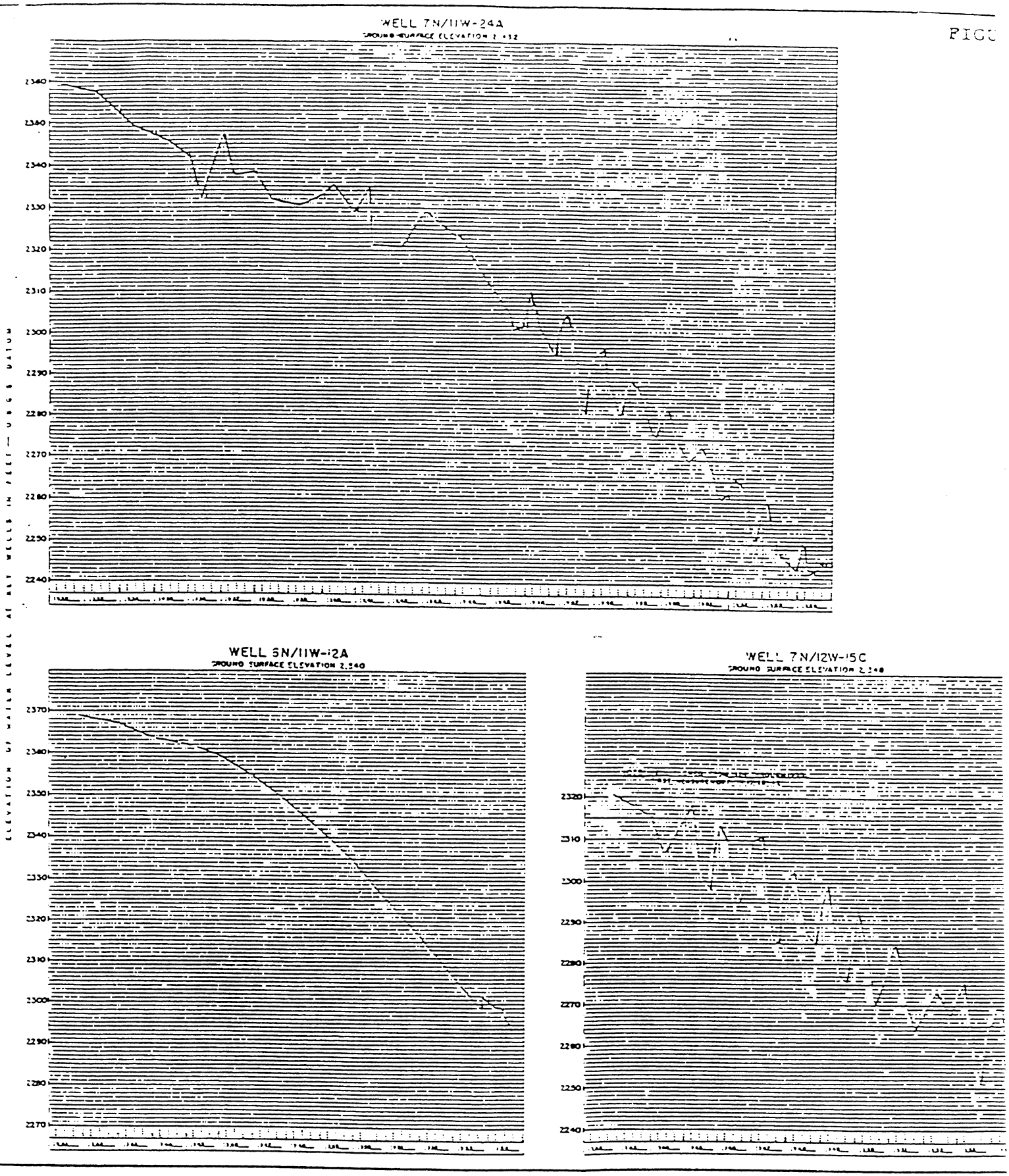
WATER LEVEL, 1982



ELEVATION OF WATER TABLE AT WELLS

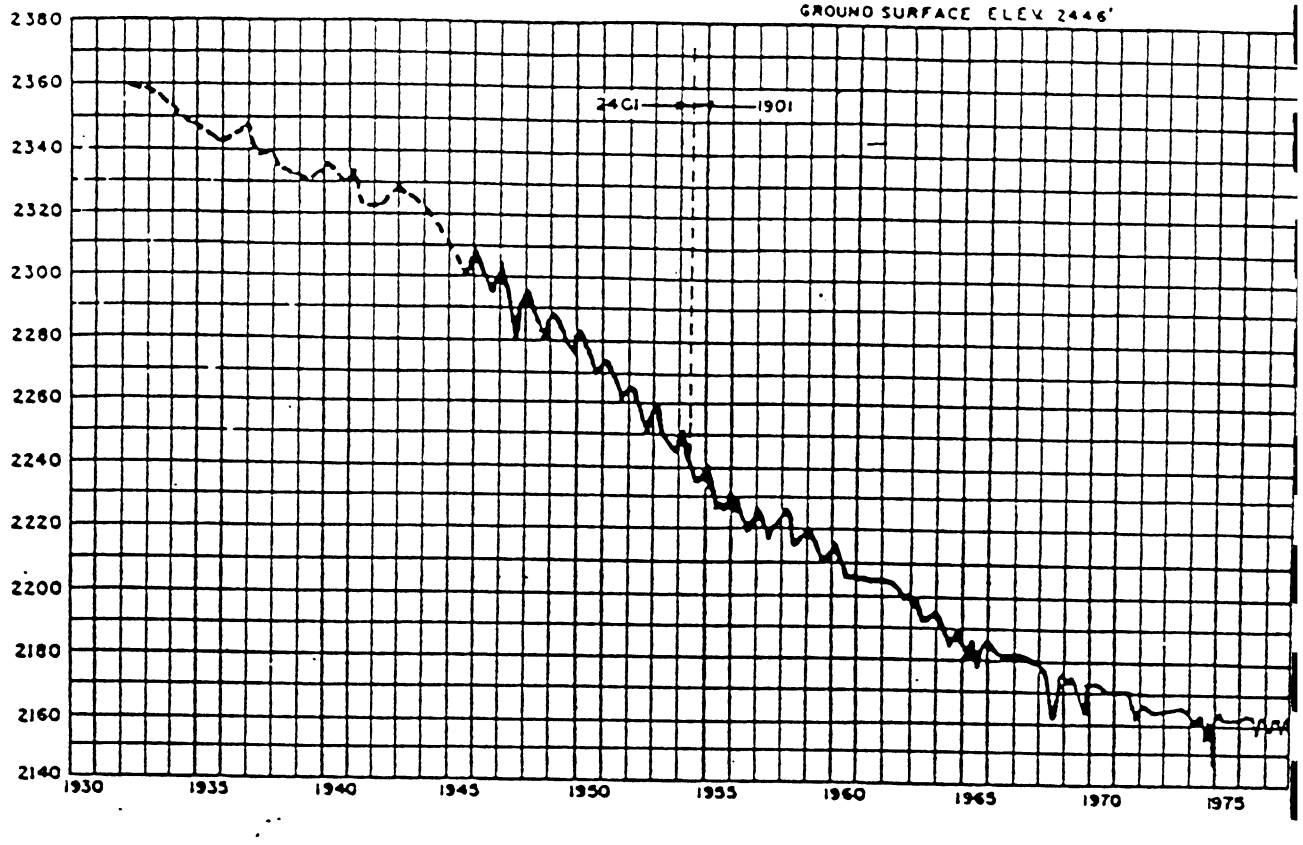
AFTER DWR, 19

FIGU

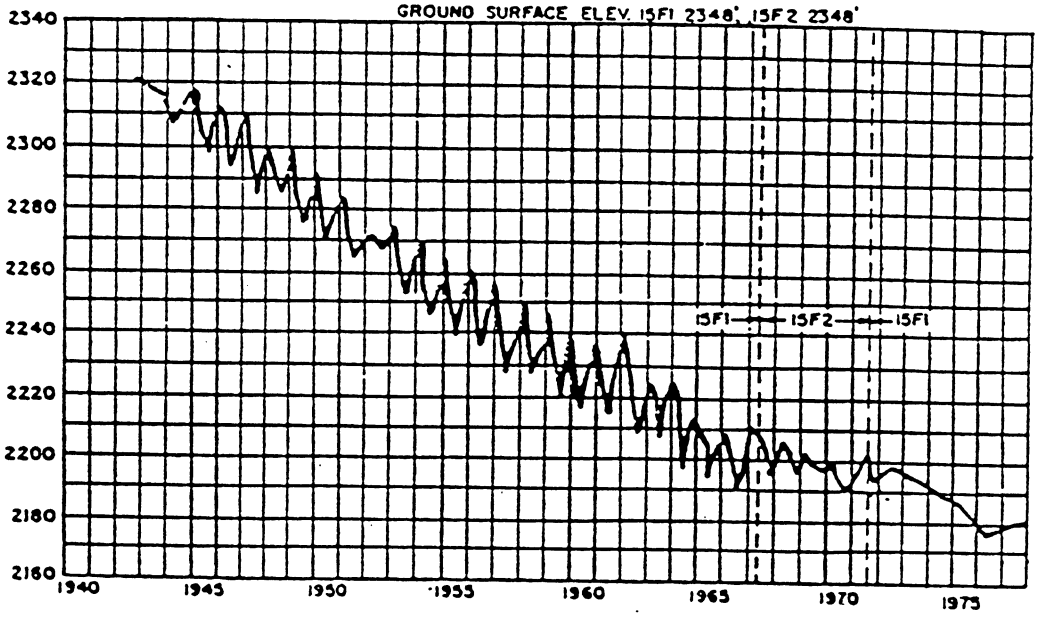


FLUCTUATION OF WATER LEVELS AT KEY WELLS WITHIN LANCASTER BASIN OF ANTELOPE VALLEY

WELLS 7N/11W-24C1, 7N/10W-1901, S. B. B. & M. (NEAR LANCASTER)



WELL 7N/12W-15F1, 15F2, S.B.B.&M. (NEAR LANCASTER)



ELEVATION IN FEET* U. S. G. S. DATUM

YEAR

* FEET X 0.3048 = METRES

FLUCTUATIONS OF WATER LEVELS IN WELLS

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1960

FIGURE 9

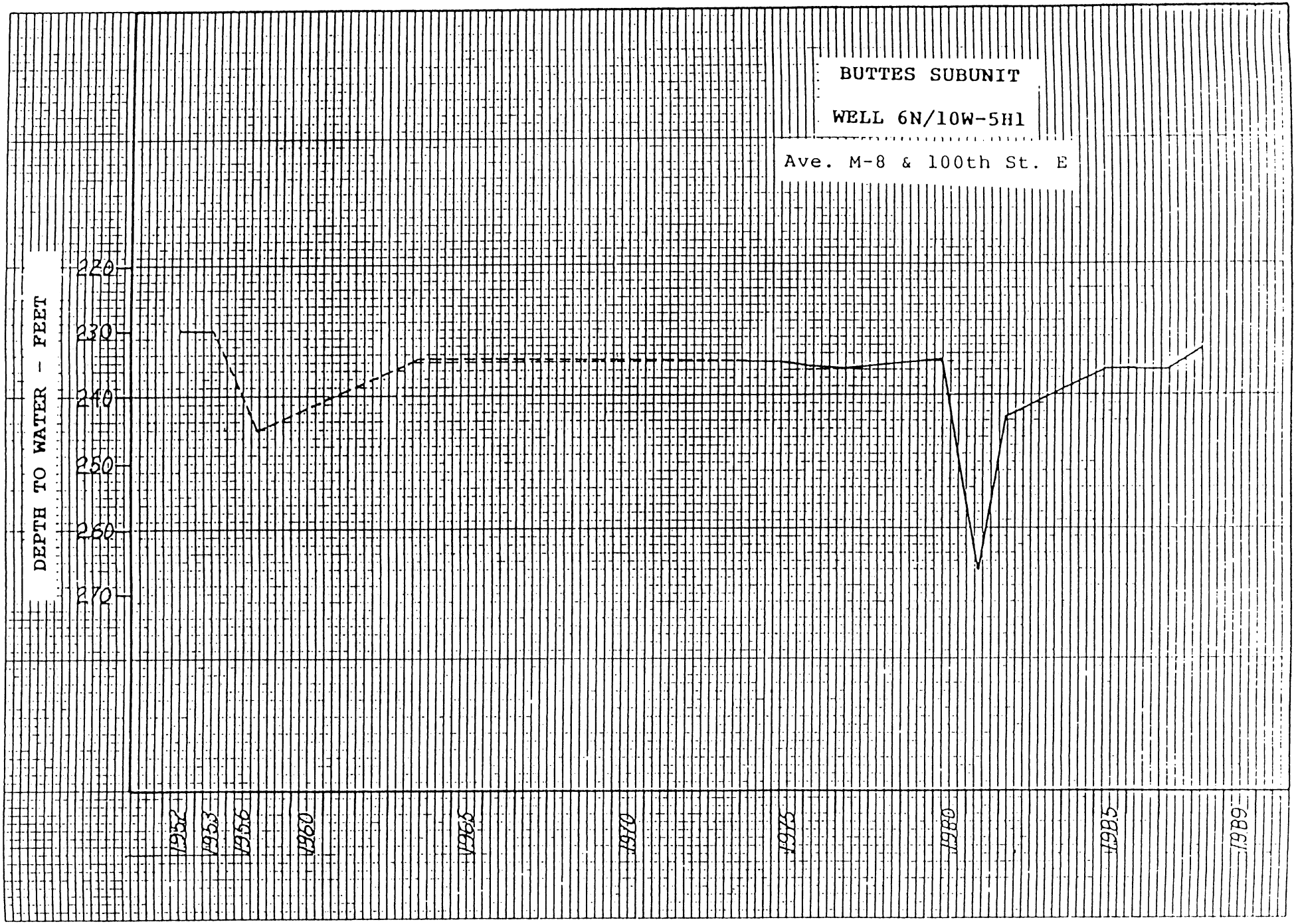

BUTTES SUBUNIT
WELL 6N/10W-5H1
Ave. M-8 & 100th St. E
DEPTH TO WATER - FEET
220
230
240
250
260
270
1952
1953
1956
1960
1970
1975
1980
1985
1989

FIGURE 10

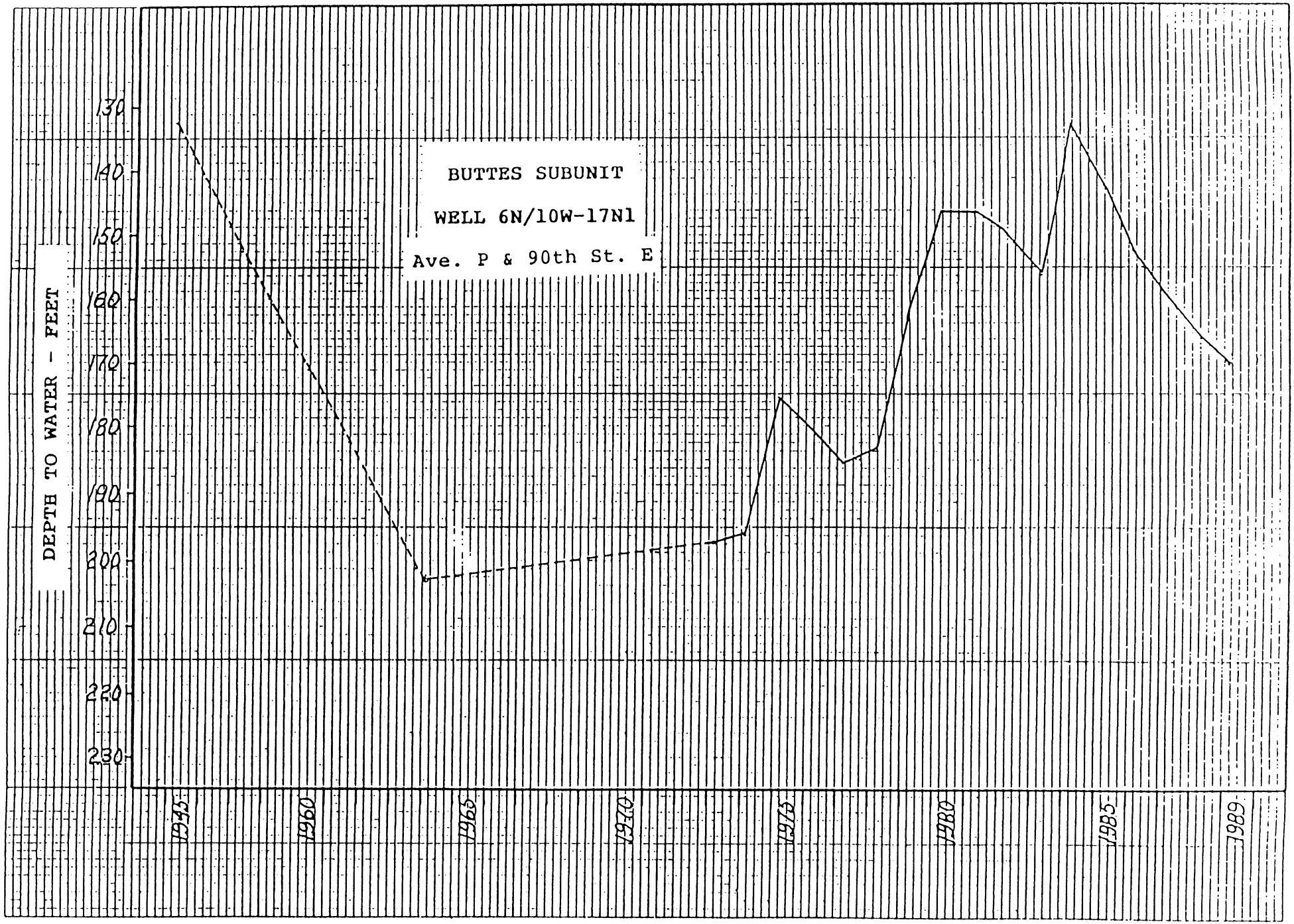
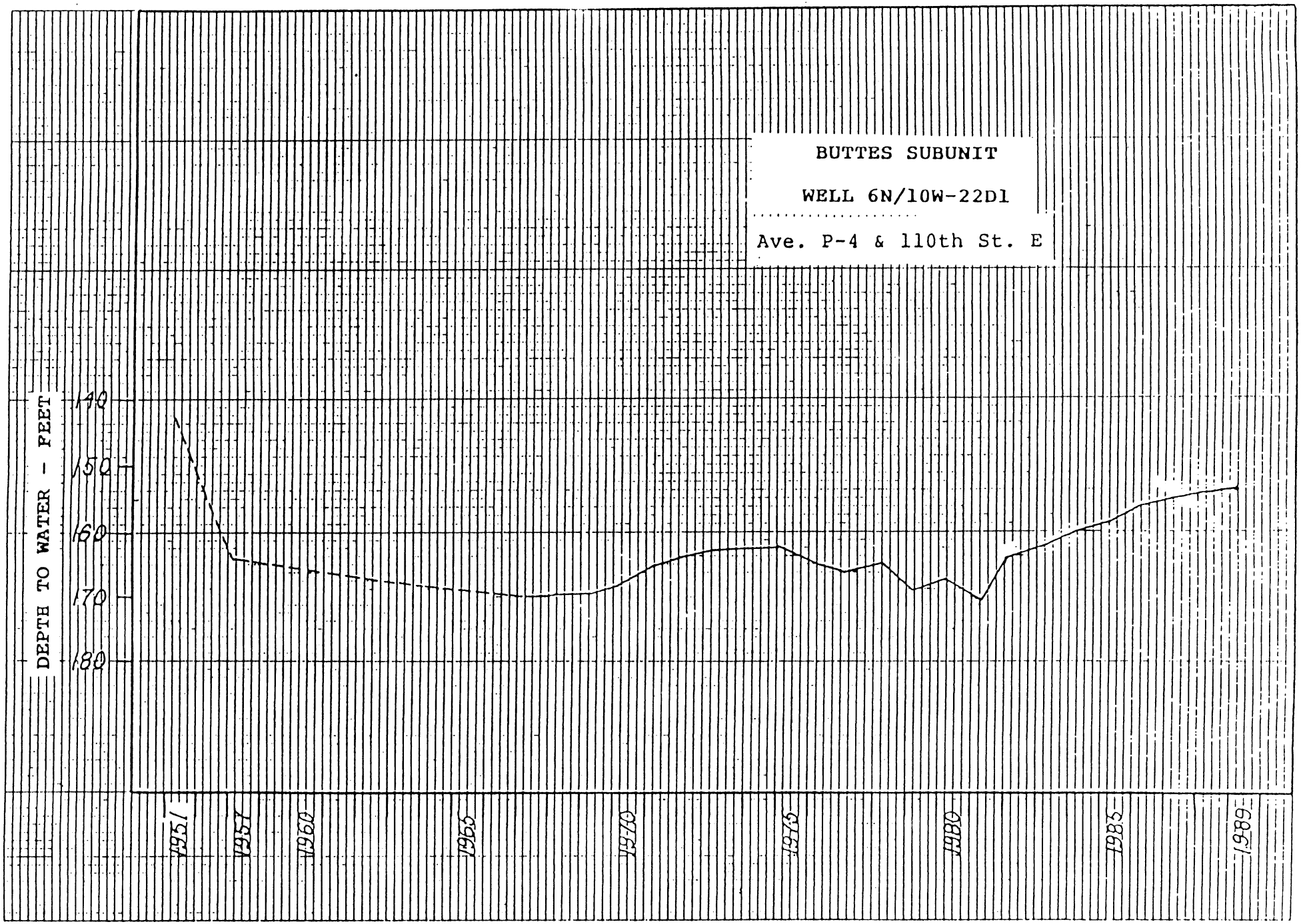
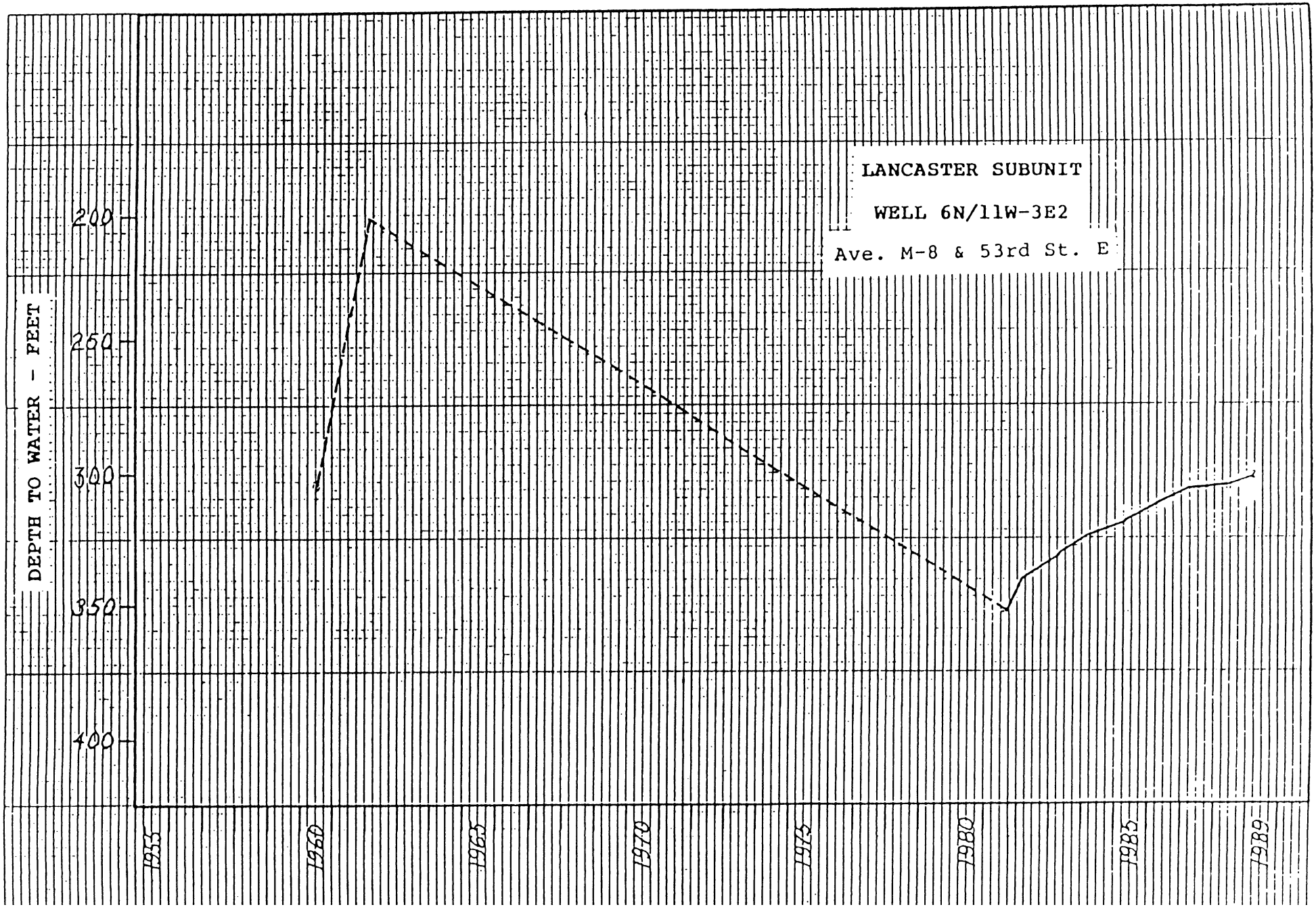

BUTTES SUBUNIT
WELL 6N/10W-17N1
Ave. P & 90th St. E
DEPTH TO WATER - FEET
130
140
150
160
170
180
190
200
210
220
230
1945
1960
1965
1970
1975
1980
1985
1989

FIGURE 11


BUTTES SUBUNIT
WELL 6N/10W-22D1
Ave. P-4 & 110th St. E
DEPTH TO WATER - FEET
140
150
160
170
180
1951
1957
1960
1965
1970
1975
1980
1985
1989

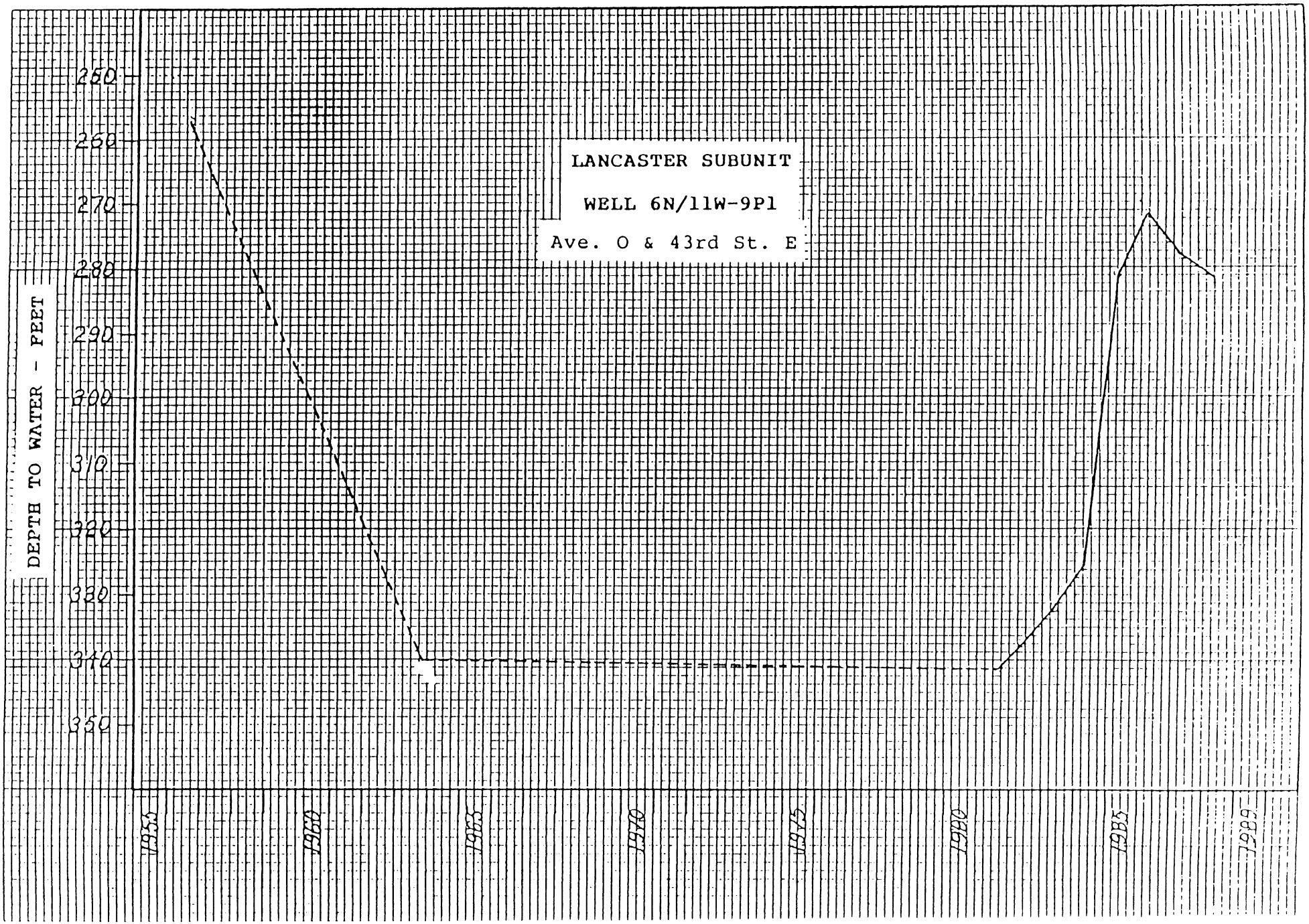
K·E 16 x 16 TO THE INCH • 7 x 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 12



K·E 16 x 16 TO THE INCH • 7 x 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 13



K·E 16 x 16 TO THE INCH • 7 x 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 14

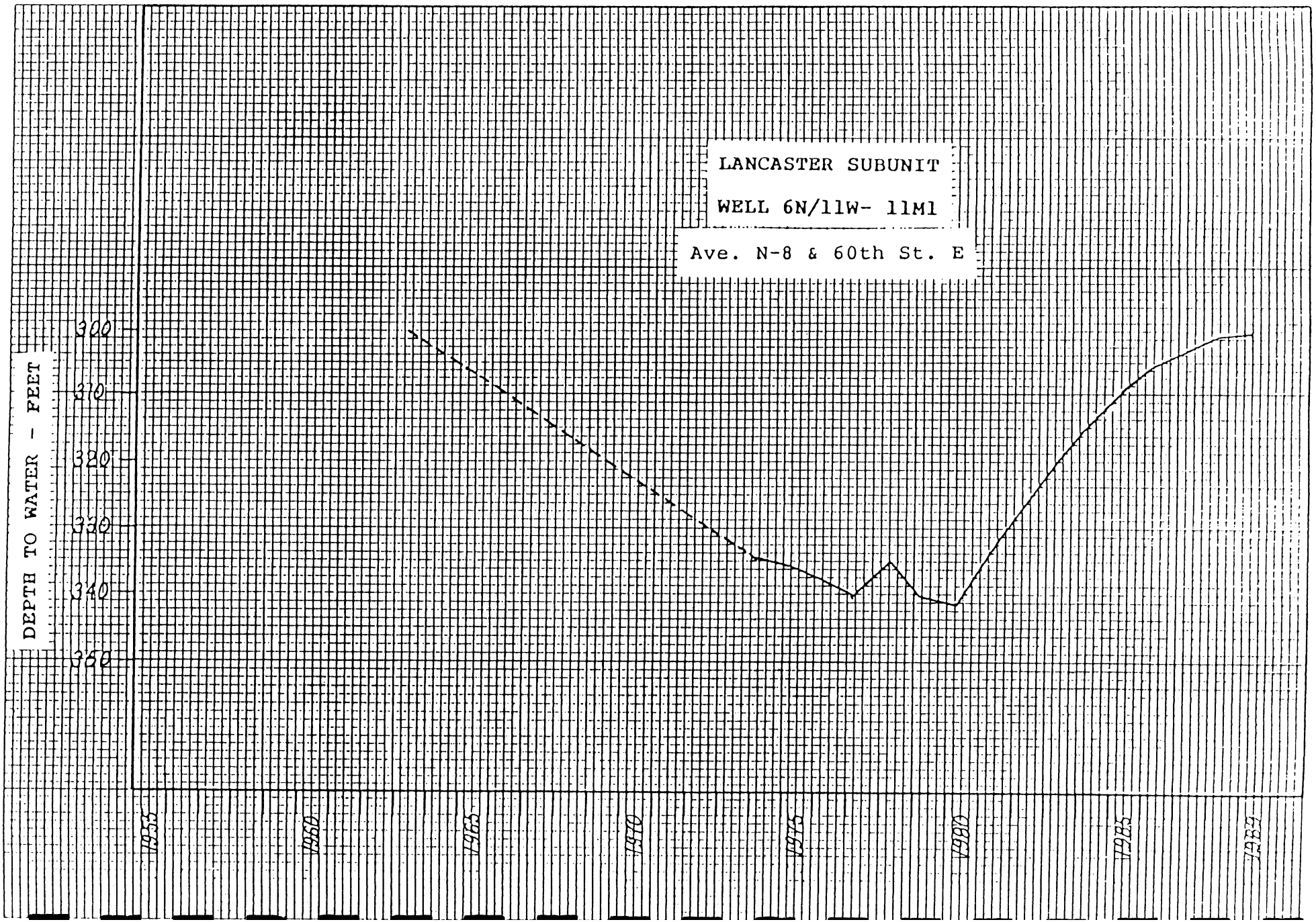
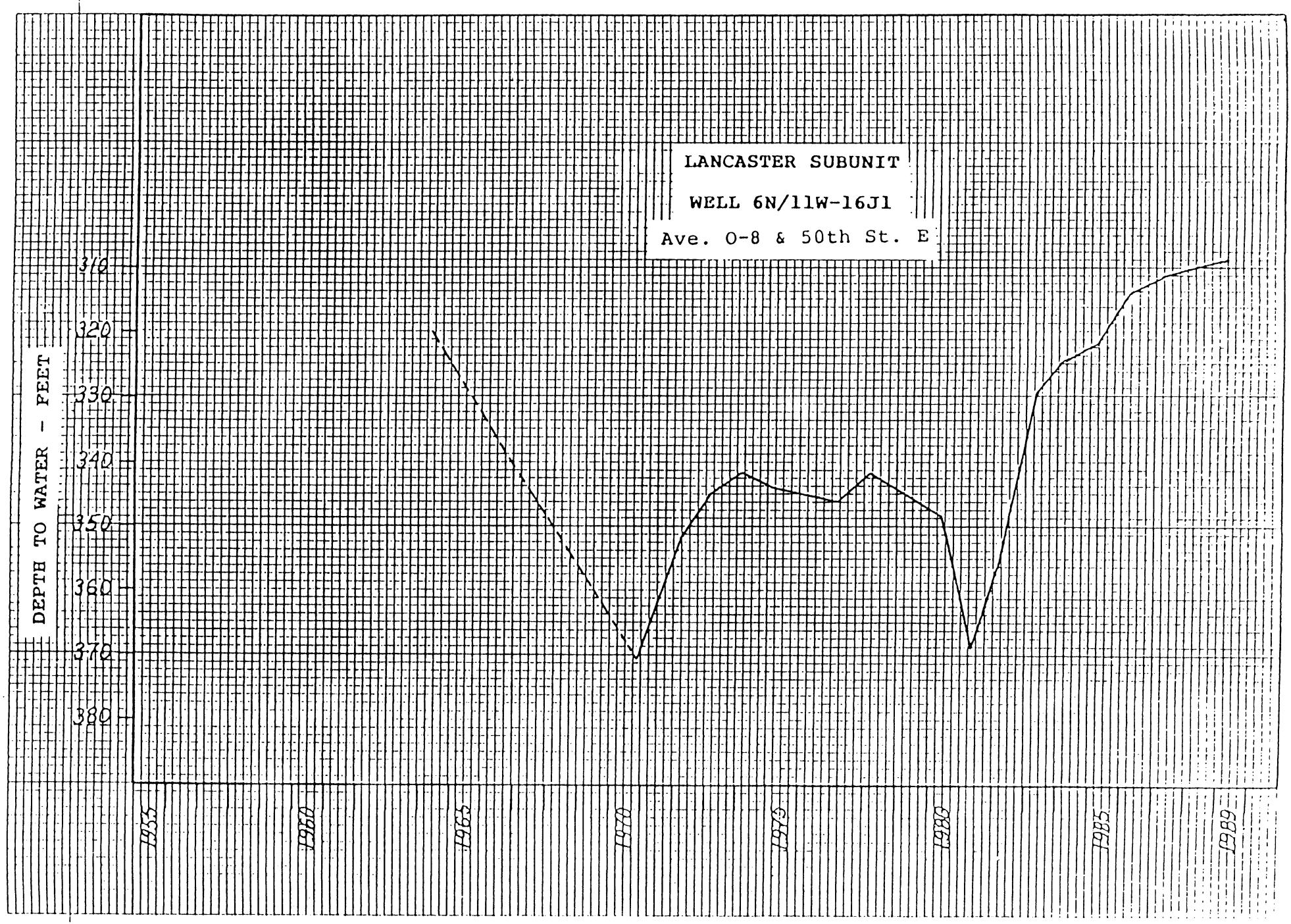


FIGURE 15


LANCASTER SUBUNIT
WELL 6N/11W-16J1
Ave. O-8 & 50th St. E
DEPTH TO WATER - FEET
310
320
330
340
350
360
370
380
1955
1960
1965
1970
1975
1980
1985
1989

K&E 16 x 16 TO THE INCH • 7 x 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

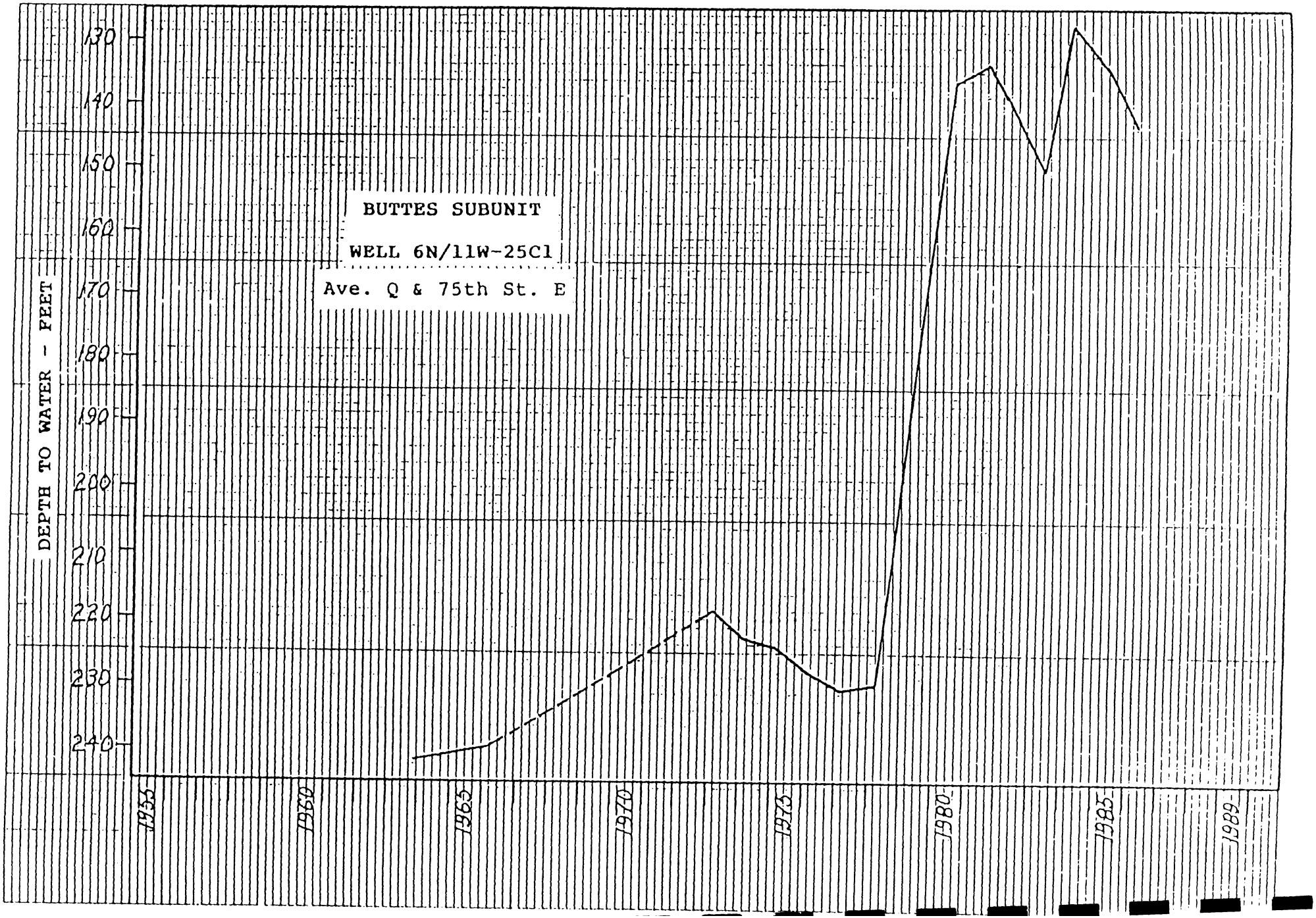



FIGURE 16