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COUNTY OF SAN LUIS OBISPO
DEPARTMENT OF PLANNING AND BUILDING
ENVIRONMENTAL DIVISION
COUNTY GOVERNMENT CENTER
SAN LUIS OBISPO, CA 93408

USI

WATER RESOURCES MANAGEMENT STUDY

FOR

THE WOODLANDS

APRIL 1996

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EXECUTIVE SUMMARY

Cleath & Associates has performed a water resources study for The Woodlands, a 957-acre site on the south edge of the Nipomo Mesa east of Highway 1. The purpose of the study was to evaluate potential impacts to water resources in the area from proposed development of the property. The Woodlands development program consists of three phases constructed over consecutive 8-year programs with annual construction in accordance with market demand. The first phase of development includes an 18-hole golf course and approximately 500 single-family residences. The second phase includes an 18-hole golf course, approximately 400 single-family residences, a hotel/resort complex, a mixed-use village center with 75 multi-family residences, and a school. The third and final phase of the development program would include approximately 300 single-family residences and 75 multi-family residences. Also phased into the development program are various parks, a habitat preserve, maintenance areas, recreational vehicle storage, and a wastewater treatment plant. Project water demand at total buildout is estimated at 1574 afy. An estimated average 1,228 afy of ground water would be pumped from four on-site production wells, with the balance of demand coming from reclaimed wastewater (346 afy).

Ground water is the principal source of water for the Nipomo Mesa and adjacent areas. Issues addressed in the study include ground water conditions for the Nipomo Mesa and the impacts of project-related pumpage on ground water quality, neighboring wells and ground water in storage. Potential impacts to ground water quality from the proposed project is discussed in terms of the salt loading to the ground water basin resulting from domestic water use and the importation of plant fertilizers. The estimated quality of recharge water percolating to ground water at the site following development would generally be of similar or better quality compared to the existing water quality beneath the site. The estimated average concentrations of water quality constituents in the recharge water would not exceed drinking water standards.

Impacts on water levels in neighboring wells from project-related pumpage is estimated at less than five feet of decline in the closest wells. Production in neighboring wells should not be significantly impacted from project-related pumpage at The Woodlands, based on the modeled water level elevations and the available data on perforated intervals. Future ground water in storage beneath the Nipomo Mesa, based on 1992 pumpage with the addition of project pumpage, is estimated to decline about 275 afy per year during the first 16 years (Phase I and II), of which 82 afy decline in storage is attributable to the project. Declines in storage within subsequent 16 year cycles are estimated to be 60 afy during the second cycle, of which 29 afy is attributable to project pumpage, and 8 afy decline in storage within the third 16 year cycle, of which 4 afy is attributable to the project. Therefore, at the conclusion of the third 16-year cycle, the average decline in storage over the 48-year period is estimated at 114 afy with the project and 76 afy without the project (38 afy net difference).

The ratios for impacts on ground water resources from the three project phases (I:II:III) as compared to the total project impact are estimated at approximately 0.4:0.85:1 for water demand figures; 0.6:0.9:1 for water quality impacts, and 0.3:0.7:1 for ground water storage impacts.

INTRODUCTION

Cleath & Associates has performed a water resources study for The Woodlands, a 957-acre site on the south edge of the Nipomo Mesa east of Highway 1 (Figure 1). The purpose of the study is to evaluate potential impacts to water resources from the development of the property. The development plan calls for a residential community with single-family and multi-family residences, a school, parks, recreational facilities including golf courses, a hotel and resort complex, and a commercial/mixed use village center.

The study is divided into two major sections: Existing Conditions and Proposed Project Conditions. Existing Conditions describes the current site conditions, summarizes previous area studies, and presents the regional and site geology and hydrogeology. Proposed Project Conditions is a section devoted to the project description and the evaluation of potential impacts to the water resources in the area.

CONDUCT OF WORK

The purpose of this section is to briefly review the types of work conducted during the study and to explain how and where information was gathered for use. Each of the following paragraphs summarize selected topics of investigation and a representative portion of the work performed.

Hydrogeologic Investigation

The basic data used for development of geologic cross-sections and contour maps came from drilling logs and electric logs of boreholes. Approximately 200 individual logs were reviewed and were interpreted as to the lithologies represented (i.e. depth and thickness of the shallow aquitard, top of the Paso Robles Formation, top of the Careaga Formation, base of permeable sediments, etc.). Aquifer parameters such as permeability, specific yield and storativity were interpreted from the results of about two dozen pump tests in the Nipomo Mesa - Oso Flaco areas, including those found in the literature (such as Worts, 1951). In areas where pump test data were lacking, interpretation was made based on lithology. Contour maps for lithologic horizons were initially developed by hand and digitized. These digitized maps were then computer-contoured for model input, thereby retaining the original interpretation of the data.

Water Demand and Water Quality Investigation

Project water demand was estimated by assigning each proposed land use with a water duty factor and consumptive use factor. These factors were typically obtained from published studies, although some factors were also researched independently due to their priority (golf course irrigation) or to conflicting information (school water demand). Once the individual water duty factors were standardized into annual water demand figures, the monthly water demand cycle was back-calculated by proportioning

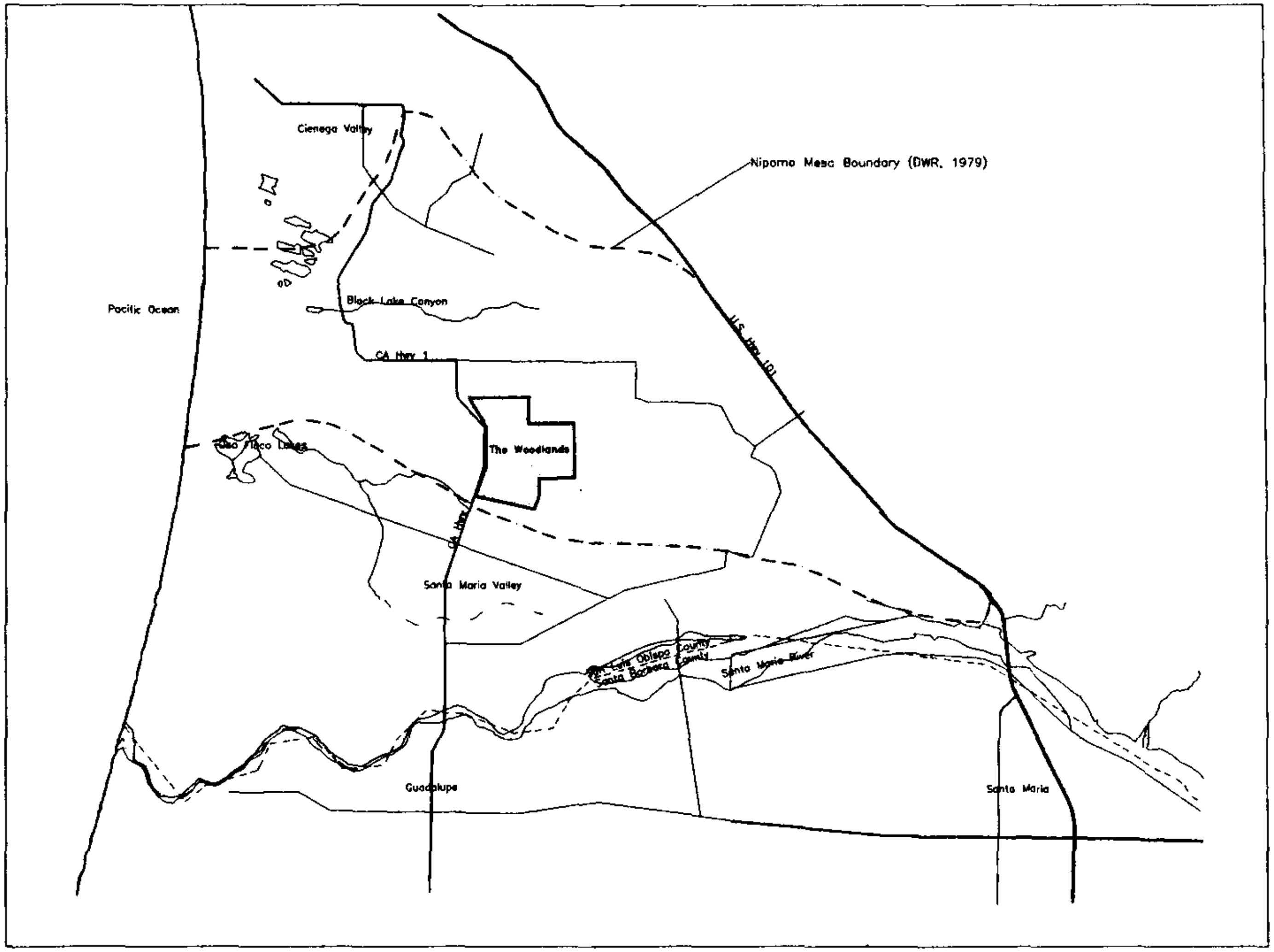

Figure 1
Site Location

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Area_Map.DWG

outdoor use according to reference evapotranspiration rates obtained from maps published by the California Department of Water Resources (DWR). A similar but much less variable monthly demand cycle was calculated for indoor use. The monthly wastewater influent flows to a central treatment plant were estimated, as were monthly return flows to ground water. The water quality studies estimated reclaimed water quality based on well water quality and average mineral pickup during a use cycle, evaluated uptake of nutrients by turfgrasses and estimated the quality of return flow from golf course irrigation. Fertilizer application and well water quality according to production estimates are included in these calculations.

Investigation of Potential Impacts to Ground Water

Potential impacts to ground water were studied using water quality analyses as described above, using well interference analyses based on a tentative production plan, and using a numerical flow model. The flow model was applied in several ways. Regional water levels for selected years were calculated with and without pumpage from the proposed project. These water levels were used to derive annual ground water storage estimates, identify trends, and evaluate pumping depressions. In addition, hydrologic budget items for the Nipomo Mesa area (DWR, 1979 definition) were extracted from the model for the representative time period (1977-1992) and used to evaluate storage changes and changes in subsurface flow to or from agricultural regions to the north and south. Model inputs were in large part based on hydrogeologic investigation. The locations of residential and production wells in the model area and pumpage estimates for municipal and agricultural wells were based on information provided by the local water companies, field reconnaissance and land use data from the San Luis Obispo Agriculture Commissioner's Office. Cleath & Associates conducted a reconnaissance survey of the northwest Santa Maria Valley in July, 1995, to identify pumping wells in the model area and talk to local farmers about cropping, production estimates, and water quality.

EXISTING CONDITIONS

SITE BACKGROUND

This section briefly describes the site and historical land use. In addition, pertinent water resources studies for the Nipomo Mesa are reviewed.

Site Description and Historical Land Use

The Woodlands encompasses about 957 acres of land on the southern edge of the Nipomo Mesa, San Luis Obispo County, California (Figure 1). Site topography is characterized by a central (dune) ridge about 300 feet above mean sea level which divides the property along a northwest to southeast trend. North of the ridge is an interdunal depression that begins to rise again toward the property boundary. South of the central ridge, site topography gently slopes (up to 5 percent grade) toward the Santa Maria Valley.

There are about 863 acres of eucalyptus trees on the property (90 percent of the total area). The property is believed to have been utilized for grazing at one time but has been vacant for several decades. There is still some debris of an old house and corrals toward the southwest corner of the property. There are at least two older wells and four new wells on-site (Figure 2). The new wells are discussed in detail in the ground water facilities section of this report (Project Description section). One of the older wells (11N/35W-22C2; drilled in 1944) has been located adjacent to the former homestead and is in poor condition.

Previous Reports

There have been several reports relevant to the evaluation of potential impacts to water resources on the Nipomo Mesa. Many of these reports are discussed or referenced as part of this study. The following paragraphs presents summaries of the most pertinent reports in chronological order:

California Department of Water Resources, 1970, Bulletin No. 63-3, Sea-Water Intrusion: Pismo-Guadalupe Area.

The sea-water intrusion study presents information regarding evidences for sea-water intrusion along the coastline from Pismo Beach to Guadalupe. This report concluded that: (1) "Sea-water intrusion is not an immediate problem onshore at present."; and (2) "Intrusion is probably advancing landward from different salt water forebays at different rates in each confined aquifer." (Page 8). Based on these conclusions, coastal observation wells were recommended to monitor sea-water intrusion and standards for well construction be established to preclude movement of degraded water from one aquifer to another.

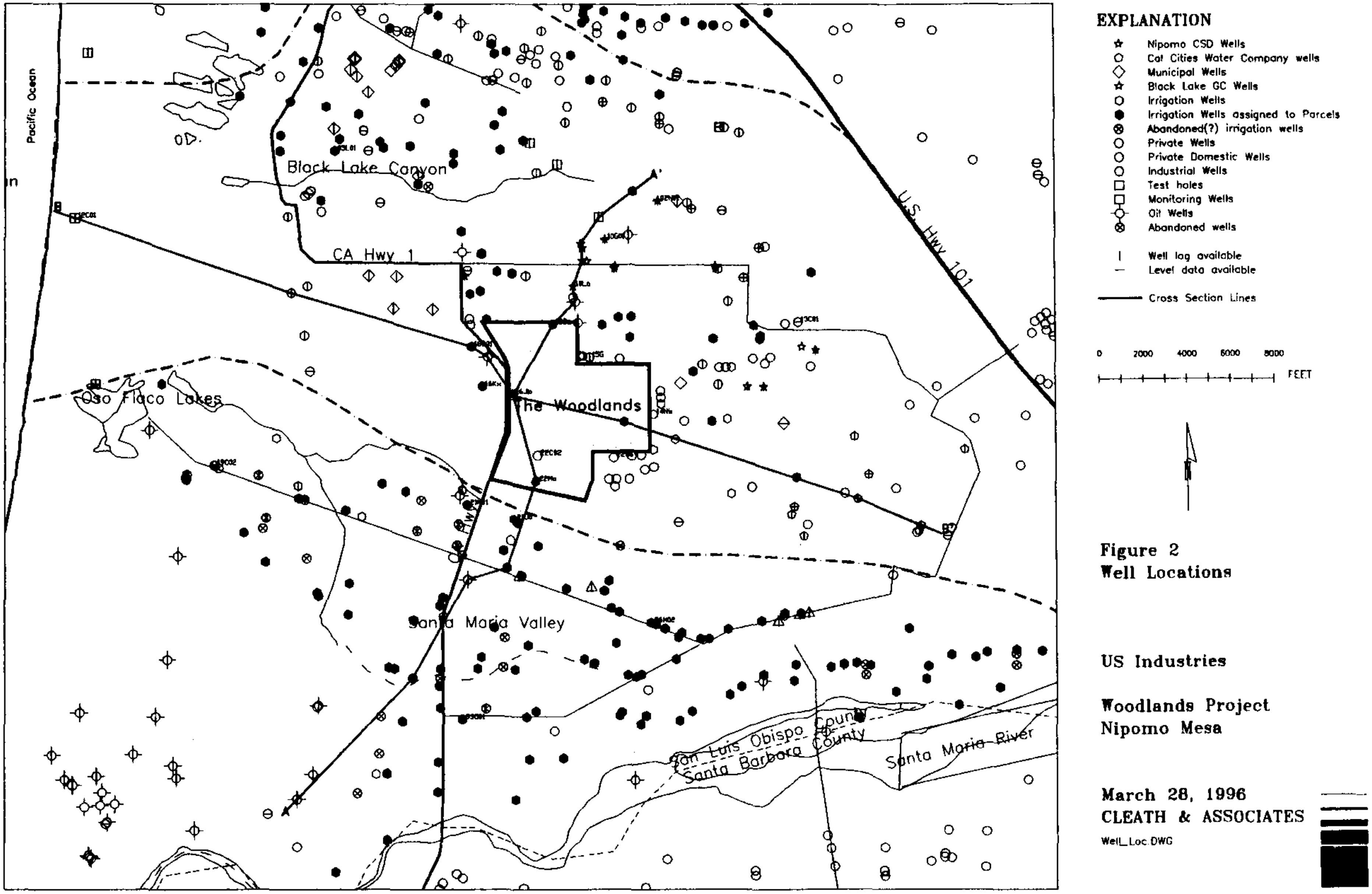

Figure 2
Well Locations

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Well_Loc.DWG

California Department of Water Resources (DWR), 1979, Ground Water in the Arroyo Grande Area.

This report presented an overall summary of ground water conditions in the area including the Nipomo Mesa. The report concludes, "With average annual replenishment, the amount of ground water in storage at elevations above sea level in the Arroyo Grande Plain-Tri Cities Mesa area appears to be adequate to meet the water demand until at least 1990, and in the Nipomo Mesa and the Santa Maria Valley within San Luis Obispo County to at least 2000. Generally, as long as ground water levels remain above sea level, the sea water is not likely to intrude". A more detailed discussion of the DWR report is presented in the water resources section of this report.

The agency began an update of this investigation in 1994 and will be conducting additional research and analyses over the next few years, prior to submitting its findings and conclusions. Cleath & Associates has been in contact with the project personnel regarding the status of their work and have assisted the DWR in their research efforts.

Lawrance, Fisk & McFarland, Inc., 1987, Water, Wastewater and Drainage Studies Nipomo Mesa Planning Study

LFM summarized the hydrogeology, updated the hydrologic budget items, reassessed the long-term annual yield, assessed existing water quality and wastewater generation in light of the ground water quality objectives, and discussed drainage considerations for the Nipomo Mesa area. LFM concluded that the "groundwater pumpage on Nipomo Mesa has increased significantly within the past few years so that a surplus supply no longer exists."

The Morro Group, 1990, South County Area Plan (EIR).

The discussions and analyses relevant to water resources are in Appendix A: Review of Groundwater Conditions in the Northern Santa Maria Basin. Appendix A presents a relatively thorough review of previous studies and study areas, and combines USGS and DWR terminology and basin/study area divisions into a unified system. Some basic concepts, such as basin definition and use of the term overdraft are consistent with those used in the present study. The changes in storage in the Santa Maria ground water basin and the Nipomo Mesa area are compared from various sources using various methods. The study observes that the trend in storage level decline in the Santa Maria ground water basin since 1918 has decreased since about 1959 and is generally one of a "leveling-off" of reductions in storage. The main discussion centers around the Nipomo Mesa area, which the study reasons has evolved into the recharge area for adjacent agricultural areas to the north and south. The report concludes " Therefore, there is not now information indicating there is a significant and continuing state of decline in groundwater levels beneath the mesa" (page A-46).

Chipping Geological Services, 1994, Black Lake Canyon Geological and Hydrogeologic Study.

This latest review of Black Lake Canyon describes the hydrogeology of the canyon in terms of an upper and lower aquifer. The relationships between the two aquifers are similar to those identified by Cleath & Associates in this and previous studies. A clay aquitard separates the upper and lower aquifers in the eastern portion of the canyon, but dips below the regional water table west of Zenon Way.

One emphasis of the report was to characterize ground water conditions in the vicinity of Black Lake Canyon. Several water-level maps were prepared and regional (Mesa) drawdown rates of 0.37 to 0.55 feet per year were calculated. One conclusion reached in the report was "the regional water table utilized by most wells near the upper canyon is in a state of overdraft, and is below the perched aquifer". Details of this report are discussed in the current study.

GEOLOGY AND HYDROGEOLOGY

The regional geology and hydrogeology summarized below is based on a literature review as well as interpretation based on cross-sections developed by Cleath & Associates. The site geology and hydrogeology section is based on site-specific data. Additional discussion in this report of geology and hydrogeology can be found in the water resources section. Figure 2 shows selected hydrogeologic features and the orientation of geologic cross-sections discussed below.

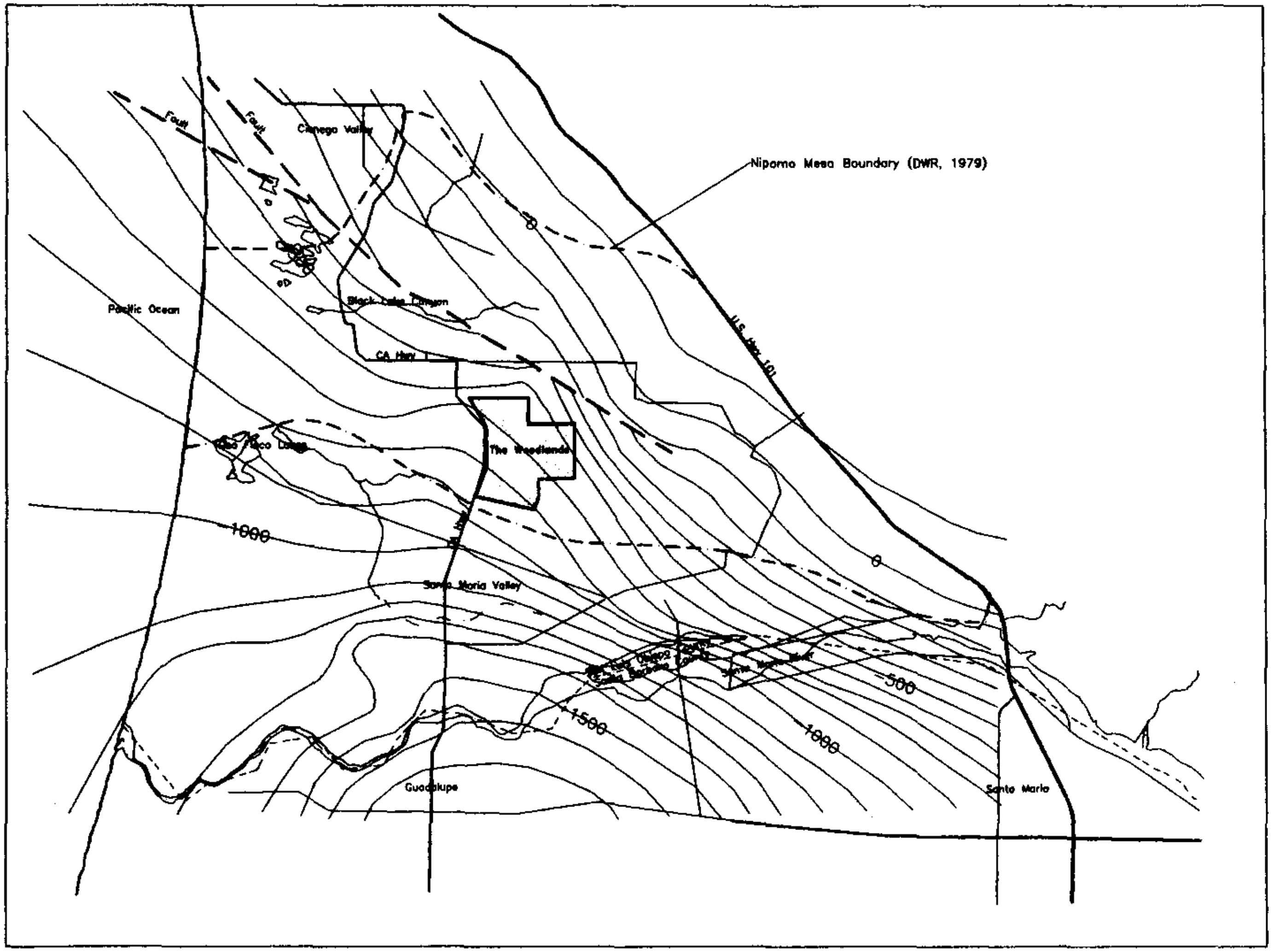
Regional Geology and Hydrogeology

The Woodlands is located on the south side of the Nipomo Mesa, a physiographic upland in the Coast Ranges Province of California. The Nipomo Mesa is bounded by the Arroyo Grande Valley to the northwest, by Los Berros Canyon and the Nipomo Valley to the north and east, by coastal dunes to the west, and by the Santa Maria Valley to the south. Surficial deposits in the valley floors consist of Recent alluvial gravel, sand, silt, and clay. A complete stratigraphic sequence for the southern Nipomo Mesa from ground surface down would includes older dune sand (Qds), Paso Robles Formation deposits (TQpr), Careaga sand, Foxen mudstone, Sisquoc Formation shales, Monterey shale, Point Sal Formation, Lospe Formation, Knoxville Formation and the Franciscan Formation. The following paragraphs describe the water-bearing deposits and some general relationships between lithologic units of interest.

Water-Bearing Deposits. The ground water supply for the Nipomo Mesa and surrounding areas east of Highway 101 is derived primarily from unconsolidated sediments. The effective base of fresh water, herein referred to as the base of permeable sediments, generally coincides with the base of the Careaga sand. A map showing elevation contours on the base of permeable sediments is shown in Figure 3.

Elevation contours on the base of permeable sediments show a generally northeast to southwest sloping surface with a depression beginning near Guadalupe. This depression continues to the southeast toward Betteravia and Orcutt along the axis of the synclinal fold beneath the Santa Maria Valley. The base of permeable sediments rises from about 900 feet below mean sea level along the southwest edge of the Nipomo Mesa to about 100 feet above mean sea level near Highway 101. There is a sharp increase in base elevation northeast of the subject site due to displacement on the Oceano Fault.

The primary ground water sources tapped by wells on the Nipomo Mesa include the Paso Robles Formation and, to a lesser extent, the Careaga Formation. In the Cienega Valley and Santa Maria Valley the major ground water sources tapped by wells include Recent alluvium (Qal) and the Paso Robles Formation. A general description of these water bearing sediments and their hydrogeologic characteristics follow below.



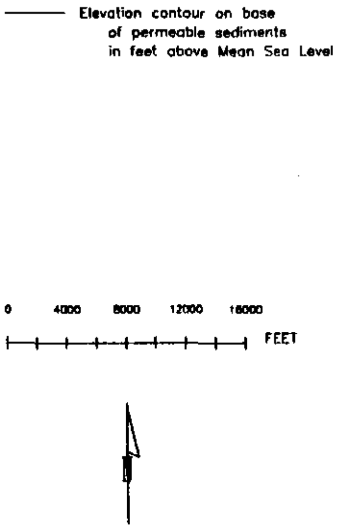


Figure 3
Base of Permeable Sediments

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Base_FWS.DWG

Recent Alluvium

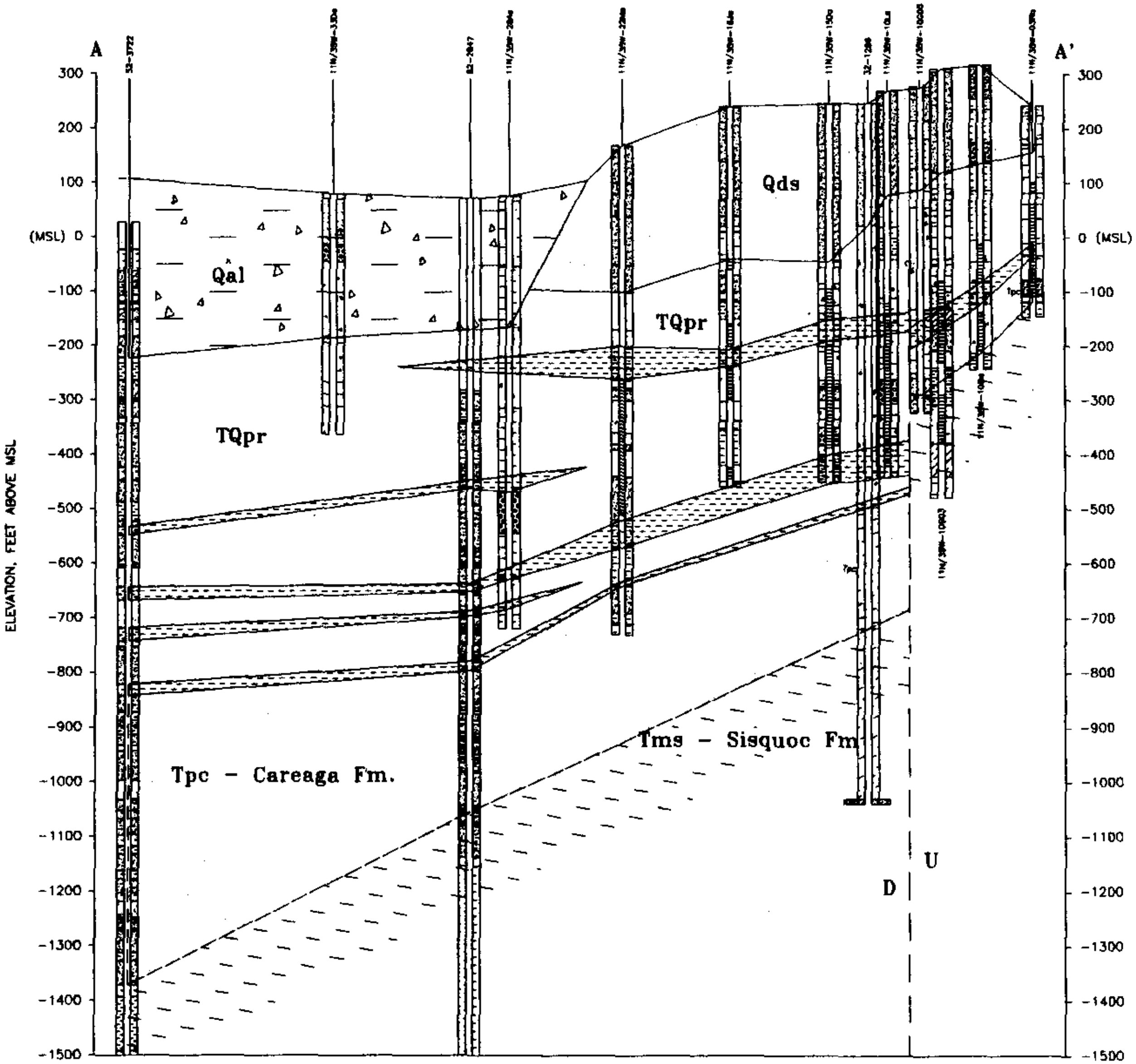
The alluvial aquifers in the Santa Maria Valley and Cienega Valley are tapped by production wells for commercial agriculture. Historically, these wells penetrated below shallow, often perched water, and were perforated in the highly transmissive gravels of the lower alluvium, as well as in the deeper Paso Robles Formation deposits. Permeability of the lower alluvium in the Santa Maria Valley was reported at about 470 feet per day (well 10N/33W-21R1; Worts, 1951). The permeability generally decreases towards the coast. The lower member of the alluvium is missing in the Santa Maria Valley roughly north of latitude 35°00', and is confined beneath a clay aquitard from about Bonita School Road west to the coast (Worts, 1951).

Older Dune Sand

The Pleistocene-age and younger dune sands are described as well sorted, fine-grained sands composed of 85-90 percent quartz and 10-15 percent feldspars (Hall, 1973). Differentiation of younger and older dune sand is made on the basis of vegetation; older dunes are inactive and more heavily vegetated than active, younger dunes. Other descriptions for dune sand include medium to coarse grained, highly porous, highly permeable sand (SBCWA, 1966 and 1994) and lightly compacted fine sands containing clay and silt stringers (DWR, 1979). Dune sands on the Nipomo Mesa are typically about 150-250 feet thick and may include perched ground water zones, such as in Black Lake Canyon. The thickness of dune sands increases to the south and is estimated to be closer to 300 feet beneath the subject site based on cross-sections A-A' (Figure 4) and B-B' (Figure 5).

An important hydrogeologic issue for the Nipomo Mesa is the deep percolation rate. Runoff from the Mesa is low due to both the high percolation rates of the sands and from the transverse dune structure that includes many closed depressions. Deep percolation of precipitation to ground water beneath the Nipomo Mesa has been estimated at 12 percent (DWR, 1979) and 28 percent (Envicom, 1985, and The Morro Group, 1990). Cleath & Associates has estimated the deep percolation of precipitation on the Nipomo Mesa at about 25 percent, based on hydrologic budget and ground water modeling analyses.

The dune sands may contain perching layers of clay which result in shallower ground water zones above the Paso Robles Formation (or ponds, in the case of upper Black Lake Canyon) . This perching layer is not a continuous bed beneath the Mesa but is found in enough areas to infer a generalized regional aquitard. The aquitard acts as a confining layer in the western Santa Maria Valley. Contours of the thickness and of the bottom of the shallow aquitard is presented in Figure 6 and Figure 7. The shape of the aquitard may be related to the sea level fluctuations that occurred during the ice ages, which could be interpreted to have submerged the Santa Maria River Channel up to Bonita School Road, based on the absence of confining conditions to the east of the crossing. The moderately decreased thickness of the aquitard in the west central Santa Maria Valley, which to a certain degree corresponds to a topographic high on the base of aquitard, suggests (along with other evidence) that the main river



EXPLANATION

See Well Location Map
for Cross Section Location
See Abbreviation List for Full
Lithologic Descriptions

▥ Perforated Interval

0 2000 4000 6000 8000 FEET

Figure 4
CROSS SECTION A – A'

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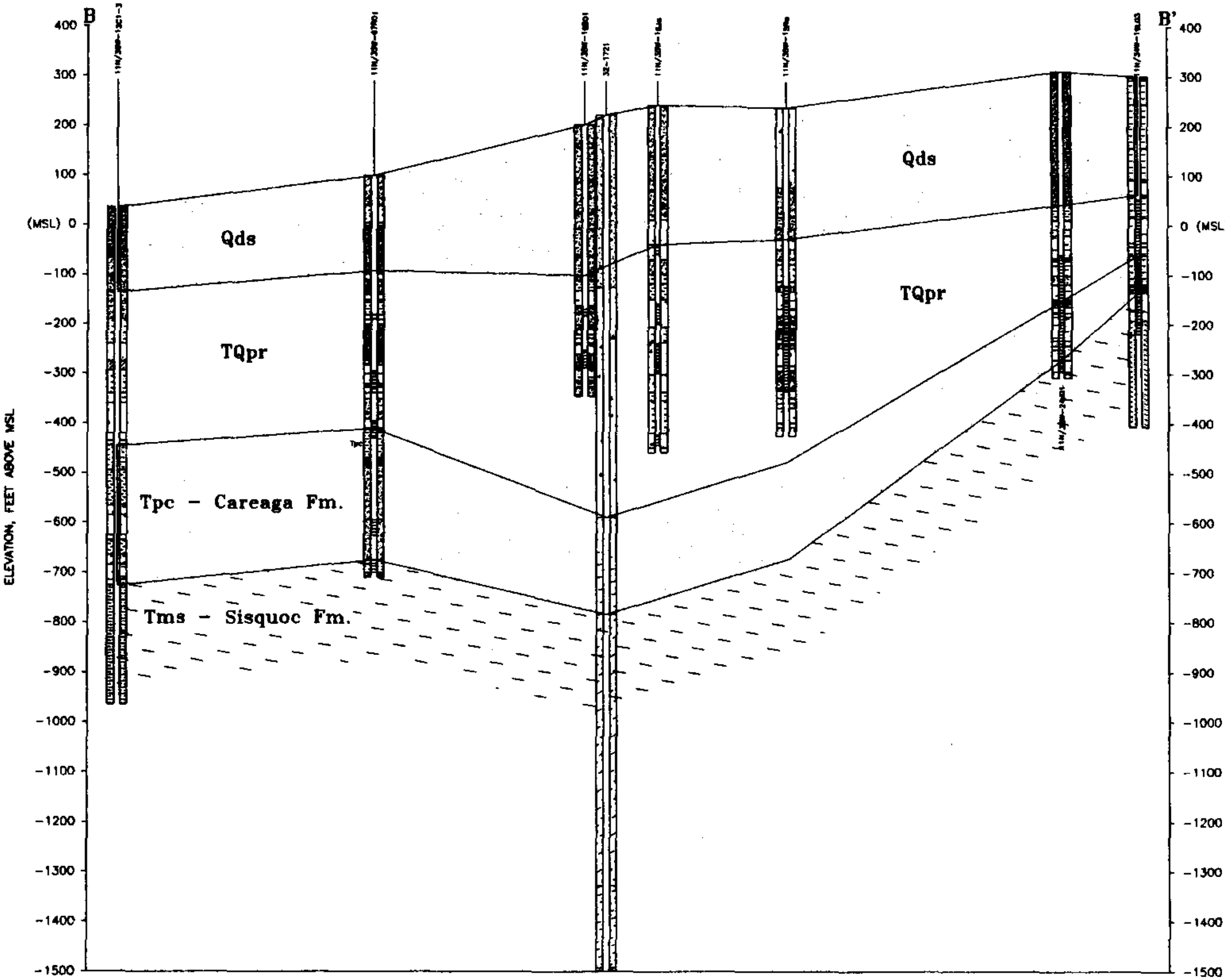

EXPLANATION

See Well Location Map
for Cross Section Location
See Abbreviation List for Full
Lithologic Descriptions

▥ Perforated Interval

Figure 5
CROSS SECTION B-B'

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X_B.DWG

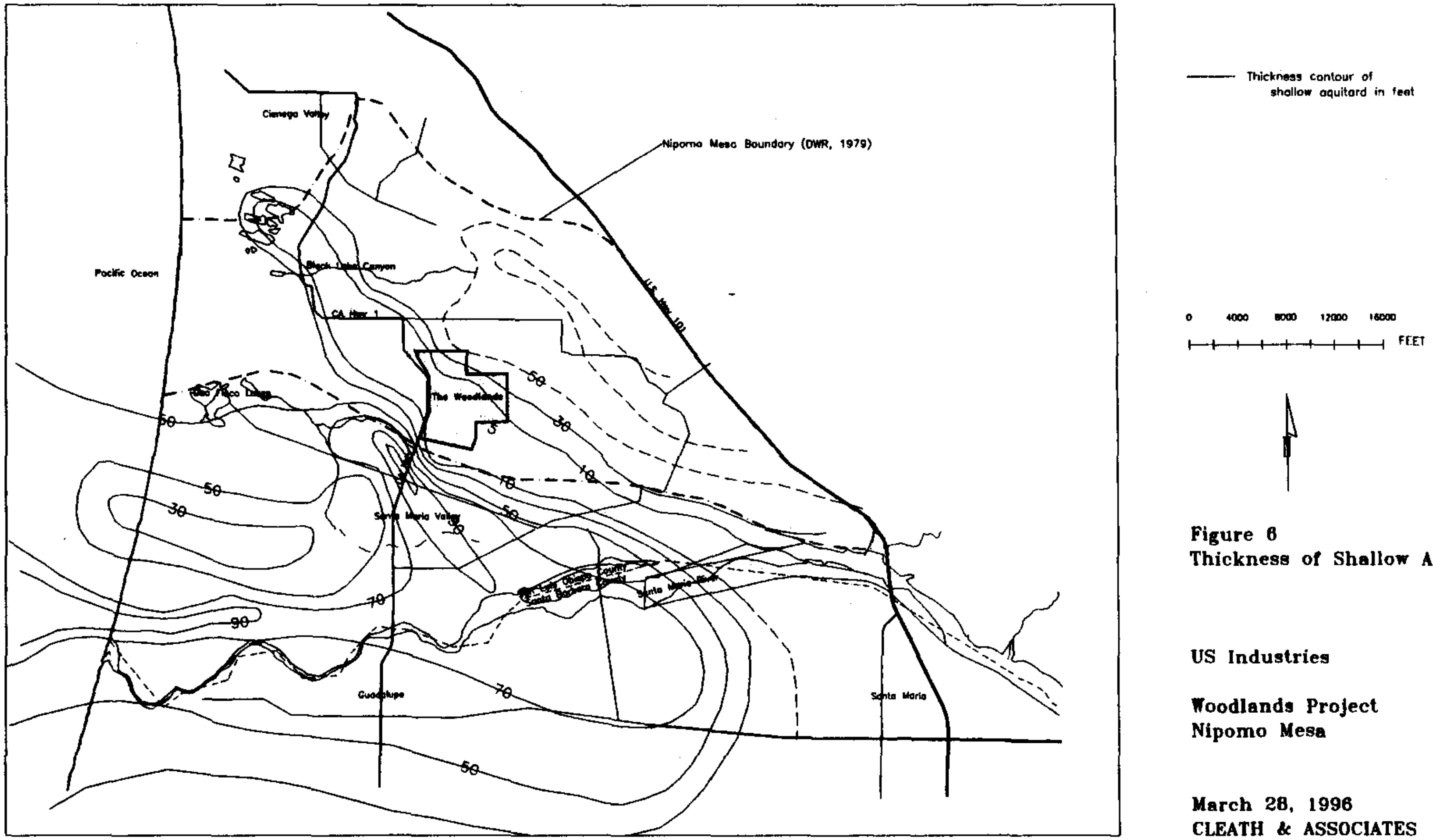

Figure 6
Thickness of Shallow Aquitard

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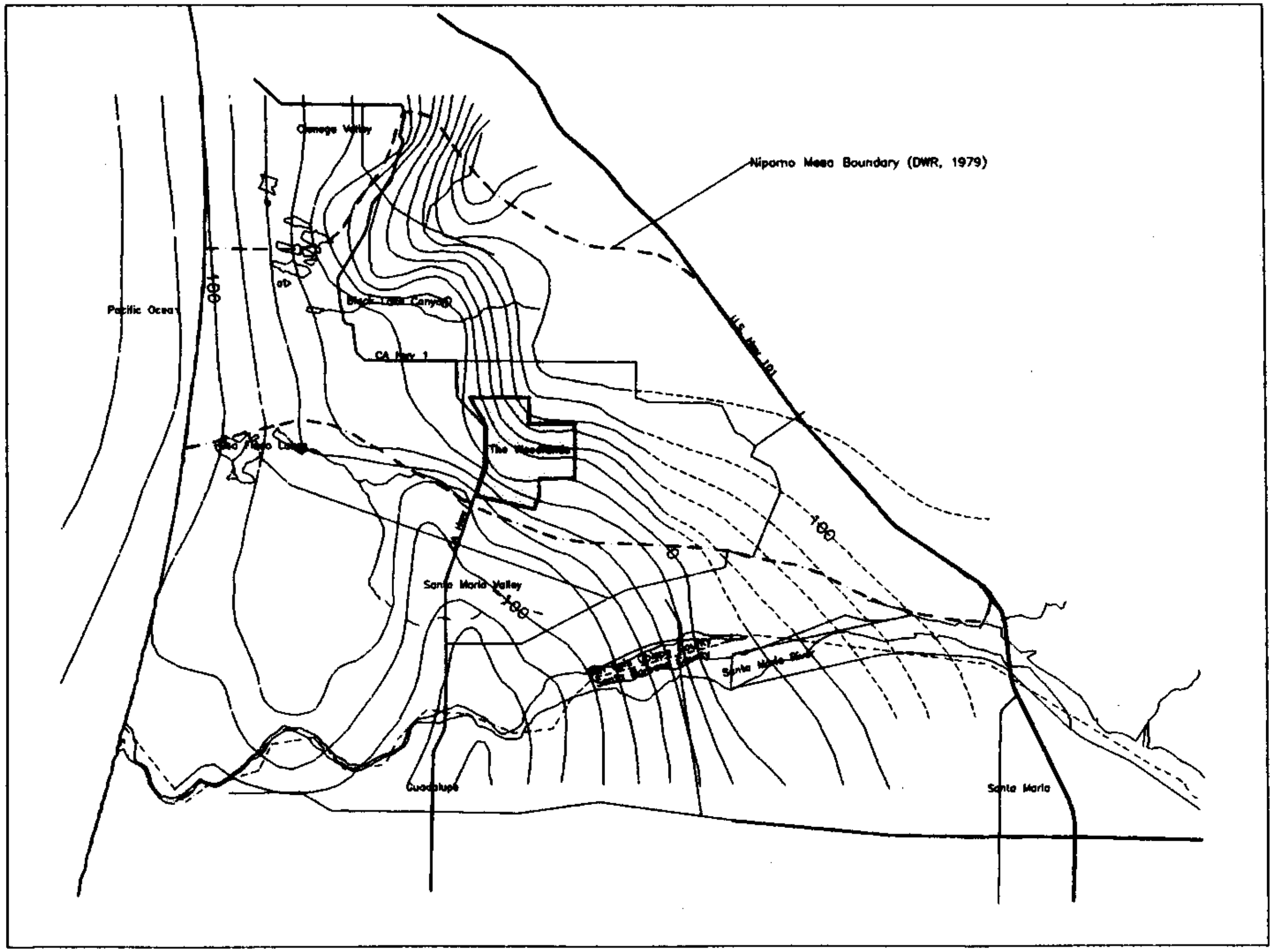
AqtThick.DWG



Elevation contour on base of shallow aquitard in feet above Mean Sea Level

Figure 7
Base of Shallow Aquitard

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Aql_Base.DWG

channel once passed through the Oso Flaco area to the Pacific Ocean. These contour maps have been used for hydrogeologic input to the ground water model.

Paso Robles Formation

The Paso Robles Formation is a widespread assemblage of Late Pliocene to Pleistocene-age unconsolidated and poorly consolidated gravel or conglomerate, sandstone, siltstone, and claystone lying unconformably on many Pliocene and older rock units (Hall, 1973). The formation is predominantly non-marine and has a gray color except in the upper parts of the formation where it is light brown. In the Santa Maria area, the formation conformably overlies the Careaga sand (Woodring and Bramlette, 1950). Beneath the Nipomo Mesa, the Paso Robles Formation is comprised of sandy gravels forming distinct aquifer zones separated by less permeable silts and clays. The gravels are composed mostly of Monterey shale pebbles in a sandy to somewhat clayey matrix, crudely bedded to cross-bedded (Dibblee, 1994). The thickness of Paso Robles Formation deposits beneath the Mesa varies greatly, ranging from an estimated 600 feet thick at the south west end of the Mesa to less than 100 feet thick in the northeast adjacent to Los Berros Canyon. The characteristic base of the Paso Robles Formation includes a clay unit 50-100 feet thick often with fresh-water limestone (Woodring and Bramlette, 1950).

Cross-section A-A' (Figure 4) illustrates the northeast thinning of the Paso Robles Formation beds and an abrupt rise in basement rocks associated with movement on the Oceano fault (Cleath & Associates has located this fault based on well data). Vertical displacement across the fault is estimated at about 370 feet; the northeast side is upthrown relative to the southwest side of the fault. Late Quaternary displacement on the Oceano fault has not been directly observed using geophysical methods, but being along the southwest boundary of the actively rising San Luis/Pismo structural block, movement may have occurred in the past 500,000 years (PG&E, 1988).

The Paso Robles Formation is the main source of ground water for the Nipomo Mesa. Production rates of several hundred gallons per minute (gpm) are typical and rates of over 1,000 gpm are possible. Permeability of the Paso Robles Formation ranges from about 5 to 50 feet per day, based on Cleath & Associates' review of data from about two dozen pump tests and efficiency tests on wells on the Mesa. The specific yields are estimated between 10 and 20 percent (storativity is estimated at about 0.002 to 0.003 under semi-confined conditions). Water quality in wells tapping the Paso Robles Formation is usually good, although moderately elevated levels of nitrates (15-20 milligrams per liter) are common on the Mesa, especially to the northeast.

Careaga Sand

The Careaga sand consists of two members, an older fine-grained Cebada member, and a younger coarse-grained Graciosa member. The Graciosa member is more often than not unconsolidated, although hard sandstone and conglomerate is also found. The Graciosa member is generally gray while the Cebada member is yellowish-brown (Dibblee, 1994).

Cross bedding is common in the Graciosa member, which is itself divisible into two parts: a lower conglomerate composed of porcelaneous shale and an upper coarse sand where reddish and grey quartzite and rhyolite porphyry are chief constituents. The Careaga sand is the youngest marine formation in the Santa Maria area, although the upper portions include non-marine deposits (Woodring and Bramlette, 1950). The lower Careaga sand often coincides with the deepest extent of the effective base of fresh water (DWR, 1971). The Careaga sand, like much of the Paso Robles Formation, thins to the east and northeast beneath the Nipomo Mesa as basement rocks rise to ground surface near Highway 101 (Figures 4 and 5).

Non Water-Bearing Rocks. The non (fresh) water-yielding rocks beneath the Nipomo Mesa and Santa Maria Valley include oil-bearing zones in two producing fields: the Guadalupe Oil Field (Sisquoc Formation) and the Santa Maria Valley oil Field (Foxen-Sisquoc-Monterey). The first commonly identified bedrock beneath the Nipomo Mesa is the Sisquoc Formation. There are two principal lithologic facies represented in the Miocene-age Sisquoc Formation: a fine-grained basin facies, consisting chiefly of soft diatomaceous or hard porcelaneous mudstone, and a marginal sandstone facies identified in the Foxen Canyon area. The fine-grained basin facies may be indistinguishable lithologically from older Monterey Formation rocks. The formation is typically light gray and massive to vaguely bedded (Woodring and Bramlette, 1950).

Bedrock rises toward the northeast beneath the Nipomo Mesa (Figure 4). Rock outcrops in the vicinity of Highway 101 are commonly identified as part of the Franciscan Formation. This formation and related basement complex rocks in the Santa Maria-Nipomo area includes sedimentary, igneous, and metamorphic rocks. The sedimentary rocks include dark blue to greenish gray (when fresh) graywacke, siltstone, claystone, minor amounts of conglomerate, and red, brown, green or white chert. Igneous rocks include basalt, gabbro, peridotite and serpentine. Metamorphic rocks include greenstone, altered pillow basalt, blue schist, and glaucophane schist (Hall, 1973, and Woodring and Bramlette, 1950).

Site Geology and Hydrogeology

The lithology beneath The Woodlands has been interpreted based on electric logs, penetration logs, and drill cuttings. A general lithologic description of the soils and aquifer materials follows:

Orange-brown sand is observed from beneath the surficial soil horizon to approximately 130 feet below ground surface (bgs). Silt content increases with depth to about 130 feet bgs. The sand color changes to tan or light brown beginning at approximately 130 feet bgs and gravels are present as minor constituents beginning at about 270 feet bgs. The shallowest aquifer zone occurs within these gravels that also mark the upper portion of the Paso Robles Formation.

A total of five aquifer zones were identified beneath the site through a depth of about 700 feet below mean sea level. The composition of the aquifer zones are typically sand and gravel, and are separated by lower permeability zones between about 30 and 60 feet in thickness. Static water levels prior to pump testing in the four production wells were consistently higher than the top of the first aquifer zone, indicating confined or semi-confined conditions. The apparent lack of a substantial aquitard above the first zone, however, suggests that the confinement is restricted to the deeper aquifer zones. Analysis of observation well data from the Highway 1 well pump test yielded a storage coefficient of 0.0018, also indicative of semi-confined conditions.

WATER RESOURCES

Fresh-water resources in the general vicinity of The Woodlands include ponds along Black Lake Canyon, lakes at the western periphery of the Nipomo Mesa and Santa Maria Valley, and ground water.

Surface Water

The Nipomo Mesa has little natural surface water, due to the typically high permeability of the dune sands. The main surface water features on the Mesa are ponds along Black Lake Canyon, about 7000 feet north of the site. The canyon drains into Black Lake to the west (Figure 2). Several dune lakes below 20 feet in elevation lie west of the Mesa at the south end of the Cienega Valley. Lakes are also found along the western edge of the Santa Maria Valley. These surface water resources are used in a variety of ways, as discussed in the following paragraphs.

Black Lake Canyon. Black Lake Canyon is a San Luis Obispo County sensitive resource area. The topography of the canyon floor is gently sloping from Highway 1 to Zenon Way, and then rising more steeply, with undulating land surface due in part to alluvial fans extending into Black Lake Canyon from side canyons. The interfan areas are where the ponds occur in the upper canyon area. These ponds are recharged from percolation of precipitation and runoff. The percolated water accumulates in sedimentary beds about 50 to 100 feet thick above a clay aquitard. The ponds occur where the shallow sands are saturated to the level of the canyon floor. Near Zenon Way, the thickness of the upper sand bed diminishes and water rises above ground surface and flows into the lower canyon.

In the lower canyon, below Zenon Way, marsh and peat bog conditions dominate. A review of U.S. Geological Survey (USGS) topographic maps from 1919 and 1963 (edited in 1976 and 1979), and of aerial photos of the canyon from 1949 and 1956 do not show the presence of surface water bodies. Ponds have probably occurred at times in the lower canyon, however, in response to fluctuating water levels beneath the canyon floor. The sensitive resource area status of Black Lake Canyon reflects concern for the preservation of the natural habitat and the surface water resources in the canyon.

Dune Lakes and Oso Flaco Lakes. The Dune Lakes and Oso Flaco lakes are surface water resources that interact with the intensive agricultural activities in the Cienega Valley and the Santa Maria Valley, respectively. Celery Lake has been connected to the agricultural drainage system for the south Cienega Valley, as has Oso Flaco Lake and Little Oso Flaco Lake for agricultural drainage in the Santa Maria Valley. In addition to receiving irrigation water runoff, these lakes are pumped for irrigation. Black Lake and the other dune lakes may have some agricultural use, however, they appear to be principally utilized for recreation by hunters.

Ground Water

Ground water is the principal source of water for the Nipomo Mesa, the Cienega Valley, and Santa Maria Valley. As previously mentioned, ground water production is primarily from the Paso Robles Formation, with some wells also producing from shallower alluvial zones or the deeper Careaga Formation. Perched water zones are present in parts of the valleys and beneath the Mesa, but these are generally not utilized as a pumped ground water supply.

Limits of Ground Water Basin and Study Area. In 1966, the USGS published a study on ground water utilization in the Santa Maria Valley (Miller and Evenson, 1966). This study was an update to a USGS investigation by Worts (1951). The limits of the ground water basin were defined in the 1966 study using the configuration of the effective base of fresh water with a notable exception on the Nipomo Mesa; only about two thirds of the Nipomo Mesa was included in the Nipomo storage unit (one of eight storage units comprising the Santa Maria Valley ground water basin). The Nipomo storage unit was bounded on the south by the Santa Maria Valley, on the east by the Nipomo Valley, on the west by the Pacific Ocean, and to the north by a line that split the Mesa near Black Lake Canyon. The eight storage units as defined by the USGS have been adopted by the Santa Barbara County Water Agency (SBCWA, 1994).

The California State Department of Water Resources (DWR) defined a study area for Arroyo Grande that was bounded by the Santa Maria River to the south, the Nipomo Valley and San Luis Hills to the north and east, and by the Pacific Ocean to the west (DWR, 1979). Within this DWR area is the Nipomo Mesa storage area, with boundaries roughly equivalent to the USGS Nipomo storage unit, except that the northern extent of the DWR area extends to the edge of the Nipomo Mesa at Nipomo Hill. The DWR report also divides the study area into two hydrologic subareas and a hydrologic subunit. The hydrologic divisions appear to follow watershed boundaries, and the DWR Nipomo Mesa hydrologic subarea is roughly equivalent to the DWR Nipomo Mesa storage area.

In Appendix A to the South County Area Plan prepared for San Luis Obispo County, the terminology from DWR was used for subareas having boundaries based on physical characteristics, and the USGS terminology used for storage units having arbitrary boundaries within subareas (The Morro Group, 1990). The limits of the Santa Maria ground water basin were extended to the north to approximate the configuration of the effective base of fresh water, and included (in San Luis Obispo County) the Nipomo Mesa, the Arroyo Grande Valley, and the Tri-Cities Mesa area.

Cleath & Associates concurs in defining the limits of the Santa Maria ground water basin using the effective base of fresh water; the work performed in Appendix A of the South County Area Plan at a minimum conforms to the appropriate definition of terms. There is obviously value, however, in subdividing a basin into manageable units for the purpose of analyses. Cleath & Associates has selected the DWR Nipomo Mesa storage area as the study area for The Woodlands, with some modification. The reasons for selecting this study area are 1) previous work has been performed within the area to which new work can be compared; 2) it is an area already familiar to many professionals working in water resources and planning; and 3) the limits of the area separate the subject property from the vast agricultural activities in the Santa Maria Valley to the south, which is an appropriate boundary along which to evaluate subsurface flow. The modification made herein to the DWR study area is to exclude portions outside the Santa Maria ground water basin along Highway 101; this modification is consistent with the basin limits identified by the UGSG (1951 and 1966).

Ground Water Status of the Nipomo Mesa. A primary impact of concern from development on the Nipomo Mesa would be the continued depletion of ground water storage resulting in declining water levels and well production. The limits of the area evaluated for this concern is generally the Nipomo Mesa storage area as defined by the DWR in 1979 (Figure 1). As mentioned previously, certain portions within the DWR area near Highway 101 that are outside of the Santa Maria ground water basin have been excluded. Table 1 presents various ground water storage estimates for the Nipomo Mesa Storage Area (21,000 acres) and the Nipomo subunit (10,500 acres; USGS area).

Table 1. Ground Water Storage Above Mean Sea Level - Nipomo Mesa

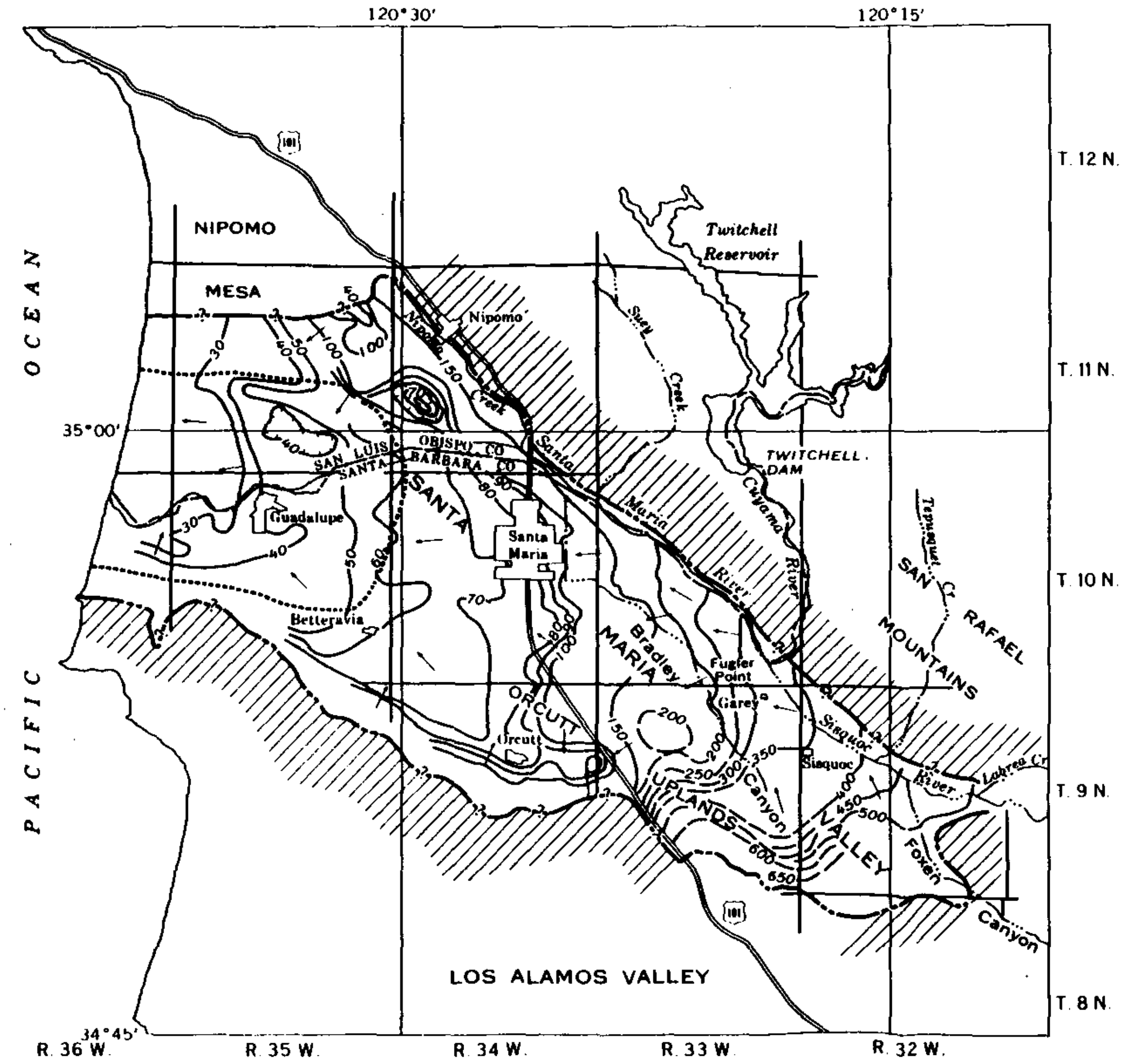
Year	Acreage	Source	Storage (af)
1918	10,500	USGS, 1966	250,000
1950	10,500	USGS, 1966	160,000
1959	10,500	USGS, 1966	140,000
1967	21,100	DWR, 1979	194,000
1975 (Fall)	21,100	DWR, 1979	172,000
1975 (Spring)	10,500	SBCWA, 1977	140,000
1977	10,500	SBCWA, 1992	136,000
1984	10,500	SBCWA, 1992	167,000
1985	21,000	LFM, 1987	173,000
1991	10,500	SBCWA, 1992	134,000

Ground water storage calculations are typically performed using water level data, aquifer specific yield and physical geometry. Changes in storage are also calculated using hydrologic budget data to estimate total basin inflow and outflow. The 1918 storage estimate above was based on extrapolating water levels from the Santa Maria Valley onto the Nipomo Mesa. Estimates for 1950, 1959 and 1975 (Fall) were based on water level contour maps and basin geometry prepared for these respective years. The SBCWA estimate for 1975 (Spring) was based on water level differences between 1975 and 1959. Storage estimates in Table 1 for 1977, 1984, and 1991 were calculated by applying changes in storage derived from hydrologic budget modeling to the 1975 (Spring) figure. The LFM storage estimate for 1985 was based on water level differences between 1985 and 1975 (Fall). Therefore, the DWR 1975 (Fall) storage estimate and the USGS 1950 and 1959 estimates are the only independently derived storage estimates for the Nipomo Mesa.

Cleath & Associates has reviewed the water level contour maps produced by Miller and Evenson (Spring 1959) and DWR (Fall 1975). The 1950 water level contour map is not published but is assumed to be similar to the 1959 map.

1959 Ground Water Storage Estimate

The Spring 1959 water level contour map from Miller and Evenson shows water levels across the Mesa ranging from about 30 feet in the west to 150 feet in the east (Figure 8). Specific yield values were assigned at 10-foot increments according to drilling logs. The USGS report indicates that logs of 10 wells in the Nipomo storage unit were used for the estimate, but these wells are not identified. Table 2 presents the Spring 1959 water levels on record with the San Luis Obispo County Engineering Department.



C. WATER-LEVEL CONTOURS, SPRING 1959

EXPLANATION

For A, B, and C

▨

Approximate boundary of the ground-water basin

Queried where inferred. Hachured areas indicate relatively non-water-bearing consolidated rocks

Boundary between ground-water storage units

In B only

Approximate boundary of confined ground water in the alluvium

In B and C

—50—

Water-level contours and generalized direction of ground-water flow, spring of 1959

Dashed where inferred; contour interval varies. Datum is mean sea level. In C only

-500—?—?—

Contour

Drawn on approximate base of fresh water; dashed where projected; queried where location is inferred; contours absent in areas of insufficient control; base of fresh water is generally within 50 feet of the base of the Careaga Sand of Pliocene age. Contour interval 500 feet. Datum is mean sea level. In A only

Approximate axis of syncline

In A only

Figure 8

Table 2. Spring 1959 Water Levels - Nipomo Mesa

Well ID	Date Measured	Depth to Water (feet)	Well Elevation (feet)	Water Surface Elevation (feet)
10N/34W-06N01	04/01/59	94.04	152	57.96
10N/35W-09F01	04/01/59	49.80	88	38.20
10N/35W-11E04	04/01/59	83.55	122	38.45
11N/34W-30Q01	04/01/59	70.80	148	77.20
11N/35W-20E01	03/31/59	12.27	48	35.73
11N/35W-33G01	03/31/59	40.89	90	49.11
12N/25W-29N01	03/11/59	12.30	29	16.70

Water elevations in Table 2 range from about 35 feet in the west to only 80 feet in the east; substantially lower than the USGS contour map. It is possible that some perched water levels were included in the 1959 contour map preparation. Based on the available water levels, however, the USGS 1959 storage estimate appears artificially high, as would be the derivative estimates shown in Table 1 from 1975 (Spring), 1977, 1984, and 1991.

Fall 1975 Ground Water Storage Estimate

The DWR 1979 Arroyo Grande Area water resources study presented a water level contour map for Fall 1975 (Figure 9). Cleath & Associates has contoured water elevations for the same period (Figure 10). Water levels to the southeast near Highway 101 are more than two hundred feet higher on the DWR contour map than on the contour map prepared by Cleath & Associates. This discrepancy is probably attributable to DWR using wells screened in perched water zones and wells located east of the ground water basin limits shown in Figure 8. Cleath & Associates selected water levels from deeper-penetrating wells within the ground water basin. Although perched water exists and may be tapped in relatively small quantities on the Nipomo Mesa, perched water levels should not be used as the upper contact of the saturated thickness of sediments and should be removed as much as possible for storage calculations.

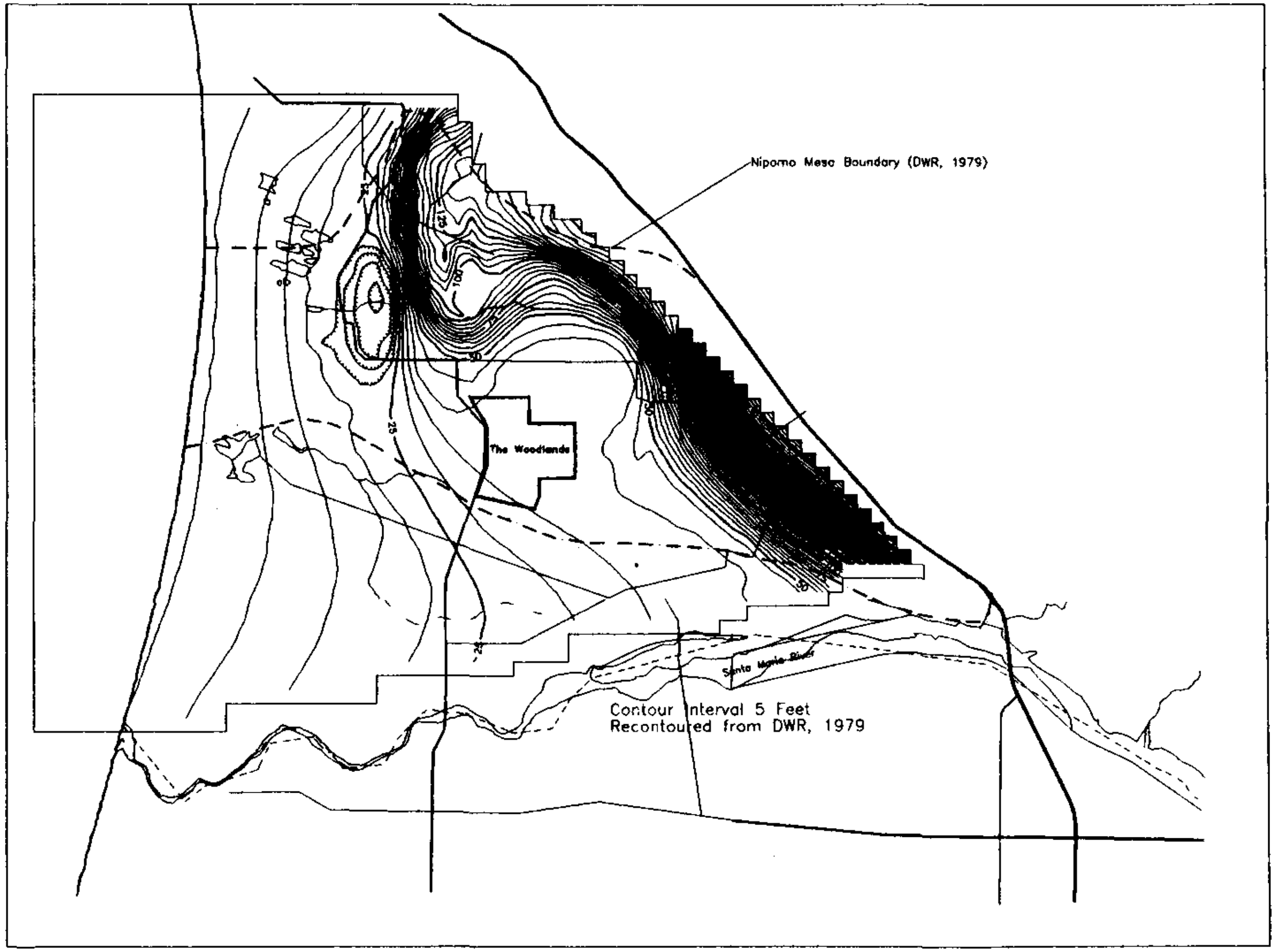
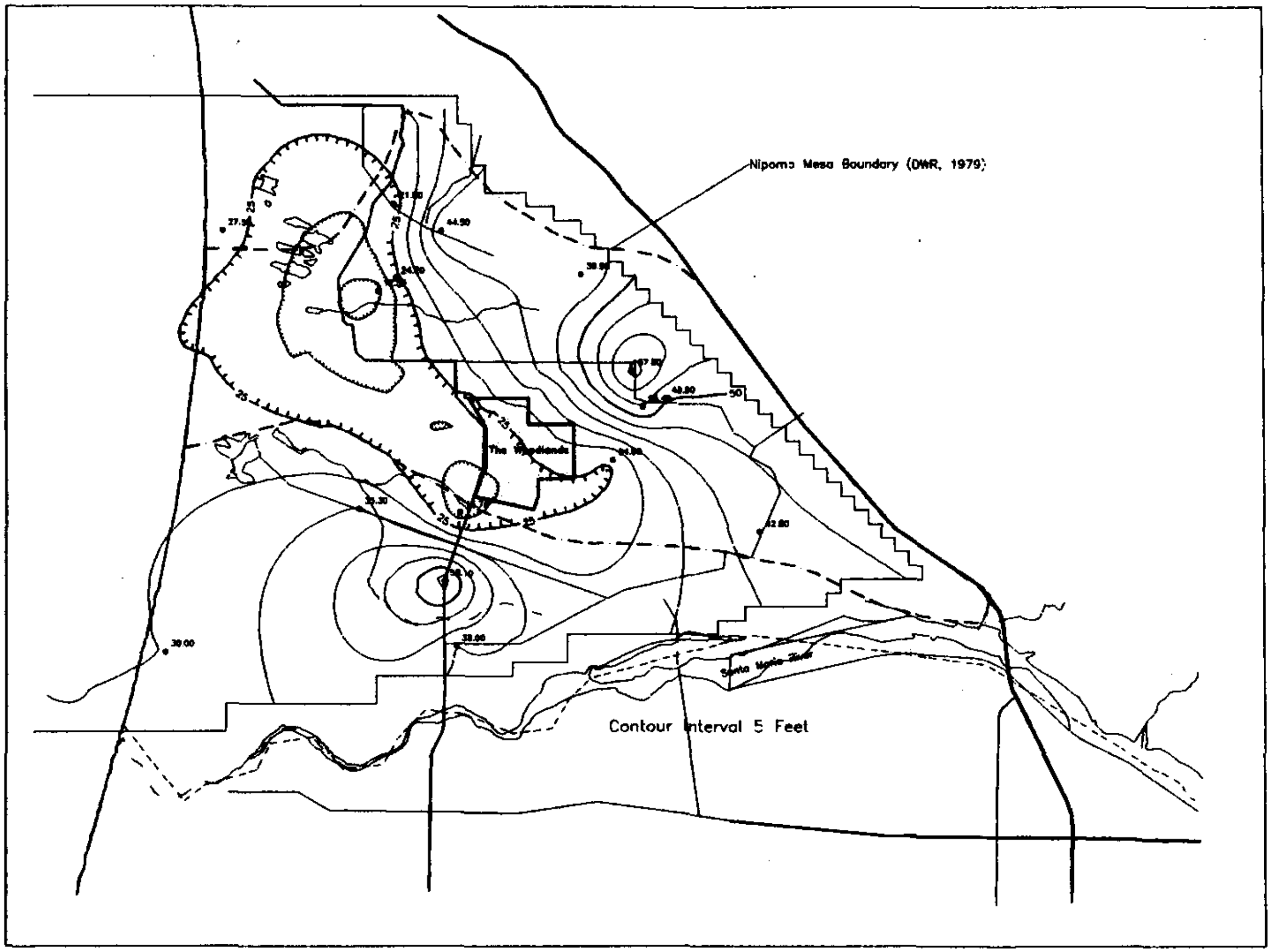


Figure 9
Water Levels, Fall 1975
from DWR, 1979

US Industries

Woodlands Project
Nipomo Mesa

March 28, 1996
CLEATH & ASSOCIATES
Lvl75DWR.DWG



Based on data from SLO Co Engineer and Santa Barbara Co Flood Control District

Figure 10
Water Levels, Fall 1975
from Levels Database

US Industries

Woodlands Project
Nipomo Mesa

March 28, 1996
CLEATH & ASSOCIATES
Lvl75New.DWG

Cleath & Associates has revised the DWR estimate with the following assumptions:

- Perched water levels are not used.
- No wells outside of the Santa Maria ground water basin are used (study area is 18,000 acres; 3,000 acres less than original DWR Nipomo Mesa storage area).
- Specific yield is generally 14 percent but varies according to lithology (see ground water model inputs section).

Applying the above assumptions yields an estimated 74,000 acre-feet of ground water in storage above sea level in Fall, 1975; about 43 percent of the original DWR estimate. Even this value for storage is probably too high, however, being about 20,000 acre-feet higher than other basin storage estimates presented below and in Appendix A for the period 1977 to 1992. This discrepancy is attributable to the general lack of data points for Fall 1975 compared to data points available for the starting heads of the ground water flow model (Fall 1976); there were 16 data points for Fall 1975 and 27 points for Fall 1976. Therefore, based on comparison with better-documented years, it is likely that the actual storage in Fall of 1975 was between 50,000 and 60,000 acre-feet.

Changes in Storage Fall 1976 - Fall 1992

Storage changes within the Nipomo Mesa storage area have been estimated by Cleath & Associates between Fall 1976 and Fall 1992 (Figure 11); overall ground water in storage decreased from about 55,200 af to 49,200 af. The average change in storage during the period was approximately 375 afy loss in storage per year. The 16-year cycle was selected based on water level records availability for a roughly balanced hydrologic cycle. A balanced hydrologic cycle is typically a sequence of years with both drought and wet periods over which the cumulative departure from rainfall is close to zero. The balanced period coverage for the Nipomo Mesa is necessarily rough due to the difference in cumulative departures from average rainfall at the four rainfall stations surrounding the Mesa. These stations are Oceano (194), Nipomo (038), Santa Maria (380), and Guadalupe (352). The cumulative departures from average rainfall for the four stations between rainfall years 1976-77 to 1991-92 are summarized in Table 3 (data in Appendix A). Two stations were below zero cumulative departure (Oceano and Santa Maria) and two were above (Nipomo and Guadalupe) for the Fall 1976 - Fall 1992 period. The average of the cumulative departure figures for the four stations over the 16-year period is about 7.1 inches, or about 0.44 inches of rain per year above the ideal balance of zero inches. Cleath & Associates compensated for the slightly positive cumulative departure from average rainfall when modeling by adjusting precipitation inputs slightly lower (see Model Inputs section).

Ground Water in Storage

Nipomo Mesa - Major Production Zones

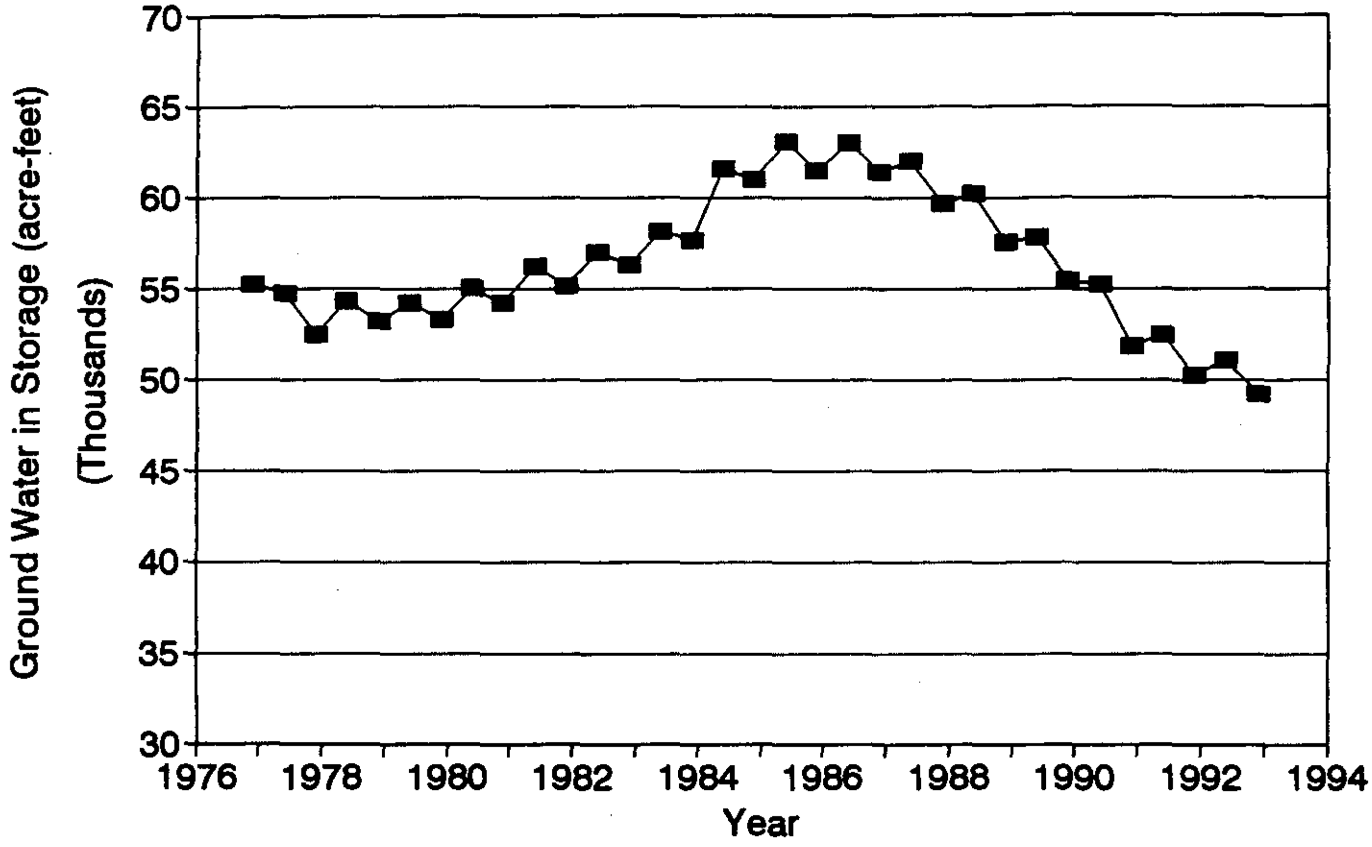


Figure 11

Table 3. Storage Changes for Balanced Time Period - Nipomo Mesa

Station:	Oceano	Nipomo	Santa Maria	Guadalupe
Balanced Period	Fall 1976 - Fall 1979			
Cum. Departure (inches)	-6.63	26.69	-10.86	19.23
Storage Change (af)	5995			
Storage Change (afy)	375			

As shown above, average change in storage over the roughly balanced period is or about 375 afy loss in storage per year. The total drop in basin storage between Fall 1976 and Fall 1992 (5,995 af) is close to the estimated annual pumpage on the Nipomo Mesa for a single year. The estimated total pumpage within the 18,000-acre Nipomo Mesa storage area was about 5,000 af in 1977, 5,700 af in 1985, and 6,770 af in 1992. Total inflow and outflow figures for the Nipomo Mesa, based on the modeling effort performed for this study, were approximately 10,000 af inflow and 12,800 af outflow in 1977; 16,200 af inflow and 15,800 af outflow in 1985; and 12,400 af inflow and 13,400 af outflow in 1992. Therefore, the estimated annual ground water storage decline between 1977 and 1992 is almost two orders of magnitude less than the annual hydrologic budget for the Mesa and over two orders of magnitude less than the average ground water in storage above mean sea level of 56,400 acre-feet (Appendix A).

Subsurface Ground Water Flow

The direction of ground water flow is different in the perched water zones than in the deeper production zones beneath the Nipomo Mesa. The two water level contour maps for Fall 1975 (Figures 9 and 10) show the difference. The DWR contour map, which presumably includes perched water levels or levels outside the basin, suggests a southwest flow direction from the Nipomo Mesa down into the Santa Maria Valley. The contour prepared with deeper-penetrating well data, however, shows flow in the main production zones moving northwest, from the Santa Maria valley into the Mesa. This northeast regional flow direction is maintained toward the Cienega Valley.

The ground water flow model discussed in the second half of this report confirms the flow pattern shown in Figure 10. Shallow, perched water generally moves to the southwest while ground water in the lower member of the alluvium, the Paso Robles Formation and the Careaga Formation (lumped together in the model) collectively move to the northwest. An estimated 3,300 afy on average flowed from the Santa Maria Valley to the Nipomo Mesa between 1977 and 1992. Figure 12 presents the estimated variation in subsurface flow between the Santa Maria Valley and the Nipomo Mesa.

Pumping Depressions

Pumping depressions on the Mesa have recently been used as to signal "overdraft" conditions (Chipping, 1992). The report on Black Lake Canyon, however, contains a significant problem in that the assumed elevation for one of the Black Lake Golf Course wells (11N/35W-10G01) is about 122 feet too low, resulting in a pumping depression about one hundred feet below mean sea level; much deeper than it actually is.

There is a pumping depression on the Nipomo Mesa northwest of the subject site toward Black Lake Canyon. The development of the depression is associated with municipal, industrial, and agricultural pumpage that is more concentrated in the area, although the depression has been mapped as early as 1965, before some of the larger municipal or irrigation wells existed (DWR, 1979). The pumping depression has generally been between 5 and 10 feet below mean sea level. The lateral extent of the pumping depression fluctuates, but was estimated from water level contours to cover about 700 acres in 1990 (largest expanse). The limited number of data points and the fact that the ground surface elevations for wells on the Mesa are estimated and not surveyed, however, leads to the conclusion that the magnitude of the pumping depression is not well defined.

Subsurface Inflow to Nipomo Mesa
from Santa Maria Valley

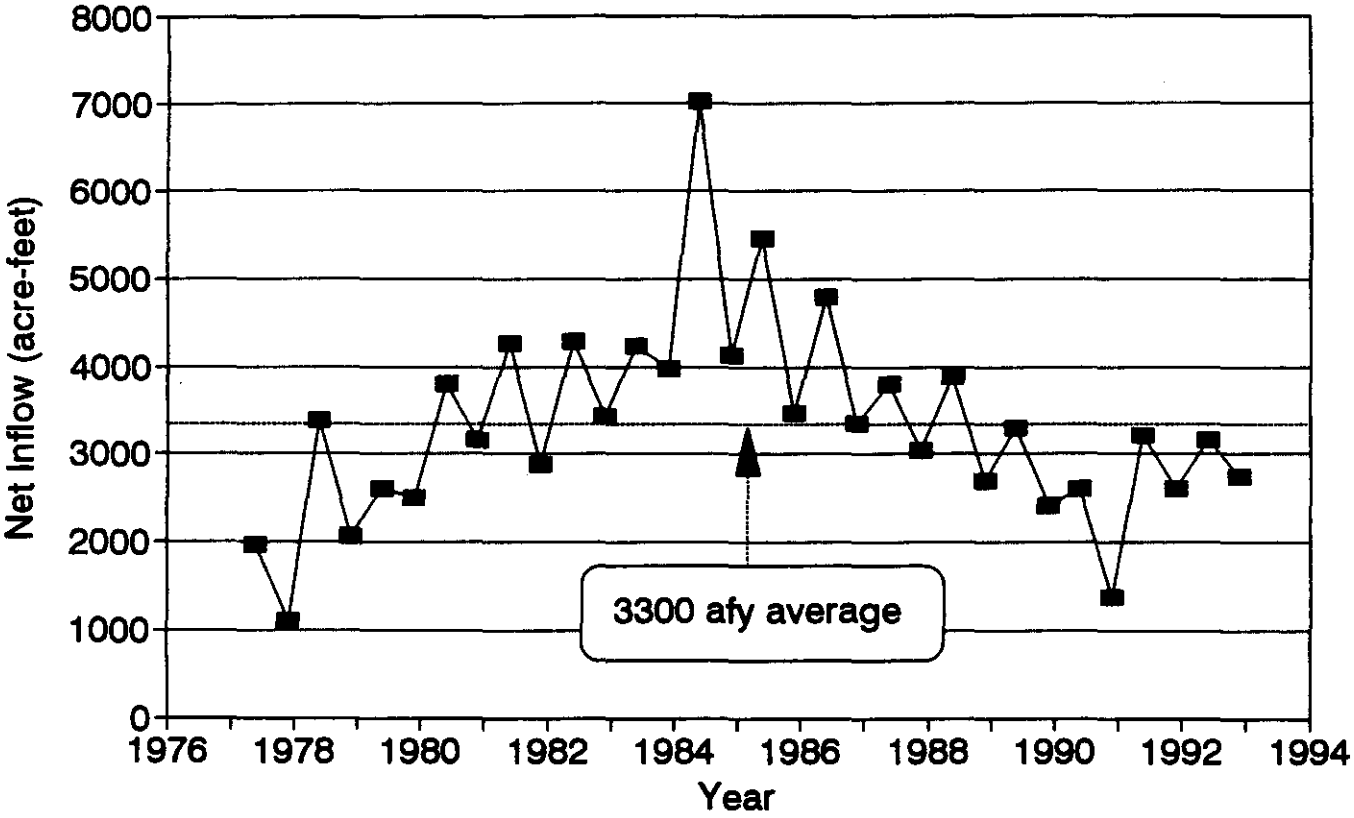


Figure 12

PROPOSED PROJECT CONDITIONS

PROJECT DESCRIPTION

The Woodlands development program consists of three phases. These phases would be constructed over three consecutive 8-year programs (24 years to total buildout) with annual construction in accordance with market demand. The first phase of development includes an 18-hole golf course and approximately 500 single-family residences. The second phase includes a second 18-hole golf course, approximately 400 single-family residences, a hotel/resort complex, a village center with commercial/mixed use and approximately 75 multi-family residences, and a school. The third and final phase of the development program would include approximately 300 single-family residences and 75 multi-family residences. Also phased into the development program are various active, passive, and neighborhood parks, a habitat preserve, maintenance areas, recreational vehicle storage, and a wastewater treatment plant. A summary of The Woodlands development program at total buildout (Phase I, II, and III combined) is presented in Table 4. For the purpose of estimating water demand, the potential maximum acreage for units specified in the development program has been used.

Project Water Demand

Table 5 presents a summary of the project water demand at total buildout (Phase III). The estimated percentage of indoor and outdoor use is listed, along with the estimated consumption for each use. More information regarding the water duty factors and demand calculations is attached (Appendix B). Figure 13 summarizes the water use for all three phases in a simplified flow diagram.

Gross water demand for Phase I is estimated at 651 acre-feet per year (afy) of which 468 afy is consumed, 57 afy percolates back to ground water (return flow) and 126 afy is available as wastewater supply. Gross water demand for Phase II (which includes Phase I demand) is estimated at 1340 afy of which 957 afy is consumed, 120 afy percolates back to groundwater (return flow) and 263 afy is available as wastewater supply. Gross water demand for Phase III (total buildout) is estimated at 1574 afy of which 1089 afy is consumed, 139 afy percolates back to groundwater (return flow) and 346 afy is available as wastewater supply. Water demand for Phase I is about 60 percent lower than Phase III water demand. Phase II water demand is about 15 percent lower than Phase III demand. The water demand ratio for the three Phases (I:II:III) with respect to total project water demand is approximately 0.4:0.85:1.

Monthly water demand for irrigation at The Woodlands is expected to vary with evapotranspiration (ET) rates. Cleath & Associates utilized data provided by DWR (1980) for ET rates in the Nipomo Mesa area to evaluate the annual demand cycle and project peak demand pumpage requirements (Appendix B). Indoor use would vary slightly with occupancy, and has been estimated to be 8% higher during the summer months (LFM, unpublished, 8/19/92). The water demand cycle for The Woodlands at total buildout (Phase III), with estimated available reclaimed water is summarized in Table 6.

WATER USE DIAGRAM
THE WOODLANDS

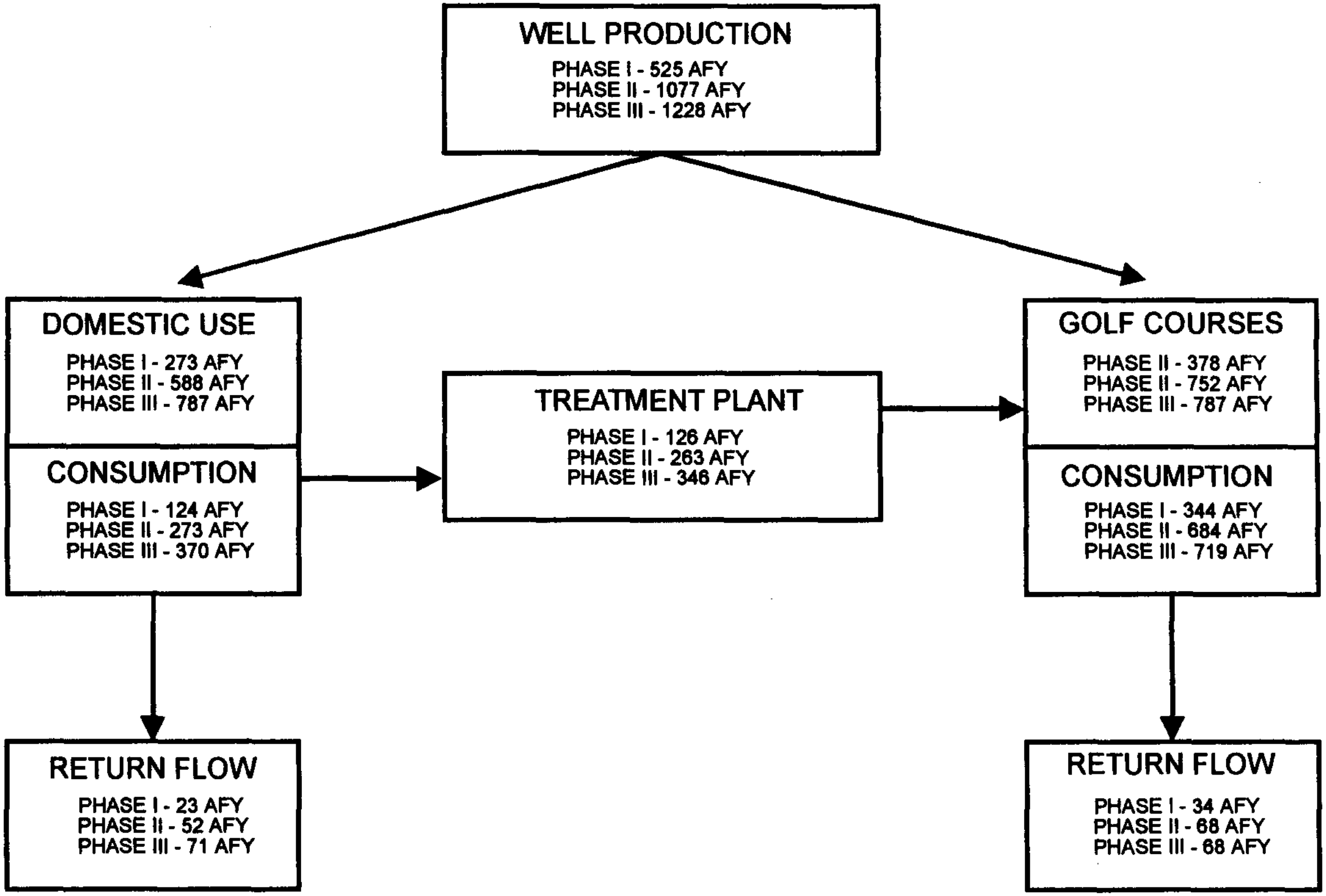


Figure 13

Table 4. Woodlands Development Program

Land Use	Unit Type	Phase I Units	Phase II Units	Phase III Units	Total Units	Total Acreage
RESIDENTIAL						
1-acre lots	D.U.	17.0	16.0	16.0	49.0	49.0
10-20,000 sf lots	D.U.	57.0	56.0	56.0	169.0	77.6
7-9,000 sf lots	D.U.	127.0	127.0	127.0	381.0	78.7
5-7,000 sf lots	D.U.	288.0	188.0	87.0	563.0	90.5
5,000 sf lots	D.U.	8.0	8.0	8.0	24.0	2.8
GOLF						
18 Holes & Clubhouse (North)	acre		131.8		131.8	131.8
18 Holes & Clubhouse (South)	acre	127.8			127.8	127.8
Practice area	acre	10.0	5.0		15.0	15.0
Ponds	acre	7.5	7.4	7.4	22.3	22.3
Maintenance Areas	acre	2.0	2.0		4.0	4.0
HOTEL/RESORT						17.5
Hotel/restaurant	room		170.0		170.0	
Conference Center/mixed uses	acre		1.5		1.5	
casitas (4-room units)	D.U.		20.0		20.0	
VILLAGE CORE						
Commercial/mixed uses	acre		1.5	1.5	3.0	3.0
Multi-Family Residences	D.U.		75.0	75.0	150.0	5.0
RV STORAGE	acre	2.0			2.0	2.0
SCHOOL	student		350.0		350.0	10.0
PARKS						
Active Use	acre		10.0		10.0	10.0
Passive with 9 acre Habitat Preserve	acre	7.0	7.0		14.0	14.0
Neigborhood (and village park)	acre	4.9	4.9	4.8	14.6	14.6
WASTEWATER TREATMENT PLANT	acre	1.0	1.0		2.0	2.0
ROADS	acre	15.0	15.0	10.0	40.0	40.0
MISCELLANEOUS LANDSCAPE ZONES						
Natural/Open Space	acre	657.5	337.4	223.0	223.0	223.0
Accented planting	acre	5.5	5.5	5.4	16.4	16.4
TOTAL ACREAGE						957.0

Table 5. Project Water Demand - Phase III (Total Buildout)

Element	Type	Number	Water Demand						Water Consumed					Return	Wastewater
Description	Unit	Units	Duty Factor	indoor		outdoor		total	indoor		outdoor		total	flow	
			(afy/unit)	%	afy	%	afy	afy	%	afy	%	afy	afy	afy	afy
Golf Courses	acre	273.0	2.50	0.0	0.0	100.0	682.5	682.5	10.0	0.0	90.0	614.3	614.3	68.3	0.0
Ponds	acre	22.3	4.70	0.0	0.0	100.0	104.8	104.8	0.0	0.0	100.0	104.8	104.8	0.0	0.0
Golf Clubhouse	facility	2.0	6.40	100.0	12.8	0.0	0.0	12.8	20.0	2.6	80.0	0.0	2.6	0.0	10.2
Resid. 5000 sf	D.U.	24.0	0.37	81.0	7.2	19.0	1.7	8.9	20.0	1.4	80.0	1.4	2.8	0.3	5.8
Resid. 5-7000 sf	D.U.	563.0	0.37	81.0	168.7	19.0	39.6	208.3	20.0	33.7	80.0	31.7	65.4	7.9	135.0
Resid. 7-9000 sf	D.U.	381.0	0.50	60.0	114.3	40.0	76.2	190.5	20.0	22.9	80.0	61.0	83.9	15.2	91.4
Resid. 10-20000 sf	D.U.	169.0	0.79	38.0	50.7	62.0	82.8	133.5	20.0	10.1	80.0	66.2	76.3	16.6	40.6
Resid. 1 acre	D.U.	49.0	1.50	20.0	14.7	80.0	58.8	73.5	20.0	2.9	80.0	47.0	49.9	11.8	11.8
Maint/WWTP	lump	1.0	7.30	49.0	3.6	51.0	3.7	7.3	20.0	0.7	80.0	3.0	3.7	0.7	2.9
Village: mixed use	acre	3.0	2.10	100.0	6.3	0.0	0.0	6.3	20.0	1.3	80.0	0.0	1.3	0.0	5.0
Village: multi-family	D.U.	150.0	0.17	100.0	25.5	0.0	0.0	25.5	20.0	5.1	80.0	0.0	5.1	0.0	20.4
Resort: Hotel	room	170.0	0.15	70.0	17.9	30.0	7.7	25.6	20.0	3.6	80.0	6.2	9.8	1.5	14.3
Resort: Casitas	D.U.	20.0	0.30	70.0	4.2	30.0	1.8	6.0	20.0	0.8	80.0	1.4	2.2	0.4	3.4
Resort: mixed use	acre	1.5	2.10	70.0	2.2	30.0	0.9	3.1	20.0	0.4	80.0	0.7	1.1	0.2	1.8
Schools	student	350.0	0.03	50.0	5.3	50.0	5.3	10.6	20.0	1.1	80.0	4.2	5.3	1.1	4.2
Parks - active	acre	10.0	2.10	0.0	0.0	100.0	21.0	21.0	20.0	0.0	80.0	16.8	16.8	4.2	0.0
Parks - passive	acre	5.0	1.00	0.0	0.0	100.0	5.0	5.0	20.0	0.0	80.0	4.0	4.0	1.0	0.0
Parks - neighborhood	acre	14.6	1.70	0.0	0.0	100.0	24.8	24.8	20.0	0.0	80.0	19.8	19.8	5.0	0.0
Accented Planting	acre	16.4	1.50	0.0	0.0	100.0	24.6	24.6	20.0	0.0	80.0	19.7	19.7	4.9	0.0
TOTAL					433.4		1141.2	1574.6		86.6		1002.2	1088.8	139.0	346.7

Table 6. Water Demand Cycle - Phase III (Total Buildout)

Month	All Quantities in Acre-Feet					
	Golf Course Demand	Domestic Demand	Gross Demand	Reclaimed Water		Net Water Demand
				Used	Stored[1]	
Jan	16	42	58	16	11	42
Feb	21	44	65	21	6	44
Mar	46	57	103	46	-18	57
Apr	73	69	142	42	-13	100
May	102	83	185	30	0	155
Jun	107	85	192	30	0	162
Jul	105	84	189	31	0	158
Aug	105	85	190	30	0	160
Sep	92	78	170	30	0	140
Oct	69	67	136	29	0	107
Nov	38	52	90	28	0	62
Dec	13	41	54	13	14	41
TOTAL	787	787	1574	346	31	1228

NOTES: [1] Stored value is incremental for each month. The cumulative storage reaches 31 acre-feet in February and is used in March and April. Golf course demand includes golf courses and lakes. Domestic demand includes everything else.

Water Sources and Quality

The viable water sources currently available to the project to meet water demand include ground water and reclaimed water. Ground water would be pumped from the existing production wells at the site and wastewater would be captured and reclaimed through on-site treatment.

Ground Water. Ground water samples collected from the monitoring wells and production wells were analyzed for water quality parameters. All the constituents analyzed were within acceptable limits for use in domestic and agricultural applications. The Highway 1 production well appears to have the best overall water quality, with lower values for almost all constituents analyzed; this well is best suited for domestic use. Table 7 summarizes the analytical results of ground water samples collected from the production wells.

Table 7. Water Quality Results

Analyte	Units	MCL	Production well (with sampling date)			
			Hwy 1 12/16/93	Dawn Rd. 8/6/94	Mesa Rd. 8/6/94	Homestead 8/6/94
pH	unit	none	6.9	7.7	7.6	7.2
EC	µmhos/cm	1600	610	1185	1060	1425
TDS	mg/l	1000	442	700	616	840
Total Hardness	mg/l	none	220	456	408	552
$HC0_3$	mg/l	none	95	211	173	221
Na	mg/l	none	43	48	41	53
K	mg/l	none	2	3.8	4	3.7
Ca	mg/l	none	54	120	115	150
Fe	mg/l	0.3	<0.02	0.14	0.14	0.14
Mn	mg/l	0.05	<0.005	<0.02	<0.02	<0.02
Mg	mg/l	none	21	38	29	43
SO_4	mg/l	500	140	314	286	429
Cl	mg/l	500	42	68	56	58
NO_3	mg/l	45	16	3.1	12.4	4
B	mg/l	none	<0.1	0.44	0.38	0.75

NOTES:
MCL = Maximum Contaminant Level (State of California)
EC = Electrical Conductance
TDS = Total Dissolved Solids
µmhos/cm = micromhos per centimeter
mg/l = milligrams per liter

Reclaimed Water. The project would construct and maintain a wastewater treatment plant to process sewage on-site. The plant would be built during the first two phases of development and would be capable of providing secondary treatment for influent sewage in accordance with the applicable standards from the California Code of Regulations Title 22 (Environmental Health).

The quality of the treated effluent would vary primarily with the quality of the original well water and the average mineral pickup during use. Due to the varying quality in the production wells, reclaimed water quality would depend on which well was being pumped for domestic use. For clarification, domestic use in this report refers to all demand except for the golf course irrigation and lakes. Table 8 presents the average mineral pickup for selected constituents and the estimated reclaimed water quality.

Table 8. Estimated Reclaimed Water Quality - Phase III (Total Buildout)

Constituent	Domestic Water Quality (mg/l)	Average Pickup (mg/l)	Estimated Reclaimed Water Quality (mg/l)
Nitrogen	3.4	18	21.4
Phosphorus	0	2.6	2.6
Potassium	2.1	10	12.1
Calcium	59	15	74
Magnesium	22	7	29
Sulfur	41	10	51
Boron	0.04	0.2	0.24
Chloride	44	75	119
Sodium	43	70	113
Bicarbonate	239	70	309
Total Dissolved Solids	463	320	783

NOTES: Domestic water supply is 11:1 average blend of Hwy 1 well and Dawn Road well (see example production plan section).
Average mineral pickup after Bouwer (1978).

Ground Water Facilities

Between November, 1993, and May, 1994, four ground water production wells were constructed at the site. The construction details for each well are summarized in Table 9. The four production wells are located around the site perimeter as shown in Figure 2. Pump testing indicates that the production wells are capable of meeting the water demands of the project.

Example Production Plan

An example production plan for each development phase is presented herein for use in evaluating the potential impacts to ground water discussed in subsequent sections. The example production plans have been developed with considerations for well yield, pump efficiency, well location, the type and number of neighboring wells, ground water elevation and ground water quality. Cleath & Associates presents these example production plans as representative of what could be implemented for The Woodlands to meet water demand.

The assignment of well pumpage, based on a preliminary evaluation, would be as follows:

1) Highway 1 Well: Best overall water quality, good location. Primary well for domestic water demand.

2) Dawn Road Well: Average water quality, average lift required but closest to existing pumping depression. Secondary well for domestic water demand.

3) Mesa Road Well: Average water quality, lowest required lift, best location for reducing interference with Highway 1 well. Primary golf course irrigation well.

4) Homestead: Poorest overall water quality and greatest lift required but farthest from existing pumping depression. Secondary golf course irrigation well.

The secondary wells (Mesa Road for domestic demand and Homestead for golf course irrigation) would be brought on-line when water demands on the primary wells exceeded about 500 gpm (continuous rating). This is based on an operational flow rate of about 1,000 gpm per well with a 50 percent duty factor (12 hours per day). With these specifications, production from Homestead is not needed.

Table 10 presents the example production plan for The Woodlands at total buildout (Phase III) using the water demand figures for the project and separating the domestic and golf course pumpage by specific well assignment discussed above. Example production plans for Phase I and Phase II are in Appendix B.

Table 9. Well Construction and Production Data

DATA DESCRIPTION	DEPTHS IN FEET BELOW GROUND SURFACE			
PRODUCTION WELL NAME	Highway 1	Dawn Road	Mesa Road	Homestead
STATE WELL NUMBER[1]	11N/35W-16J	11N/35W-15D	11N/35W-15R	11N/35W-22M
SURFACE ELEVATION[2]	255	250	260	170
SANITARY SEAL[3]	0-50	0-50	0-50	0-50
TOTAL DRILLED DEPTH	690	695	662	900
CASING DIAMETER:				
14-inch	0-539	0-440	0-450	0-430
10-inch	539-690	440-640	450-582	430-690
SCREEN:				
14-inch diameter	389-539	340-390	360-450	
10-inch diameter	540-690	442-632	452-572	430-680
PRODUCTION DATA (24-hour constant discharge test):				
Static water level	246	244	237	171
Final water level	286	295	295	251
Flow rate (gpm)	1000	1200	1400	1400
Specific Capacity[4]	25	24	24	18

NOTES:

[1] Unofficial and incomplete designation based on location

[2] Approximate surface elevation in feet above mean sea level

[3] 30-inch diameter conductor casing cemented in 38-inch hole

[4] Specific capacity for 24 hours at test flow rate .

Table 10. Example Production Plan - Phase III (Total Buildout)

Net Water Demand			Production Plan							
			Domestic Supply				Golf Course Supply			
			Highway 1		Dawn Road		Mesa Road		Homestead	
Month	af	gpm	af	gpm	af	gpm	af	gpm	af	gpm
Jan	42	308	42	308						
Feb	44	358	44	358						
Mar	57	413	57	414						
Apr	101	761	69	522			32	239		
May	155	1130	69	500	14	103	72	528		
Jun	161	1215	66	500	19	143	76	572		
Jul	159	1160	69	500	16	117	75	544		
Aug	159	1158	69	500	16	116	74	542		
Sep	140	1053	78	588			62	466		
Oct	107	777	67	487			40	290		
Nov	63	472	53	396			10	76		
Dec	41	297	41	298						
Average		759		448		40		271		0
Total	1228		722		65		440		0	

NOTES: Winter golf course water demand met in-full with reclaimed water.

GROUND WATER MODELING

Cleath & Associates has developed a finite-difference ground water model to simulate the hydrogeologic conditions of the Nipomo Mesa. The model was developed to compare the effects on the hydrogeologic regime of current conditions both with and without pumpage for the proposed project. One set of aquifer parameters was developed for use; the only differences between the current conditions and project scenarios were pumpage related to the project water demands and recharge factors related to increased percolation of precipitation from development and irrigation return flows.

Development of the model

The area selected for the model grid was designed to be large enough to include items in the hydrologic budget that affect ground water conditions beneath the Nipomo Mesa, and to minimize edge effects in model results for the main study area. Included in the model grid is all of the Nipomo Mesa, the Cienega Valley, and parts of the Arroyo Grande Valley and Santa Maria Valley (Figure 14). The model was constructed using site specific data and estimated values from recognized sources. Due to the ever-changing nature of the hydrogeologic regime, model calibration was performed against time by using well hydrographs as standards for the baseline condition. The ground water model includes a layer for perched water, where appropriate, and allows for leakage from the upper water zone to the lower aquifer.

In finite-difference ground water modeling, water flowing into and out of each of the cells in a grid is represented by a partial differential equation. This equation includes terms for inflows such as recharge from rainfall, irrigation return flow, creek surface flow, underflow, and sea water intrusion, as well as for outflows, primarily well extraction. Differences between inflow and outflow result in changes in the quantities of water in storage. The following sections describe the software utilized and data compiled in developing and calibrating the ground water model for The Woodlands.

Software Used. The modeling software used for this effort was the **ModFlow** (Modular FLOW) package developed by the United States Geological Survey. This software is documented in *A Modular Three-Dimensional Finite-Difference Ground Water Flow Model* (McDonald and Harbaugh, 1988). This is a standard ground water modeling program used widely throughout the United States, both in the public and private sectors. Minor additions to the USGS ModFlow release have been made to aid in output of data for use by other software packages.

Inputs for ModFlow were prepared with the aid of a graphical pre-processor tool, **ModelCAD-386**, published by Geraghty & Miller, Inc. This tool allowed for a more-rapid initial compilation and formatting of the data than would have been possible using only a text editor. Additional software has been developed in-house to interface the **ModelCAD** data set into the Cleath & Associates proprietary ground water inventory database system, and to produce the presentation graphics used in this report.

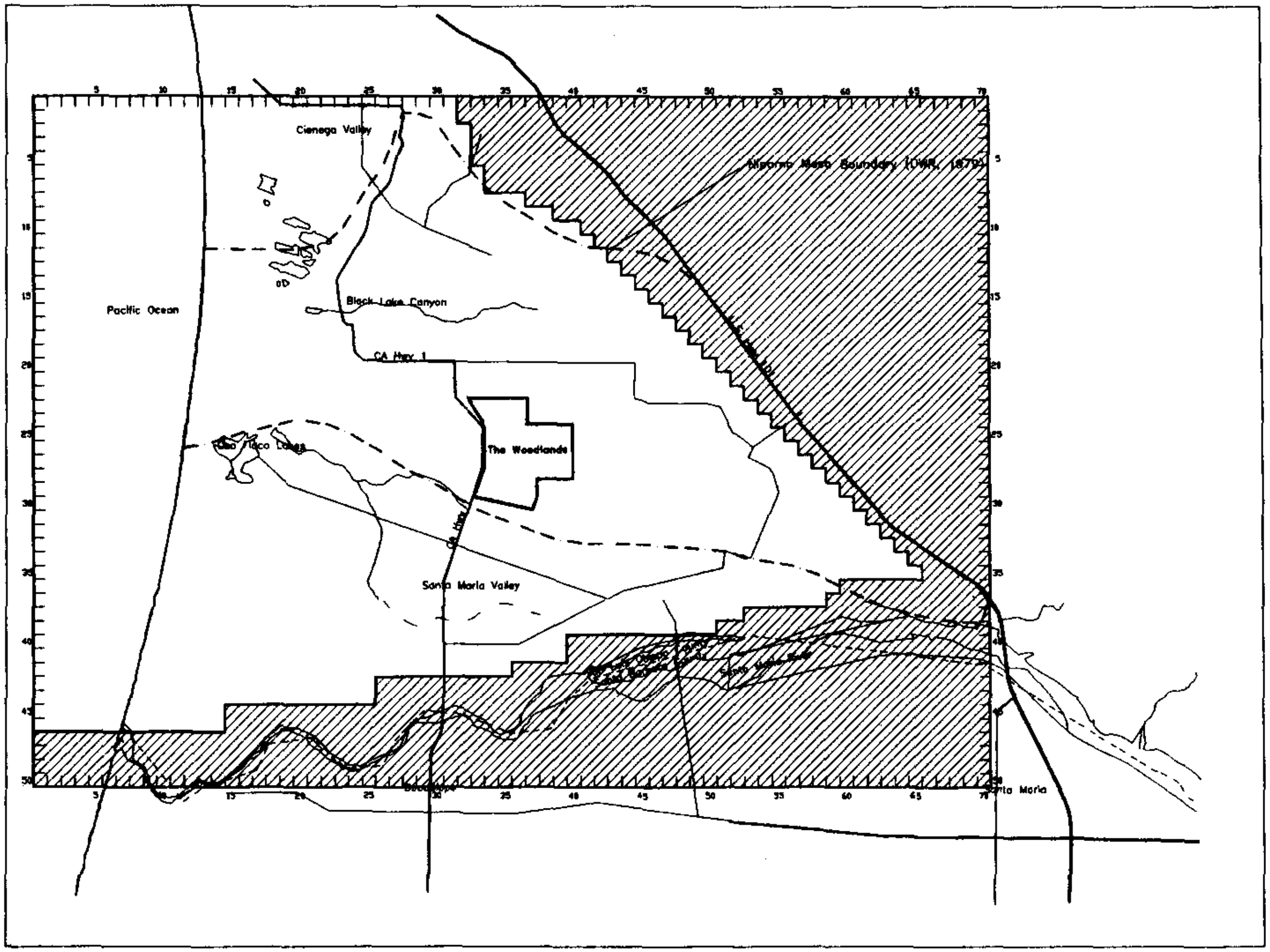


Figure 14
Model Grid

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Nipomo Mesa

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ModelMap.DWG

One of the principal uses of the model was to determine annual changes of ground water in storage. As mentioned previously in the section on Status of the Nipomo Mesa Storage Area, the DWR Nipomo Mesa storage area was selected as the main study area for evaluating storage changes. Both water levels and hydrologic budget information were output from the model for this study area. Hydrologic budget items, such as inflow and outflow along discrete boundary segments, were retrieved using **ZoneBudget** software. This software allows the outputs for specific cells or groups of cells within the model to be retrieved for further analysis.

Model Area. The active area modeled is bounded to the north and northeast by Arroyo Grande Creek and Los Berros Valley, and to the west by the Pacific Ocean. The eastern boundary is along the estimated limits of the Santa Maria ground water basin, and the southern limit is near the Santa Maria River (Figure 14). The model area was subdivided into a grid composed of 50 rows and 70 columns; each cell comprises a 1,000-foot x 1,000-foot square area. The area in the northeast portion of the model grid contains inactive cells due to shallow Franciscan Formation rocks, which are typically non-water bearing and constitute the basin boundary (Hall, 1973).

Model Inputs. Data used to construct the model were compiled from the following sources: water and oil well drilling logs on file at Cleath & Associates; current and historical production data from local water purveyors; historic water level, stream flow, and rainfall data provided by the San Luis Obispo County Engineer's Office and the Santa Barbara County Flood Control District; stream bed elevation data and agricultural pumpage information from area reconnaissance; land use data from the office of the San Luis Obispo County Agricultural Commissioner; and land use and water well data from the State of California Department of Water Resources.

The model inputs have been divided into three classes: hydrogeologic flow parameters, hydrologic inflow data, and hydrologic outflow data. A summary of these classes are presented in the following sections.

<ins>Hydrogeologic Flow Parameters</ins> Initial estimates of the parameters affecting the flow of ground water, permeability and storage coefficient, were made on the basis of well logs from the area and reports of production capability. These estimates were adjusted during model calibration runs in order to fit measured water level hydrographs. Similar values of permeability and storage coefficient were grouped into zones; zone numbers for the cells are depicted in Figures 15 through 18, and their corresponding values are presented in Table 11.

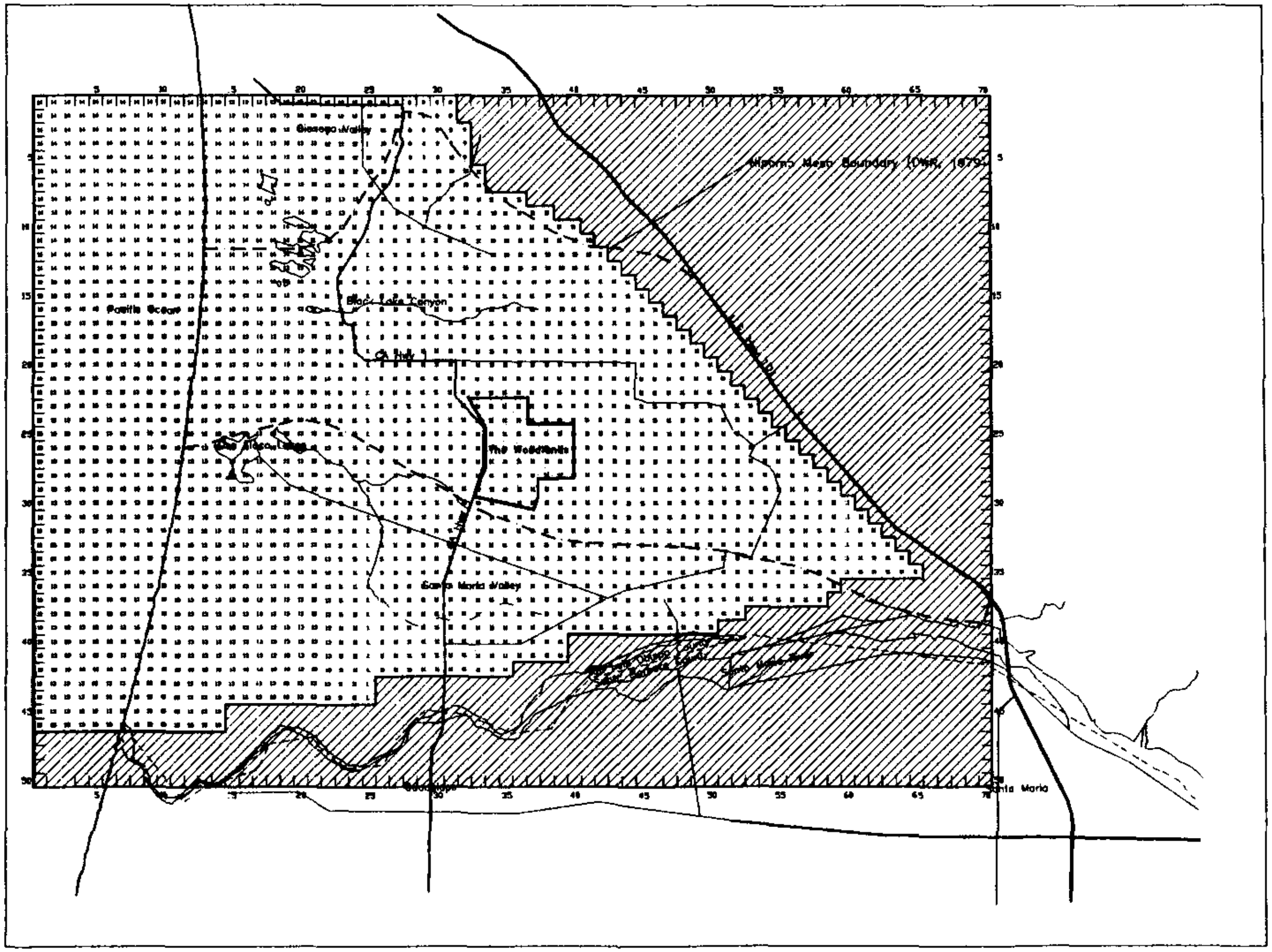

Figure 15
Model Parameters
Layer 1 Permeability

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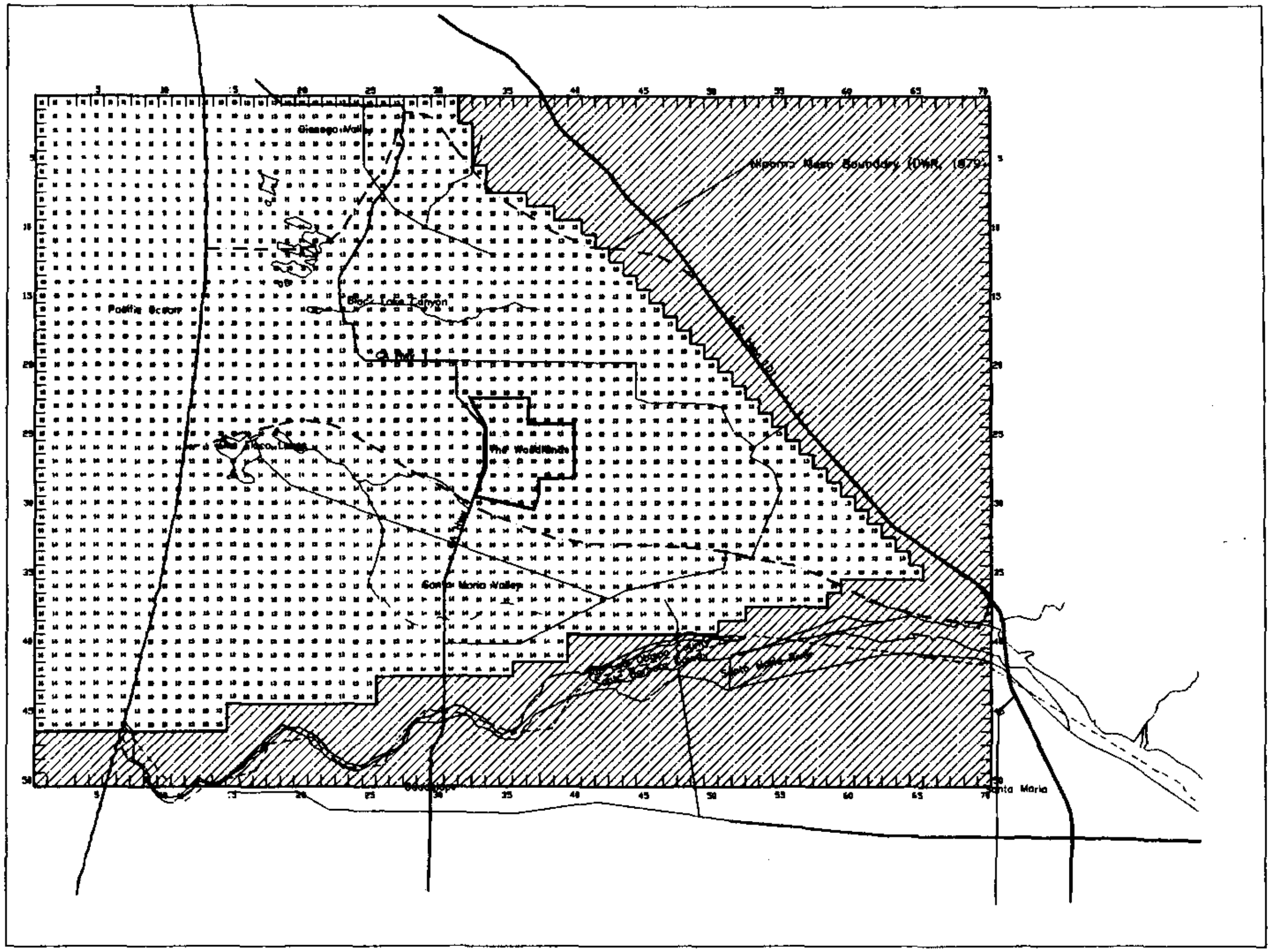

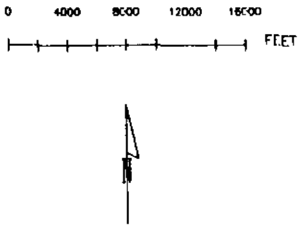

Figure 16
Model Parameters
Layer 1 Specific Yield

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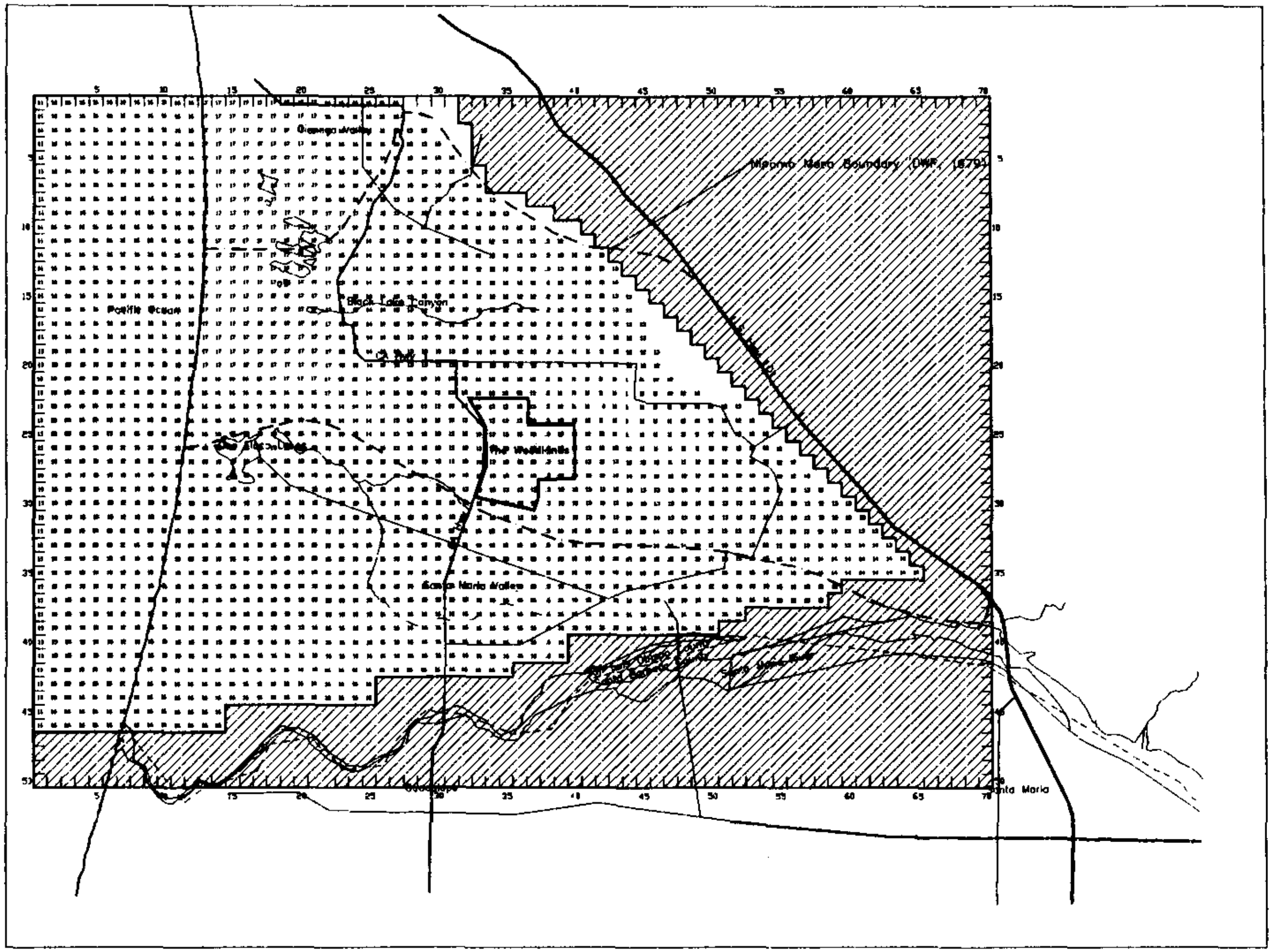

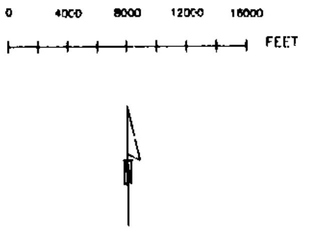

Figure 17
Model Parameters
Layer 2 Permeability

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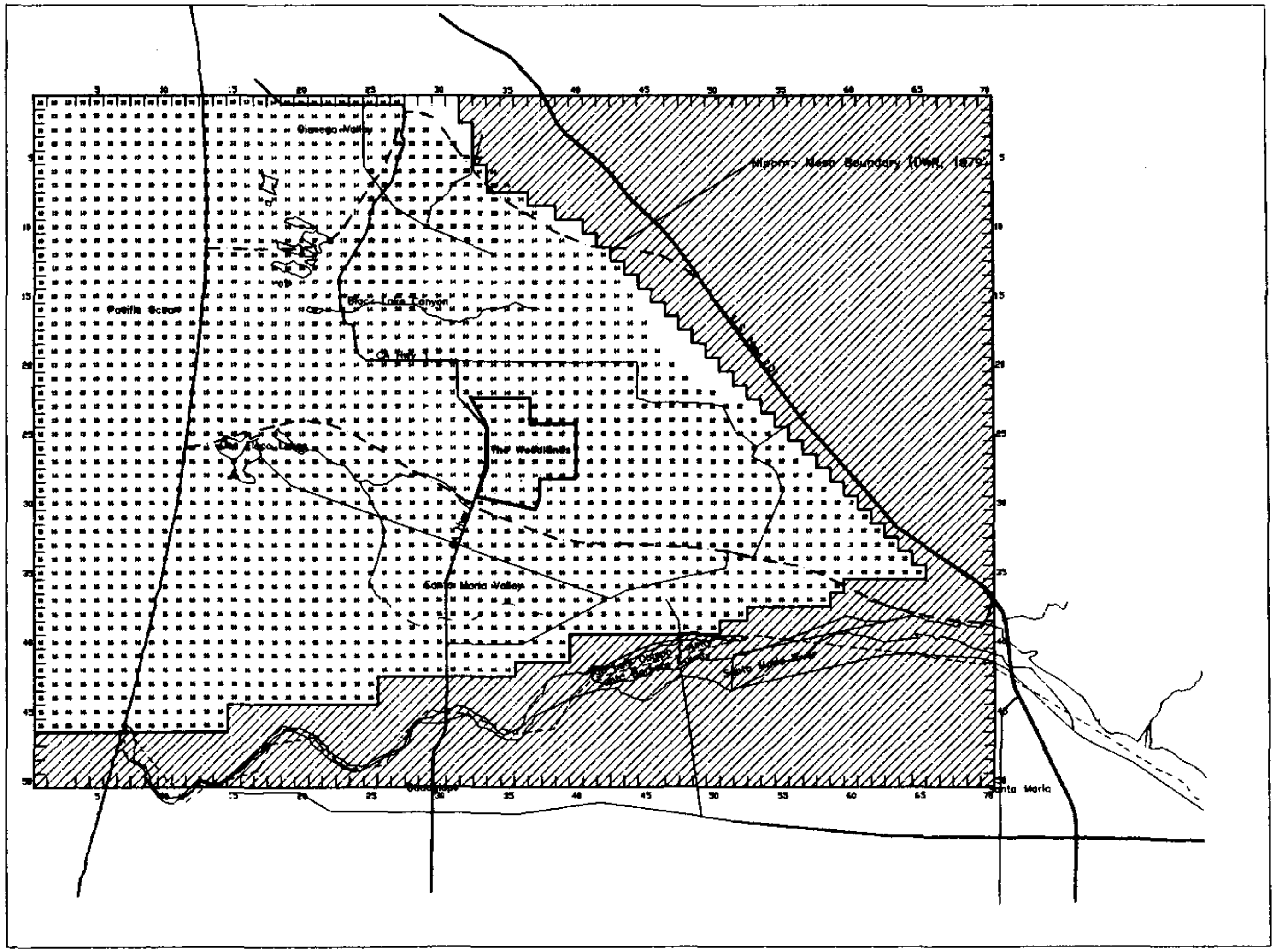

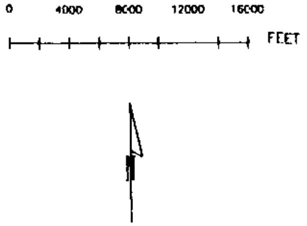

Figure 18
Model Parameters
Layer 2 Storativity

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ModelMap DWG

Table 11. Model Parameter Zones and Values

Zone	Permeability feet/day	Storage Coefficient	Specific Yield
1	0.01	0.0002	0.02
2	0.02	0.0002	0.02
3	0.05	0.0002	0.02
4	0.08	0.0003	0.03
5	0.15	0.0003	0.03
6	0.25	0.0003	0.03
7	0.5	0.0004	0.04
8	0.8	0.0005	0.05
9	1.5	0.0005	0.05
10	2.5	0.0006	0.06
11	5	0.0008	0.08
12	8	0.0010	0.1
13	15	0.0012	0.12
14	25	0.0015	0.15
15	50	0.0018	0.18
16	80	0.0020	0.2
17	100	0.0020	0.2
18	200	0.0025	0.25
19	500	0.0025	0.25

Hydrologic Inflow Data Hydrologic inflow to the ground water resources of the model area includes recharge from precipitation, stream flow, surface water storage, irrigation returns, seawater intrusion, ground water flow across the hydraulically upgradient side of the model, and wastewater discharge to land.

General recharge, or recharge applied to an area, results primarily from incident rainfall and return of excess irrigation. This was simulated by assuming that percolation of precipitation over the model grid amounted to approximately 21 percent (%) of rainfall in the Mesa, 14% - 20% in sand dune areas, 14% in the Cienega Valley area, and 10% in the Santa Maria Valley. Note that the model assumption of 21% percolation of precipitation for the Mesa appears to be less than Cleath & Associates' estimate of 25%, however, the model percolation values are calibrated specifically to the Nipomo rain gage station, which has a higher average rainfall (16 inches) than most of the model area (15 inches) and was used for model precipitation input. In addition, a downward adjustment was made in the percolation of precipitation to offset the positive cumulative average departure from rainfall for the period (see Storage Changes Fall 1976- Fall 1992 section). The percolation of precipitation adjustment from 25 % to 21% over the Mesa brings the cumulative departure from average rainfall for the 16-year period to -1.39 inches, or 0.09 inches less rainfall per year than the ideal balance (Appendix A). It was assumed that most of the percolation of precipitation occurred during the wet season, running from November 1 through April 30. Return flows from irrigation are calibrated independently from percolation of precipitation but cover a similar range of values.

Stream flow data is measured in Los Berros Creek by a gage maintained by the County of San Luis Obispo Engineer's office, for which data was available at the time our study for the period from August 1968 through September 1993. Stream flow data for Arroyo Grande Creek is measured in a gage maintained by the United States Geological Survey (USGS), for which data was available at the time of our study from 1940 through September 1993. There is no gaging station data for lower Los Berros Creek or Black Lake Slough. Input data for stream flow for the latter water courses were estimated based on area reconnaissance by Cleath & Associates. Inflow and outflow of ground water from reaches of Los Berros Creek, Arroyo Grande Creek, and Black Lake Slough were calculated by the model based on the permeablities entered and the elevations of the surface and ground water in the boundary cells. Inflow/outflow from the dune lakes was calculated by the model in a similar fashion.

The Santa Maria River was modeled by using a general head boundary several grid cells north of the channel. The elevation of the general head boundary is programmed to fluctuate annually according to the hydrographs of wells adjacent to the river. When simulated ground water levels are above the general head boundary, water flows out of the model toward the river channel. When ground water levels are below the general head boundary, water flows into the model from the river. Seawater intrusion was simulated utilizing constant head boundaries slightly above mean sea level located offshore.

Hydrologic Outflow Data Hydrologic outflow from the water resources of the model area includes pumpage, ground water flow across the hydraulically downgradient side of the model area, and evapotranspiration. Streams may also act as outflow areas if they remove more water than they bring into the model.

Irrigation pumpage in the Cienega Valley and Santa Maria Valley was derived from land use survey data provided by DWR and the San Luis Obispo County Agricultural Commissioner. Acreage planted in individual crops were noted, and applied irrigation data for each crop for Coastal Valleys in this region of California were employed to estimate the total annual quantity of water needed. Monthly irrigation demands were derived from this information by scaling the total annual water need by the monthly distribution of evapotranspiration in excess of usable precipitation. Based on information from the DWR land use studies, about 10% of agricultural land appears to be fallow at any given time; for this reason, we adjusted the estimated irrigation demand downward by 10%. Adjusted pumpage estimates for each parcel were distributed among the various wells serving the parcel. Cleath & Associates canvassed the Oso Flaco area of the Santa Maria Valley to determine which wells were being used for production and to refine pumpage estimates. Extractions for irrigation were adjusted slightly for a few parcels to achieve closer fits to water levels measured during the years used.

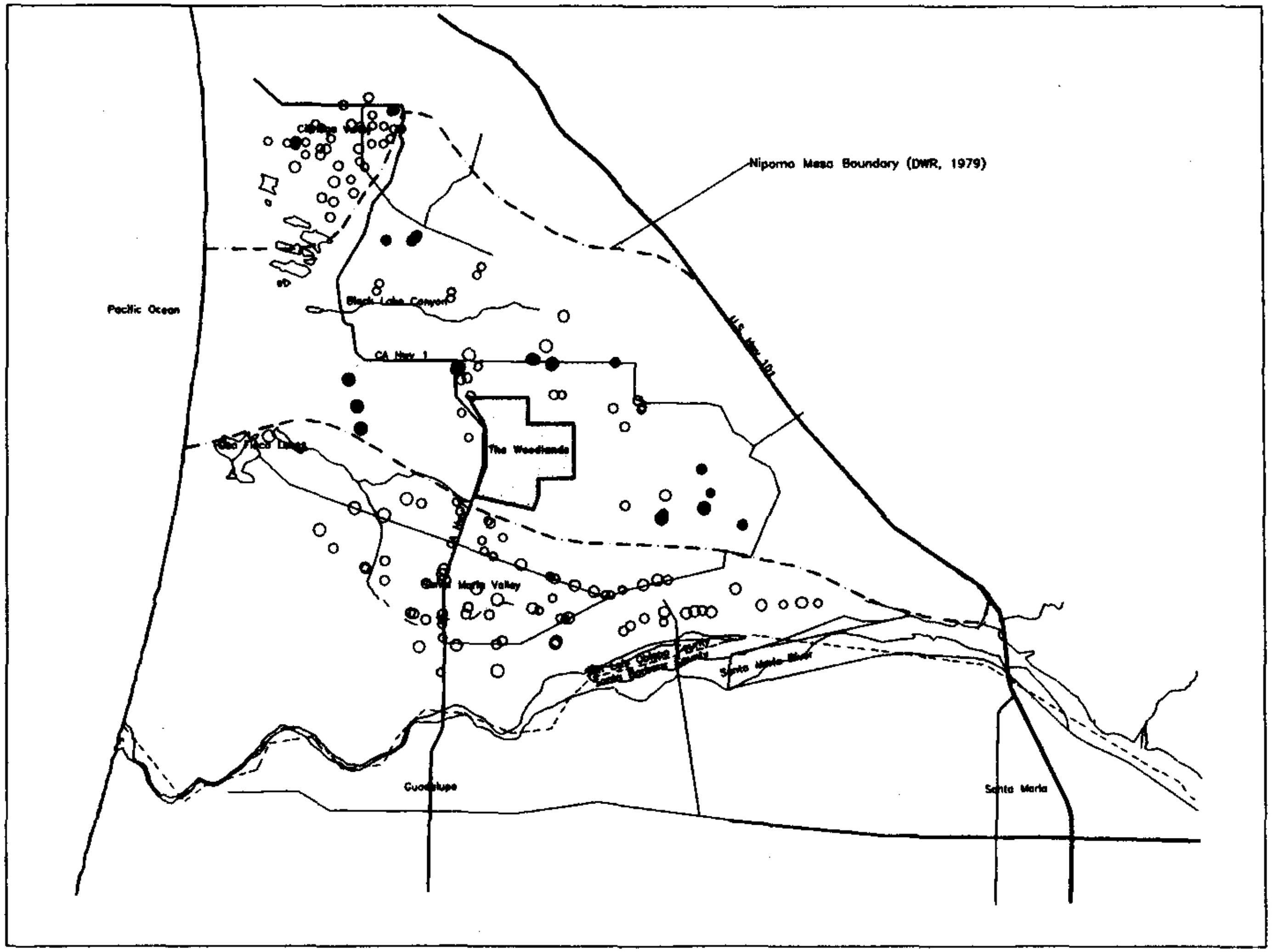
The irrigation pumpage on the Nipomo Mesa was derived in a similar fashion to the Cienega Valley and Santa Maria Valley estimates. Site-specific pumpage from nursery operations on the Mesa was also used where available. Figure 19 shows the major wells and relative production for the Nipomo Mesa and surrounding area modeled.

Extractions of water for domestic use by residents of the Nipomo Mesa is largely accounted for by seventeen local water purveyors. Two of these purveyors, Nipomo County Service District (NCSD) and California Cities Water Company (CCWC), account for 84 percent of the residential water supply. Unocal Corporation (Unocal), a significant water user on the Mesa, has also been included in the model construction.

Model Calibration

The model was calibrated using the data and estimated parameters as detailed above to simulate the conditions prevailing during the years 1977 through 1992. Ground water flow parameters (permeability and storativity) and recharge parameters were adjusted until there was a close fit between the historic water levels and those predicted by the simulation. The calibration wells were selected based on availability of historic data and proximity to the main study area (see Figure 20).

It should be noted there may be considerable variation of water levels in wells that are screened in different production horizons. For example, at the new Woodlands Highway 1 wells, water levels in the monitoring well are consistently 25-30 feet higher than those in the adjacent production well. Effects from the vertical variations in heads were also found in calibrating the model. In several of the



EXPLANATION

Pumpage (afy)

○ 50 - 100
○ 100 - 200
○ 200 - 500
○ 500 - 1000
○ 1000 - 2000

Solid symbol indicates
municipal or industrial well

0 4000 8000 12000 16000
FEET

Figure 19
High Production Wells

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Nipomo Mesa

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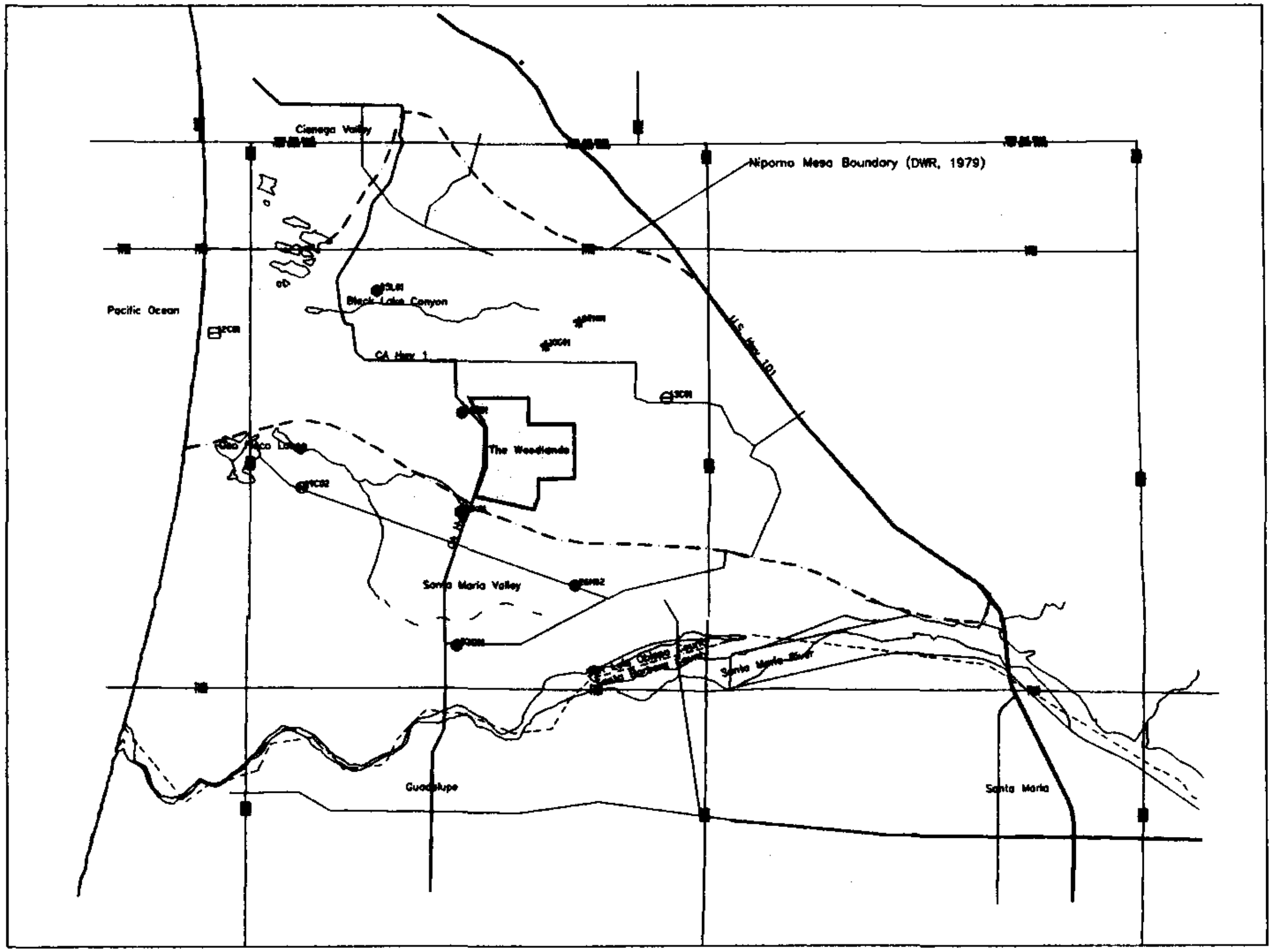
PostPump.DWG



EXPLANATION

- ✩ Nipomo CSD Wells
- ✩ Black Lake GC Wells
- ● Irrigation Wells assigned to Parcels
- ⊗ Abandoned(?) irrigation wells
- ○ Private Domestic Wells
- ☐ Monitoring Wells

0 4000 8000 12000 16000 FEET

Figure 20
Simulated Hydrograph Wells

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Nipomo Mesa

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HydroGrf.DWG

calibration target wells, the levels calculated by the model did not match the actual historic levels, but did match the seasonal variations in levels fairly closely.

Because much of the data utilized for the development of the model were estimated (such as agricultural ground water production and water levels in the creeks), the accuracy of this model should not be considered to be any greater than the accuracy of the many estimates and assumptions. The results of ground water modeling are included in both the previous section on Status of the Nipomo Mesa Storage Area and in the following section on Potential Impacts to Ground Water.

POTENTIAL IMPACTS TO GROUND WATER

The primary issues of concern with regard to environmental impacts to water resources resulting from development at The Woodlands are: 1) potential impacts to ground water quality, 2) interference of neighboring ground water wells, and 3) potential impacts to ground water storage. Each of these issues is discussed herein.

Potential Impacts to Ground Water Quality

The potential impacts to ground water are primarily increases in nitrogen and total dissolved solids. These increases result from the mineral pickup during the domestic water use cycle, and the commercial fertilizers and other chemicals typically used on golf courses and landscaping. The estimated average quality of recharge water percolating to ground water from the site following development would generally be of similar or better quality compared to the existing water quality beneath the site and would not exceed drinking water quality standards for the constituents evaluated.

To assess the potential impacts to ground water in the above terms, Cleath & Associates has evaluated the proposed development impact in terms of a net "basin pickup". Basin pickup represents the quantity of each water quality constituent evaluated that is imported onto the site and eventually leaches to ground water. Basin pickup is a long-term concept, and it may take several years for the leachate concentrations to equilibrate. The impact of basin pickup on other ground water users would depend on the direction of ground water flow beneath the site and the particular aquifer zones that other users draw from. Production wells on the subject property are all screened below the shallowest aquifer zone. Given the semi-confined conditions of the deeper aquifer zones, the water supply for the project would probably not be immediately impacted from the basin pickup which leaches into the shallowest zone.

Regional ground water flow patterns indicate shallow ground water probably moves southwest toward the Oso Flaco area and out to sea. A certain amount of the former leachate (now ground water) would move into deeper aquifer zones where the vertical component of the hydraulic gradient increases (recharge zones) or through water wells perforated in both shallow and deeper zones. Once the former leachate reaches deeper aquifer zones, the horizontal flow directions are more dependent on the active production wells and any "basin pickup" constituents from the subject site would be dispersed into local pumping depressions.

Constituents. The purpose of the basin pickup analysis is to estimate the percentage of select constituents applied to the turfgrasses that would eventually leach to ground water. These constituents, selected based on health concerns and general water quality, are nitrogen, sulfur, chloride, boron, metals, total dissolved solids, and pesticides.

The nutrient value of reclaimed water is an important contribution to satisfying the fertilizer requirements of the turfgrasses. Turfgrasses use reclaimed water nutrients efficiently because they are applied on a regular basis. In most cases the turf will obtain all phosphorus and potassium they need, and a large part of the nitrogen requirement, as well as sufficient micronutrients (Harivandi, 1994).

The method employed herein to account for the nutrient value of reclaimed water and well water is to subtract the average annual tonnage of nutrients supplied by the irrigation water sources from the estimated fertilizer requirements of the turfgrasses. The resulting difference will be the quantity of fertilizers imported the site. Detailed calculations for basin pickup analyses are included in Appendix C.

Much of the estimated basin pickup of water quality constituents is associated with reclaimed water and fertilizer use on the irrigated golf courses. There is, however, non-golf course acreage where landscaping would be maintained and fertilized. These areas are discussed separately below.

Nitrogen

Nitrogen (N) is the major fertilizer component. The estimated quantity of total N required annually to maintain golf course turfgrasses on subject property would be approximately 8 pounds per 1,000 square feet (sf) per year on greens and tees, 4 pounds per 1,000 sf on fairways and 2 pounds per 1,000 sf on playable rough.

Over 273 irrigated golf course acres (total buildout), the N requirement is estimated at about 21.4 tons N. A significant portion of this requirement would be provided by the reclaimed water and a small fraction by the well water. Assuming golf course irrigation using 346 acre-feet per year of reclaimed water averaging 21 milligrams per liter (mg/l) N, the resulting fertilizer contribution is about 8.5 tons N. Well water irrigation on the golf courses contributes an estimated 3.2 tons N. Therefore, an estimated 9.7 tons of N fertilizer would be imported annually for golf course maintenance.

The potential export (removal from system) mechanisms for N would be direct volatilization of ammonia, denitrification to N_2 and N_2O gas, adsorption by organic matter, and incorporation in to microbes. Volatilization of a portion of the organic nitrogen in the clippings is also likely (Turgeon, 1991).

Direct volatilization of ammonia (NH_3) is probably a small factor, considering only about 10 percent of the total N in reclaimed water would be in this form, and most irrigation would probably be at night when volatilization rates are low.

Biological denitrification is a potentially significant export factor. The nitrogen present in secondary effluent is comprised mainly of NH_4-N (ammonium nitrogen) and must be oxidized to form nitrate. Following oxidation (nitrification), a reduced oxygen zone within soil containing denitrifying bacteria and sufficient organic carbon may result in removal of the nitrate compounds (denitrification). Denitrification of nitrates introduced in commercial fertilizers would also occur. The rates of denitrification vary and would be site specific. In a well-drained aerobic soil typical of golf course conditions, denitrification is limited to reduced microzones near a plant root or near pieces of decomposing plant and animal residue. The extent of denitrification by this (microzones) mechanism is limited to less than 30% of the total nitrate, whereas all nitrate may be denitrified in a water-logged soil (Lance, 1975).

Living plants stimulate denitrification. As a rule of thumb, a 1:1 ratio of organic carbon to $N0_3$-N is needed for 80%-90% denitrification. The organic carbon is a food supply for denitrifying bacteria and can temporarily store ammonium-N in reclaimed irrigation water until oxygen is available to nitrification and subsequent denitrification in microzones. Ammonia also reacts with soil organic matter to form complexes that are resistance to leaching and decomposition. A range of 33 milligrams (mg) to 36 mg of N may be adsorbed per gram of carbon, therefore, organic fixation of ammonia can remove a significant amount of N present as NO_3-N. Organic carbon available from irrigation water itself, however, is usually limited (Lance, 1975).

The existing organic carbon supply in soil at the site is not to be considered because it would eventually be depleted as a food source, cation exchange site, or adsorption site. The most promising renewable (imported) source of soil organic carbon would be from plants and plant clippings. It is common for turf to contribute organic materials to the soil through the decomposition of plants (Beard, 1973).

The results of a three year research program conducted by the United States Golf Association (USGA) were reviewed to estimate the percentage of applied nitrogen that leaches to ground water as nitrate. The USGA study consisted of several independent studies, each with different methodologies. A summary of the results of the studies are shown in Table 12.

Table 12. Summary of USGA Nitrogen Fate Studies

Site	Soil Type	Percent of Applied Nitrate in Leachate
Michigan State Univ.	Sandy loam	0 - 0.18
Iowa State Univ.	Silt loam	0.21 - 10
Univ. of California	Sand/peat	0.55 - 1.69
	Sandy loam	0.57 - 1.71
	Loamy sand	0.30 - 0.75
Washington State Univ.	Sand	0.06 - 7.55
	Sand/peat	0.02 - 3.37
Univ. of Nevada	Loamy sand	0.03 - 100

Reference: USGA, 1995

The results of the studies indicate that in most cases the percent of applied nitrate leaching below the turfgrass root zone is less than 10 percent. The exception occurred in field experiments at the University of Nevada, where 30-100 percent of applied nitrogen leached below the root zone. These experiments were part of an irrigation salinity and drought study; high nitrate leaching in the field experiments were thought to be the result of excessive root zone salinity under deficit irrigation (in excess of 40 decisiemens per meter). These conditions are not expected at the Woodlands.

Iowa State University reported 10 percent of applied nitrogen leaching below the root zone in growing plots given a excessive irrigation (1 inch distilled water applied immediately following fertilizer application). By comparison, identical plots given 1 inch of distilled water spread in four 0.25-inch applications over 7-days resulted in a 40-fold reduction in the amount of leached nitrogen. Irrigation application at the Woodlands is expected to follow best management practices; excessive irrigation (or heavy rains) immediately following fertilizer applications would be avoided.

The Washington State University study used a pure sand growing medium and a modified sand/peat growing medium over a three year period. The highest percentage of applied nitrate to leach below the root zone (7.55 percent) occurred in the pure sand sample during the first year on plots given an annual nitrogen application of 12 pounds per 1,000 square feet (sf). The percentages for the sand growing medium were significantly lower in during the second year (maximum 0.70 percent) but rose again in the third year maximum (4.28 percent).

Annual application rates for nitrogen at the Woodlands would be expected to be about 8 pounds per 1,000 sf on greens and tees, about 4 pounds per 1000 sf on fairways. At these application rates, the percentage of applied nitrogen leaching below the root zone during the final year of the Washington State University study was 3.17 and 2.71 percent, respectively. The irrigation quantities in this study are not specified, but are described as sufficient to sustain normal turf growth.

The impact of irrigation quality on nitrate leaching are evaluated in the University of California (Riverside) study. The percentage of applied nitrogen leaching below the root zone when irrigating at 130 percent of ET_C (30 percent excessive irrigation) were about double compared to irrigating at 100 percent ET_C (optimum irrigation). At The Woodlands, state-of-the-art irrigation systems are anticipated, and 30 percent over-irrigation is not likely. However, a certain amount of over-irrigation may occur.

About 90 percent irrigation efficiency is feasible at The Woodlands. The resulting correction, based on the University of California study, would be about 33 percent additional nitrate leaching over that occurring at optimal irrigation. Therefore, assuming the Washington State University study was conducted at optimal irrigation and adjusting those results for 10 percent over-irrigation, the percentage of applied nitrogen leaching below the root zone as nitrate would be about 3.6 percent for fairways and 4.2 percent for greens and tees; approximately 4 percent overall.

In summary, it is assumed that 96 percent of the imported commercial nitrogen fertilizer is exported from the system. The remaining 4 percent of commercially applied N is assumed to reach ground water. About 10 percent of the applied golf course irrigation water is estimated to reach ground water as return flow. Reclaimed water is blended and applied with normal irrigation, therefore, an average of 10 percent of the imported nitrogen present in reclaimed water is assumed to reach ground water as return flow.

Sulfur

The estimated annual sulfur requirement for the turfgrasses at the subject site would be about 7 pounds per acre per year (Envicom, 1994). Sulfur is available to the turfgrass from both reclaimed water and well water. At total buildout, the supply from these irrigation sources is estimated at about 120 tons of sulfur, whereas the total fertilizer demand is less than 2 tons. Therefore, no significant importation of sulfur for fertilization is expected.

The sulfate ion, like nitrate, can be readily leached from the soil. Gypsum, a common soil amendment on golf courses, weathers to yield sulfate ions (Turgeon, 1991, and Sutcliffe, 1962). The component of sulfur imported to the system in reclaimed water and fertilizers is mostly water-soluble anionic sulfate. With plant uptake and mowing, some of the sulfur is recycled (no information is available on potential loss in volatilization). It is assumed that all imported sulfur (through domestic water use pickup) eventually becomes basin pickup.

Chloride and Boron

The role of elemental chlorine and boron in plant nutrition is not well defined, but both are considered micronutrients. In sandy soils, boron removal by adsorption is insignificant (Bouwer, 1978). Leachate concentrations of boron were found to be equal to those found in the wastewater used to irrigate, indicating a continuous leaching through the soil profile. Chlorides leach easily through the soil because they also are anionic. Little information is available on chloride leaching from wastewater-irrigated turf (Mancino and Pepper, 1994). It is assumed that all imported chloride and boron leaches to ground water.

The majority of chloride and boron imports to the plant-soil-ground water system come from the use of reclaimed water. Chloride, however, is also a major component of potassium chloride (KCl), a widely used turfgrass fertilizer. The chloride contribution of KCl fertilizer applications is discussed under the total dissolved solids section below.

Metals

The nutrient requirements of turfgrasses include some transition metals as micronutrients (iron, manganese, zinc, copper, and molybdenum). Of these micronutrients, iron is the most important for turfgrass performance. The actual quantities of micronutrients applied to turfgrasses is very small; only about 7 gallons of iron supplement and 1 gallon of micronutrient would be used in a year on about 80 irrigated acres (Envicom, 1994).

Most of the metals in raw sewage end up in the sludge. The concentrations of metals in treated effluent is usually below drinking water limits, especially coming from a primarily residential use cycle. Metal ions in sewage effluent are bound by clay, hydrous oxides, and organic matter in soil. Metals may react with sewage organic matter to form chelates and cause deeper penetration by leaching (Bouwer, 1978). Overall, the metal imports to the soil-plant-ground water system are relatively small, and the potential for adsorption to renewable organic soil matter from plant decay exists, therefore no significant basin pickup of metals is assumed.

Total Dissolved Solids

Total dissolved solids (TDS), is a broad measure of ground water quality. The TDS measurement, being a summation of common anions, cations, and minor constituents, is often used to evaluate salt loading, or increased mineralization of aquifers.

TDS contributions from the site development plan would come from mineral pickup during the domestic water use cycle and from the soluble components of applied fertilizers. The primary constituents of applied fertilizers that would contribute to TDS include nitrogen, potassium, calcium, sulfur, and chloride. Phosphorus, a plant macronutrient, is generally immobile in soil and would not be expected to increase TDS; the phosphate ions combine readily with iron and aluminum cations to form insoluble compounds (Turgeon, 1991).

Based on previous discussion, 90 percent of the nitrogen component of the TDS pickup in reclaimed water will be subtracted from the pickup figures. While some additional reduction of imported TDS components is likely from soil-water interactions, the rate of attenuation would tend to decrease with time as less adsorption sites remained. Microbiological attenuation of TDS may occur, however, this has not been quantified. With the exception of nitrate and phosphate, other common anions and cations are assumed to leach through the vadose zone with no attenuation.

For the purpose of estimating the imported quantity of potential TDS components as fertilizer, a fertilizer ratio (N:P:K) for established turfgrass of 4:1:1 is assumed (Beard, 1973). Therefore, based on the total golf course N requirement of 21.4 tons per year (total buildout), the P and K requirement would be about 5.4 tons per year. The P and K requirement for non-golf course areas are calculated similarly (Appendix C).

A major potassium carrier in the turfgrass industry is potassium chloride, which is about 52 percent potassium and 48 percent chloride. The overall salt loading contribution of chloride from potassium chloride applications is negligible, however, as virtually no potassium fertilizer is estimated to be required, based on the potassium contribution from irrigation water (Appendix C).

Another common fertilizer is superphosphate, which contains about 21 percent by weight phosphorus and 27 percent by weight calcium. About 77 percent of the phosphorus requirements of the turfgrass would be assumed to be met with superphosphate (the remaining 23 percent from irrigation water). An estimated 8.3 tons of calcium per year would be added to basin pickup from superphosphate fertilizer.

One component of TDS, sodium, may cause permeability problems, and reduce the leaching capabilities of a soil. A comparison of the sodium adsorption ratio (SAR) and electrical conductivity is typically performed to determine whether a soil permeability problem would be likely. The SAR for the golf course water supply and estimated reclaimed water supply has been calculated at 1.7 and 2.8, respectively (total buildout). Electrical conductivity of the golf course supply and reclaimed water is estimated at 1.2 decisiemens per meter (dS/m) and 1.1 dS/m, respectively. Based on these SAR and electrical conductivity values, there should be no degree of restriction for irrigation use based on sodium hazard for either golf course irrigation water or reclaimed water (Harivandi, 1994). Therefore, the good drainage capabilities of the soil at The Woodlands should not be significantly decreased by sodium.

Pesticides

Pesticides as discussed herein include fungicides, herbicides, and insecticides. The use of rodenticides, presumably for ground squirrels, is assumed to drop significantly with time.

The active ingredients in pesticides may constitute 1 to 70 percent of the pesticide formulation. The remaining 30 to 99 percent of the product usually consists of inert or inactive material plus additives to increase the pesticide performance. The most common pesticide carriers mixed into the formulation include corn cob grit (dry formulations) and clay (liquid formulations). In addition to the carrier, other ingredients such as emulsifiers may be added to pesticides that have a low solubility in water to facilitate spray applications (Gaussoin, 1995).

Fungicides are the most widely used pesticide in golf course maintenance. In a national survey of pesticide use by category, the applied quantities of active ingredient per acre (a.i./A) of golf course turf in one year showed fungicides used at an annual average of 3.21 pounds a.i./A, while herbicides and insecticides were used at an annual average of 1.79 and 1.50 pounds a.i./A, respectively (Cohen, 1995).

There are several export mechanisms that would remove the soluble components of pesticide formulations from the soil-plant-ground water system. The principal avenue of fate that accounts for the disappearance of a pesticide following its application is microbial degradation. As the supply of pesticides increases, so do the microbial populations with the capacity to utilize the pesticides as food. Many pesticides are degraded to carbon dioxide or other naturally occurring compounds that do not pose a long-term threat to turfgrasses or other organisms (Turgeon, 1991). Pesticides may also naturally degrade in soil.

The potential for ground water contamination by pesticides is reduced by adherence to best management practices and integrated pest management. It is assumed that the subject property would comply with state and federal guidelines for the use of controlled substances, such as pesticides, and would manage their use to minimize potential leaching. Some of the major chemical and physical properties that affect the leaching potential of a pesticide are presented in Table 13.

Table 13. Chemical and Physical Properties of Pesticides: Values That Indicate Potential for Ground Water and Surface Water Contamination

Pesticide Characteristic	Parameter Value or Range Indicating Potential for Contamination
Water Solubility	Greater than 30 ppm
K_d	Less than 5, usually less than 1
K_{OC}	Less than 300 to 500
Henry's Law Constant	Less than 10^{-2} atm per m^{-3} mol
Hydrolysis half-life	Greater than 175 days
Photolysis half-life	Greater than 7 days
Field dissipation half-life	Greater than 21 days

Reference: USGA (1995) as reported by Balogh and Walker (1992)

Several turfgrass pesticides are commercially available that are non-leachers and the potential for ground water basin pickup from these products is minimal. A comprehensive listing of pesticides and their leaching potential is available (USGA, 1995). The golf course superintendent at The Woodlands should develop an integrated pest management program and select pesticides for use after careful consideration of the leaching potential, with effort made to reduce or eliminate the use of pesticides with high leaching potential.

The amount of pesticides that would be used at The Woodlands is very small compared to fertilizers. Therefore, basin TDS pickup should not be affected by pesticide use.

Non-Golf Course Irrigated Areas. At total buildout (Phase III), about 295 acres of the property will envelope golf courses and lakes. Another 215 acres of the property is estimated to be covered by paving or buildings (Appendix C). Open space/non-fertilized areas account for another 234 acres. Therefore, about 213 acres of the 957-acre property is available for miscellaneous landscaping. The fertilization requirements of this landscaping should be much less than the manicured golf course turfgrasses. For the purpose of estimating a basin pickup, it is assumed that the approximately 213 acres in miscellaneous landscaping (including homeowner gardening) will need about 2 pounds N per 1,000 sf. An estimated 9.3 tons of N, and 2.3 tons each of P and K would be used annually for miscellaneous landscaping maintenance.

Basin Pickup. The estimated amount of long-term basin pickup is summarized in Table 14. For perspective, the quality of percolating water (recharge water) was estimated based on the mineral pickup. The total amount of percolating water is estimated at 507 afy; 139 afy return flow and 368 afy percolation of precipitation. Support calculations are included in Appendix C.

The estimated average quality of recharge water percolating to ground water at the site following total buildout would generally be of similar or better quality compared to the existing water quality beneath the site (Table 7 and Table 14). The estimated average concentrations of water quality constituents in the final recharge water do not exceed drinking water standards.

Estimated average constituent concentrations in the final recharge water during Phase I are about 40 percent lower than estimated for Phase III. By comparison, Phase II estimated average constituent concentrations are only about 10 percent lower than in Phase III; most of the impacts to ground water quality occurs during the first phase of development. The water quality impacts ratio for the three phases (I:II:III) in comparison to the total project impact is approximately 0.6:0.9:1.

Table 14. Estimated Ground Water Basin Mineral Pickup

Analyte	Imports (tons/yr)			Exports (tons/yr)	Basin Pickup (tons/yr)	Percolating Water Quality		
	Reclaimed Water	Fertilizer	Total			Initial (mg/l)	Pickup (mg/l)	Final (mg/l)
N	8.5	15.3	23.8	22.4	1.5	0.98	2.13	3.11
P	1.2	6.5	7.7	7.7	0.0	0.00	0.00	0.00
K	4.7	0.0	4.7	0.0	4.7	0.82	6.82	7.64
Ca	7.1	8.3	15.4	0.0	15.40	23.96	22.36	46.32
Mg	3.3	0.0	3.3	0.0	3.30	7.63	4.79	12.42
S	4.7	0.0	4.7	0.0	4.70	16.62	6.82	23.44
B	0.1	0.0	0.1	0.0	0.10	0.05	0.15	0.20
Cl	35.3	0.0	35.3	0.0	35.30	20.02	51.24	71.26
Na	32.9	0.0	32.9	0.0	32.90	15.06	47.76	62.82
TDS	150.6	96.1	246.7	122.6	124.10	161.58	180.15	341.73

NOTES: Initial percolating water refers to the estimated quality of the recharge water from percolation of precipitation combined with the return flow water from irrigation (without the reclaimed water mineral pickup).

Interference Analyses

The potential interference (water level drawdown) that on-site pumpage would cause at off-site well locations has been estimated using the ground water flow model. The estimated pumping for the proposed development would lower water levels in six neighboring wells by two to 4½ feet at the time when water levels were at their lowest during the period simulated (see Table 15), during stress period 66 corresponding to the Fall of 2025.

The top of the perforated intervals in neighboring wells (for which logs are available) are as shallow as about 15 feet below mean sea level, although most wells in the site vicinity are perforated beginning at about 50 feet below mean sea level or deeper. Production in neighboring wells should not be significantly impacted from project-related pumpage at The Woodlands, based on the modeled water level elevations and the available data on perforated intervals.

Table 15. Water level elevations in nearby wells and interference effects of Woodlands Project pumping

Scenario Well Number	Baseline (ft)	Woodlands (ft)	Difference (ft)
11N/35W-10La	10.83	7.40	-3.43
11N/35W-14Nb	23.21	18.62	-4.59
11N/35W-15G	17.62	13.78	-3.84
11N/35W-16Kx	13.2	10.32	-2.88
11N/35W-21Ja	18.12	17.12	-1.00
11N/35W-22Ga	21.84	18.99	-2.85

Note: levels shown are at time of lowest levels and storage in 48 year simulation, stress period 66.

Potential Impacts to Ground Water in Storage

Potential impacts from the proposed project on ground water in storage were evaluated using the ground water flow model. After the model was calibrated to match historic water levels during the 16 year period from 1976 -1992 as closely as possible, two scenarios were developed to simulate the effects of ground water demand over the 48 years following the calibration period, with and without the proposed Woodlands development. The scenarios were designed to start with the conditions predicted by the model at the end of the calibration period, and run from November 1, 1992 to October 31, 2048. The only differences in the input data sets between the two scenarios are the pumpage and irrigation returns related to the Woodlands project (see Table 16).

Table 16. Comparison of Estimated Production for Simulation Scenarios

	Estimated production (afy)					
Scenario	Calibration		Baseline	Woodlands		
Year	1977	1992	1992	1992	2000	2008
Category				Phase 1	Phase 2	Phase 3
Irrigation	13715	14160	14160	14160	14160	14160
Municipal	1655	3160	3160	3160	3160	3160
Industrial	1320	1370	1370	1370	1370	1370
Project				525	1077	1228
Total	16690	18690	18690	19215	19767	19918

Baseline Scenario. The Baseline scenario was developed for comparison purposes in order to assess the impacts of the proposed Woodlands golf course and residential development. The Baseline scenario uses recharge from rainfall and General Head Boundary (**GHB**) conditions in three repeating cycles of the 16 years of historical record, and uses the final water levels predicted by the model for the calibration runs for its initial heads. The GHB conditions from the historic period are based on water levels in cells near streams receiving recharge related to releases from Lopez Dam for the northerly GHB nodes and from Twitchell Reservoir for those in the Santa Maria Valley area. It is expected that reservoir releases would be managed in a similar manner under similar climatic conditions in the future, resulting in similar water levels in areas near the streams. Ground water production for the baseline scenario is the estimated pumpage in 1992 applied over the entire simulation. All other inputs for this scenario used the same data as in the Calibration runs, but in the three repeating cycles.

The model indicates that during the first 16 year cycle, water in storage beneath the Nipomo Mesa follows a pattern similar to that under the historic conditions simulated during calibration (see Figures 21 and 22), but would be reduced by about 3100 acre-feet, slightly over half the reduction during historic conditions (Table 17). After the first 16 year cycle, ground water in storage is relatively stable (see Figure 22); lowered water levels in the westerly portion of the Mesa enhance recharge from the Santa Maria River. Variations in storage seen in the simulations within each cycle are due to changes in recharge corresponding to river releases and rainfall rather than a simple decline.

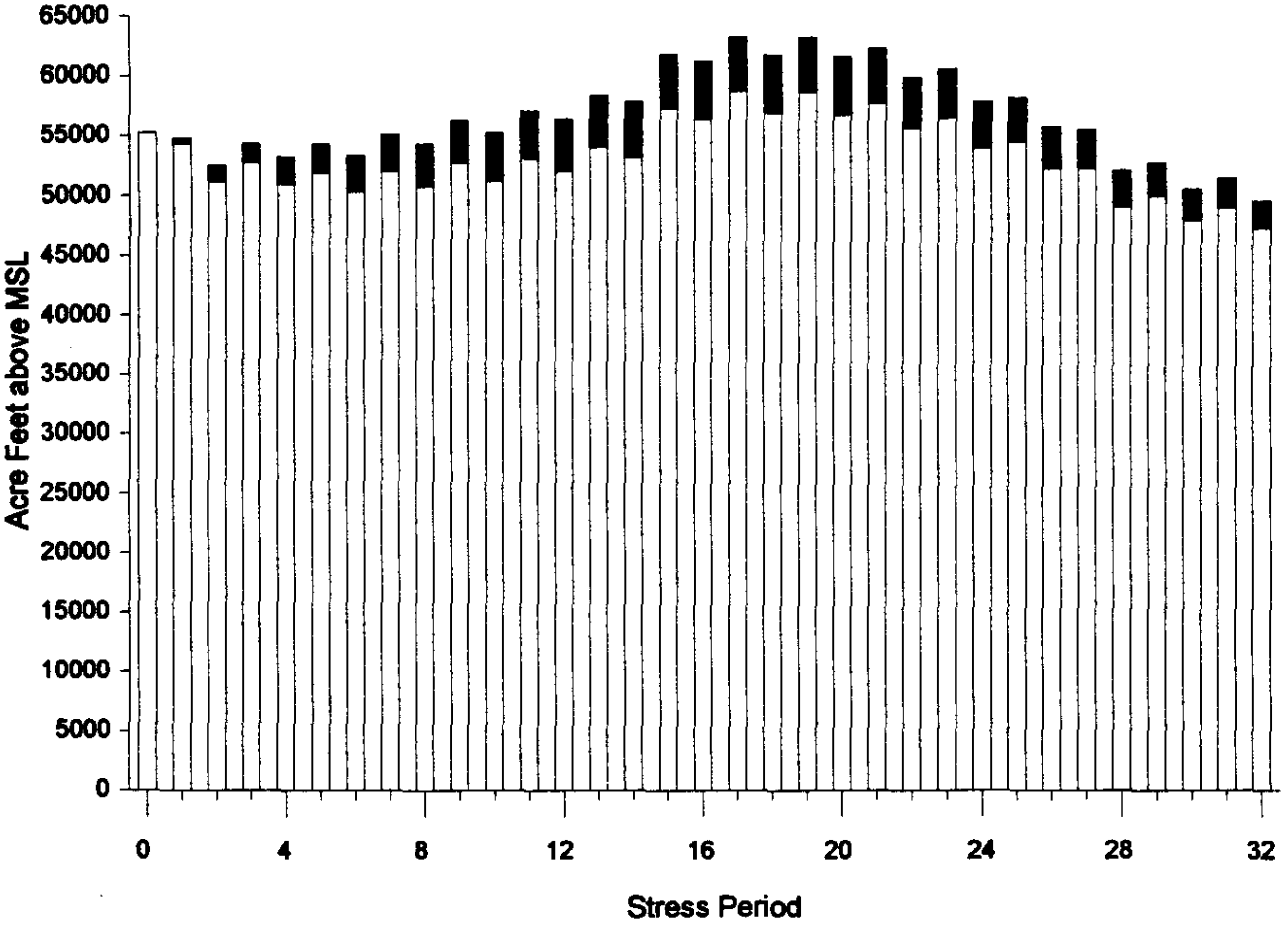

Figure 21

Estimated Storage from Model

Baseline vs Calibration Conditions

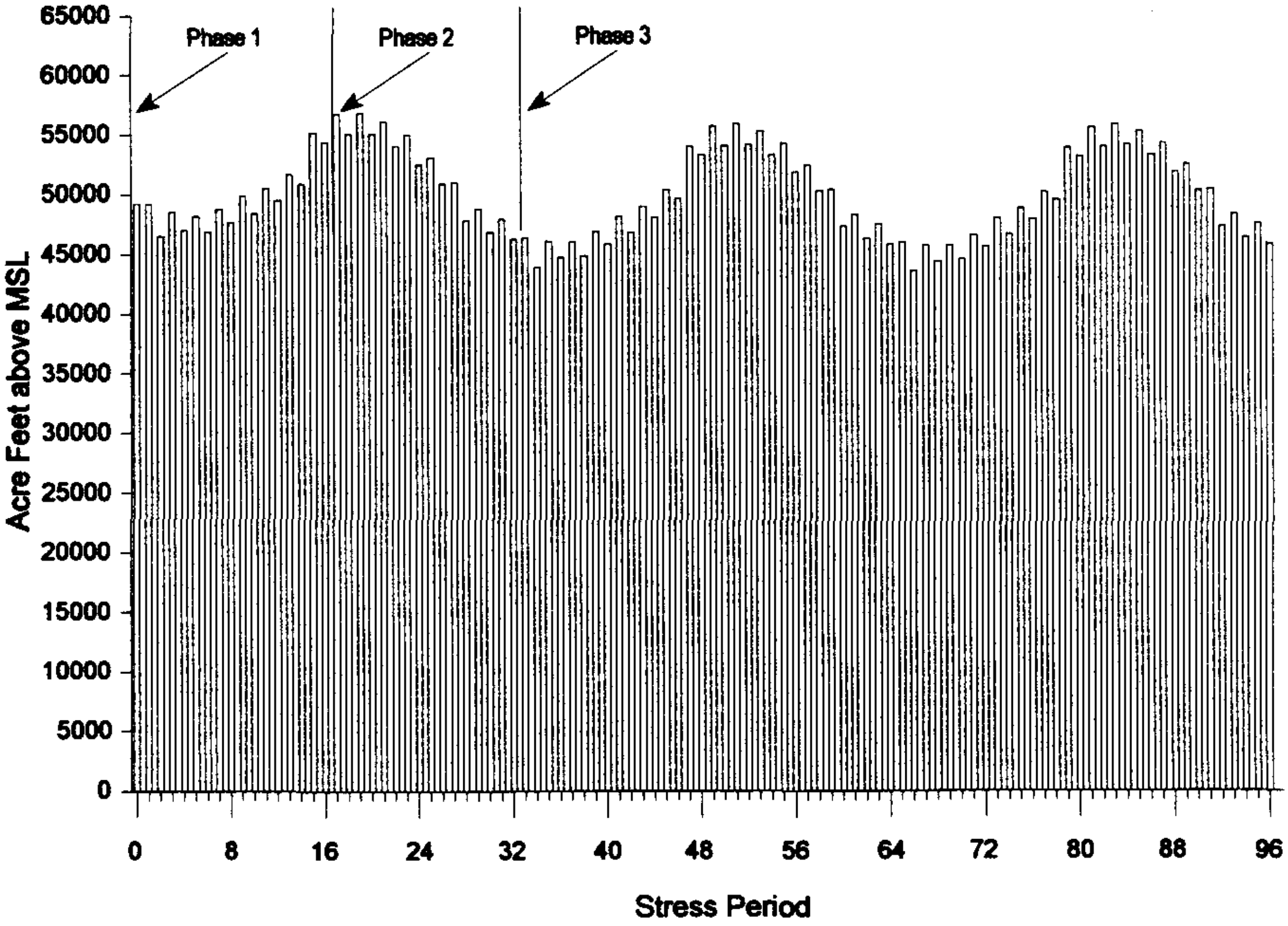

Figure 22

Estimated Storage from Model

Baseline Conditions

Table 17. Changes in storage in each of the 16 year cycles of the simulations

Scenario		Baseline (af)		Woodlands (af)		Difference Woodlands vs. Baseline (af)	
Cycle	Year	Storage	Change	Storage	Change	Storage	Change
Start	1976	55200					
Calibration	1992	49205	-5995	49205		0	
1st Cycle	2008	46122	-3083	44809	-4396	-1313	-1313
2nd Cycle	2024	45626	-496	43848	-961	-1786	-465
3rd Cycle	2040	45568	-58	43724	-124	-1852	-66

Woodlands Scenario. This scenario simulates the effects of ground water production for the Woodlands project as proposed over the 48 year period modeled in the Baseline scenario. At total buildout (Phase III) it includes two golf courses with 36 holes, 1186 residential dwelling units, a resort complex with 20 casitas and 170 hotel rooms, 150 multi-family residences, and a village center, to be built in three phases during the first 24 years of the project. The estimated net ground water production demand for the project at full buildout is 1228 afy. Input data for this scenario was developed by taking the production for the Baseline scenario, and adding the estimated pumpage for each phase of the project. The project pumpage for each phase was allocated to the locations for the four project wells according to the development plan detailed earlier. Recharge resulting from return flow from irrigation of the golf courses was simulated by adding a factor of approximately 10% of the applied water to the general recharge over each of the golf course sites as they would be phased in. All other inputs were the same as in the Baseline scenario.

Based on the simulation results, the ground water production for the Woodlands Project as proposed would result in a decrease in storage for the Nipomo Mesa Storage Unit of about 1,313 acre-feet at the end of the first 16 year cycle of the simulation when compared to the Baseline conditions, for an average annual decrease of 82 afy (see Figures 23 and 24). After the first 16 years, the reduction in storage stabilizes at about 1,800 acre-feet below that of the Baseline conditions. Regional water levels would drop an average of about 2½ feet in wells to the northeast of The Woodlands (see Table 18 and Figure 25). Levels in wells to the south and west, however, were impacted to a much lesser degree, with average declines of less than one foot.

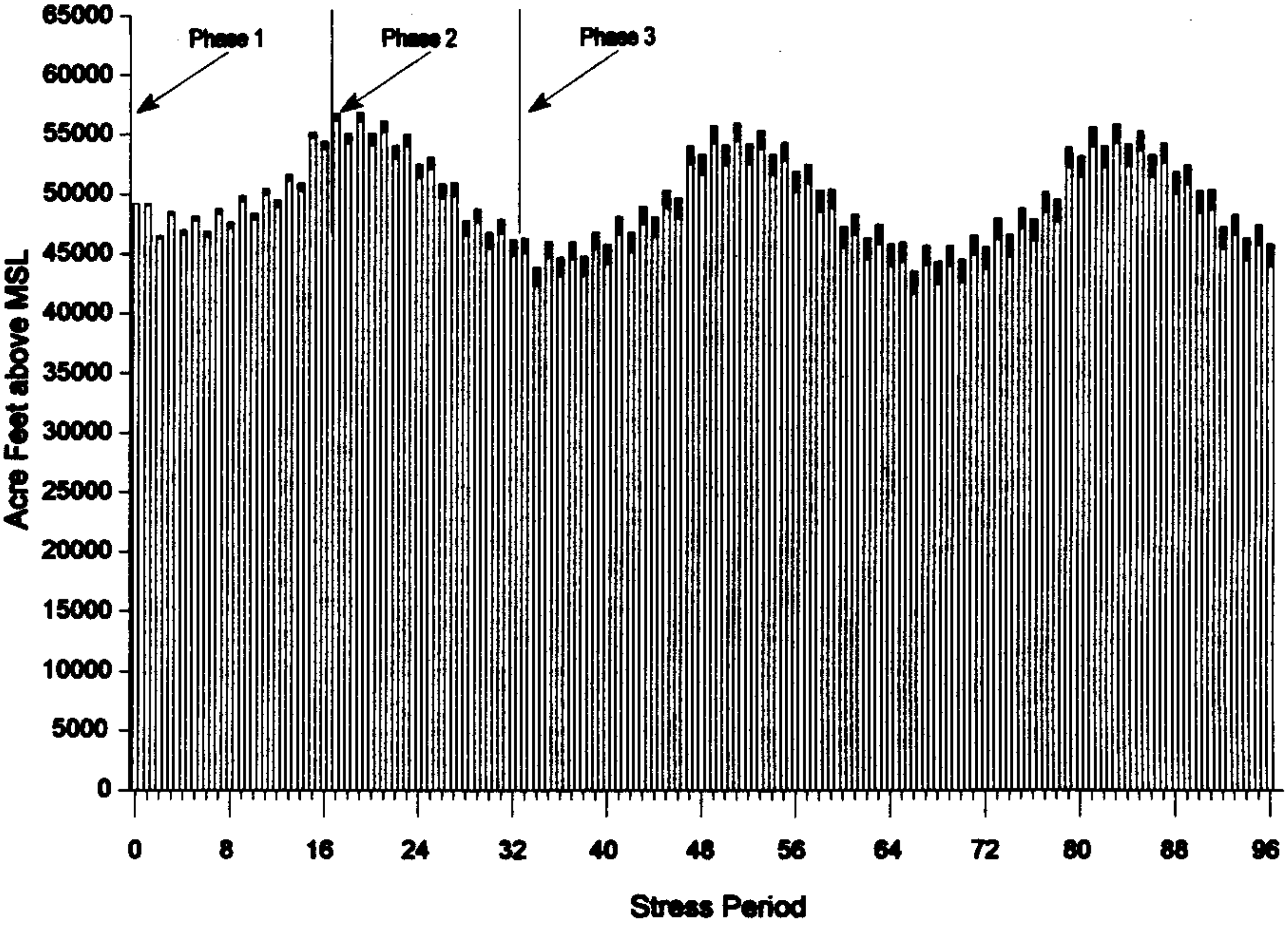

Figure 23

Estimated Storage from Model

Woodlands Scenario

□ Woodlands

■ Differences from Baseline

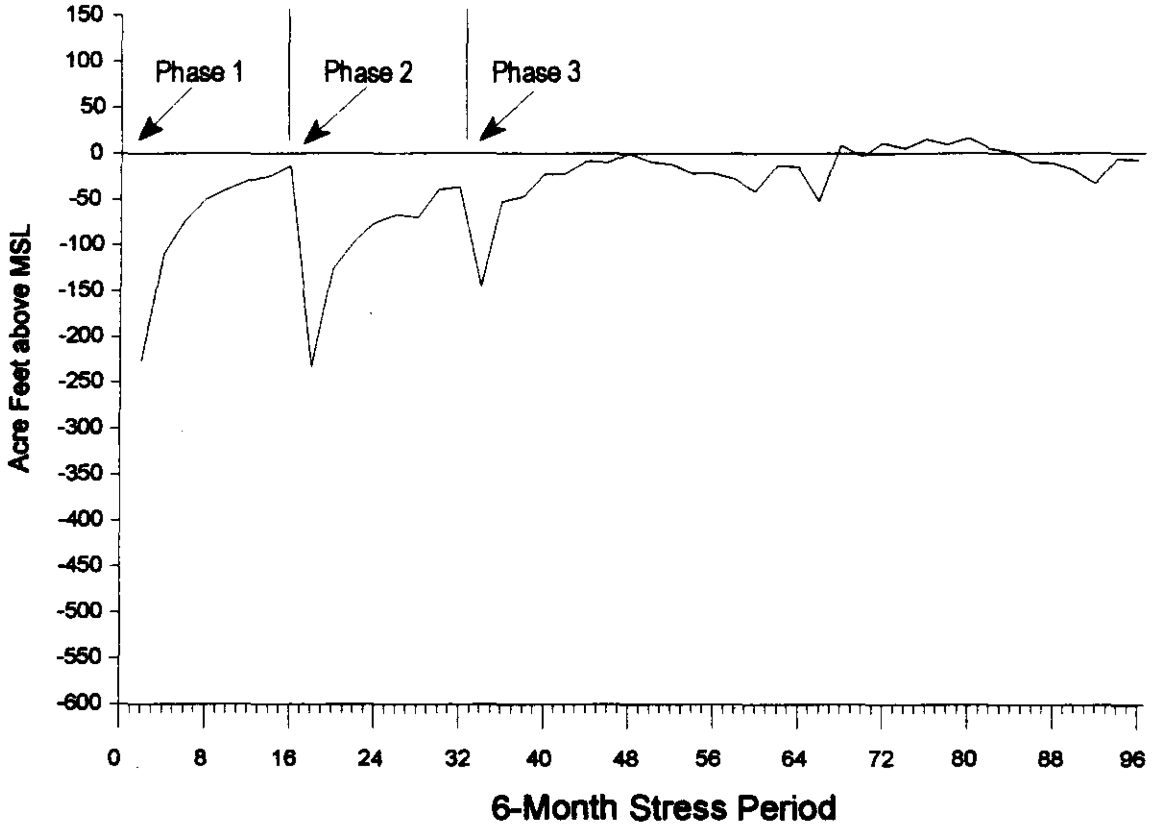

Figure 24

Annual Changes in Storage Differences between Woodlands and Baseline

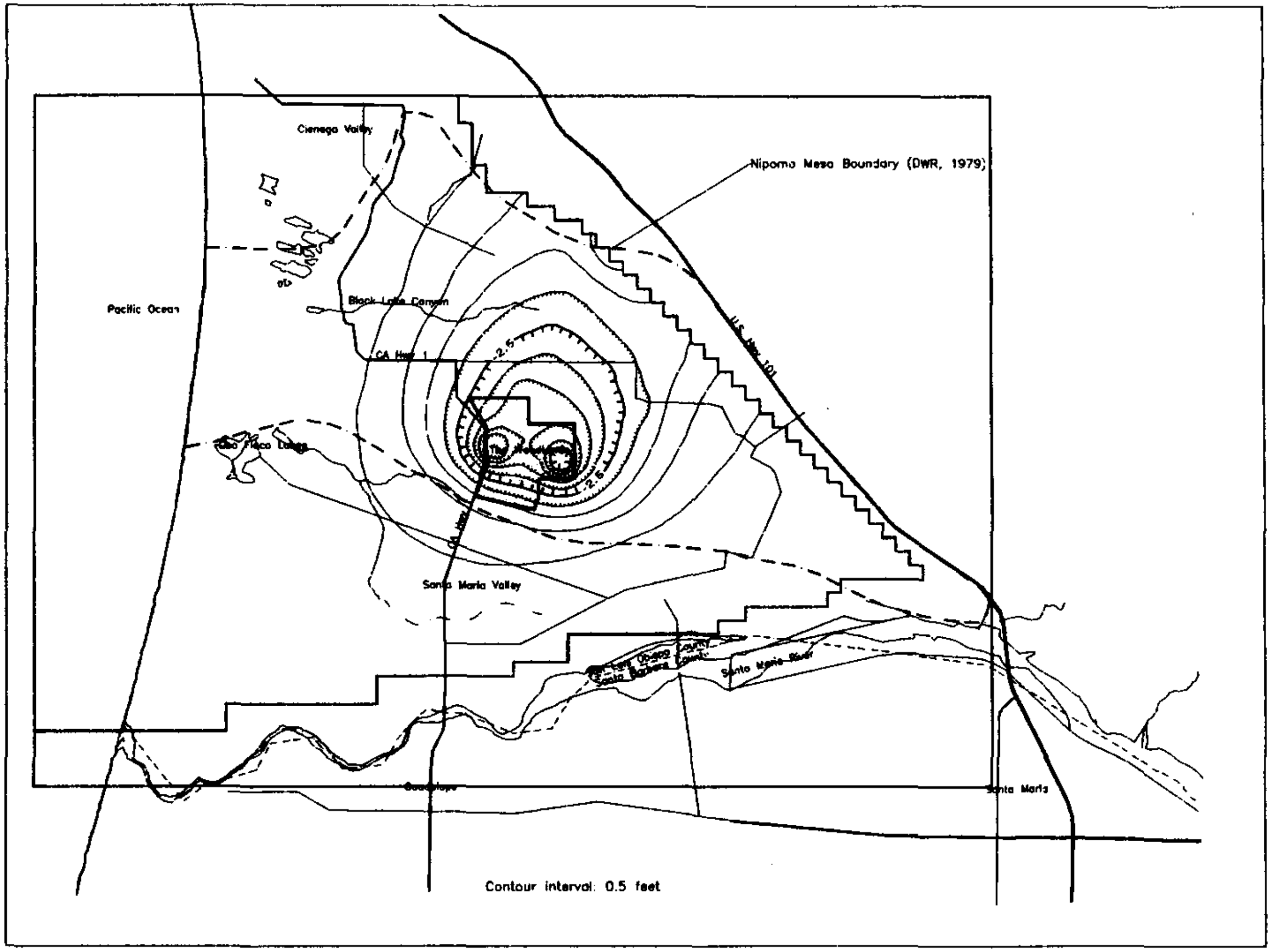

Figure 25
Differences in Water Levels
Woodlands vs Baseline
Stress Period 66

US Industries

Woodlands Project
Nipomo Mesa

March 28, 1996
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Table 18. Comparison of simulated water level elevations in Calibration wells between Baseline and Woodlands scenarios

Well Number	Fall 2002 Stress Period 20			Fall 2025 Stress Period 66		
	Baseline	Woodlands	Difference	Baseline	Woodlands	Difference
11N/35W-02N01	17.86	17.01	-0.85	15.00	12.71	-2.29
11N/35W-05L01	9.25	8.99	-0.26	3.98	3.61	-0.37
11N/35W-10G01	6.72	5.14	-1.58	0.12	-2.77	-2.89
11N/35W-13C01	37.06	36.44	-0.62	35.28	33.75	-1.53
11N/35W-16B01	23.00	20.93	-2.07	10.84	8.33	-2.51
11N/35W-19C02	24.87	24.62	-0.25	13.82	13.53	-0.29
11N/35W-21K01	36.99	36.17	-0.82	16.84	15.94	-0.90
11N/35W-26M02	51.99	51.71	-0.28	23.53	23.25	-0.28
11N/35W-33G01	42.81	42.73	-0.08	16.45	16.36	-0.09
11N/36W-12C01	8.92	8.80	-0.12	4.74	4.58	-0.16

Ground Water Levels and Storage Estimated Impacts. Based on the results of the ground water model study, development at the Woodlands property will result in some impacts to nearby wells. When compared to the present day Baseline conditions, with little or no ground water production at the site, the Woodlands production scenario predicts drops in water levels of 1 to about 4½ feet in wells near the site, and drops of up to three feet in wells farther away to the northeast (see Figure 30).

Ground water in storage in the 18,000-acre Nipomo Mesa area is predicted to drop by an average of 275 afy with the project and 193 afy without the project (82 afy net difference) during the first 16 year cycle of the time span simulated. During this first cycle, ground water in storage declines by 4396 acre feet with the project, and 3083 acre feet without it. Note that declines in storage between Fall 1976 and Fall 1992 averaged an estimated 375 afy, more than future estimated declines with or without the project. This reduction in storage declines over time, despite increased pumpage on the Nipomo Mesa, is a result of the interactions between subsurface inflow and outflow; lower overall storage increases ground water inflow and decreases ground water outflow beneath the Mesa, thereby reducing the impacts of pumpage on changes in storage.

After 16 years, a new equilibrium ground water level would be established; continued water level declines would be offset by increased recharge from the Santa Maria Valley. At the end of the second 16 year cycle, ground water in storage would have declined an average (over the 32-year period) of 167 afy with the project and 112 afy without the project (55 afy net difference). At the conclusion of the third 16 year cycle, the average decline in storage is estimated at 114 afy with the project and 76 afy without the project (38 afy net difference).

When comparing average storage declines within the three 16-year cycles, the stabilization in storage is more evident. As noted above, future ground water in storage beneath the Nipomo Mesa, based on 1992 pumpage with the addition of project pumpage, is estimated to decline about 275 afy per year during the first 16 years (Phase I and II), of which 82 afy decline in storage is attributable to the project. Declines in storage within subsequent 16 year cycles are estimated to be 60 afy during the second cycle, of which 29 afy is attributable to project pumpage, and 8 afy decline in storage during the third 16 year cycle, of which 4 afy is attributable to the project.

Analysis of the relative impacts to ground water in storage from the three project development phases is based on comparing the difference between storage under baseline conditions with storage under project conditions at the end of the first two phases and at the end of the 48-year model run. The differences in storage are 566 af less storage under project conditions at the end of Phase I; 1313 afy less storage under project conditions at the end of Phase II; and 1844 af less storage under project conditions at the end of the 48-year period (24 years after the completion of Phase III). The modeled decline of ground water in storage during Phase I is about 70 percent below the long-term Phase III declines. Phase II storage declines are about 30 percent below long-term declines. The ground water storage impacts ratio for the three phases (I:II:III extended) as compared to the total project is approximately 0.3:0.7:1.

CONCLUSIONS

o Project water demand at total buildout (Phase III) is estimated at 1,574 afy gross, of which 346 afy is supplied by reclaimed water generated on-site and the remaining 1228 afy is supplied by ground water wells. Water demand for the golf courses (and lakes) is 787 afy; 346 afy reclaimed water and 441 afy ground water. The balance of ground water production, 787 afy, satisfies domestic water demand, which includes all uses other than golf course irrigation. Consumptive use for the domestic water supply is 369 afy, return flow from domestic supply irrigation is 71 afy, and as mentioned above 346 afy is reclaimed for golf course irrigation. Golf course irrigation consumptive use is 719 afy, leaving 68 afy as return flow.

o Project water demand for Phase I is about 60 percent lower than Phase III water demand. Phase II water demand is about 15 percent lower than Phase III demand. The water demand ratio for the three Phases (I:II:III) as compared to the total project is approximately 0.4:0.85:1.

- Potential impacts to ground water quality from the proposed project is discussed in terms of the salt loading to the ground water basin resulting from domestic water use and the importation of plant fertilizers. The estimated average quality of recharge water percolating to ground water at the site following development would generally be of similar or better quality compared to the existing water quality beneath the site. The estimated average concentrations of water quality constituents in the final recharge water do not exceed drinking water standards.

- Estimated average constituent concentrations in the recharge water percolating to ground water during Phase I are about 40 percent lower than estimates for Phase III. By comparison, Phase II estimated average constituent concentrations are only about 10 percent lower than in Phase III. The water quality impacts ratio for the three phases (I:II:III) as compared to the total project is approximately 0.6:0.9:1.

- Interference effects from project-related pumpage on neighboring wells is estimated at a maximum of 4.6 feet of drawdown during years when water levels are lowest. Production in neighboring wells should not be significantly impacted from project-related pumpage at The Woodlands, based on the modeled water level elevations and the available data on perforated intervals.

- Future ground water in storage beneath the Nipomo Mesa, based on 1992 pumpage with the addition of project pumpage, is estimated to decline about 275 afy per year during the first 16 years (Phases I and II), of which 82 afy decline in storage is attributable to the project. Declines in storage within subsequent 16 year cycles are estimated to be 60 afy during the second cycle, of which 29 afy is attributable to project pumpage, and 8 afy decline in storage during the third 16 year cycle, of which 4 afy is attributable to the project.

- The modeled decline of ground water in storage during Phase I is about 70 percent lower than the long-term Phase III decline (after 48 years). Phase II storage decline is about 30 percent lower than the long-term decline. The ground water storage impacts ratio for the three phases (I:II:III extended) as compared to the total project is approximately 0.3:0.7:1.

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APPENDIX A:

GROUND WATER STORAGE CALCULATIONS

The Woodlands

Rainfall Analysis

	Oceano (194)		Nipomo (038)		Santa Maria (380)		Guadalupe (352)	
Year	Rainfall (inches)	Departure	Rainfall (inches)	Departure	Rainfall (inches)	Departure	(inches)	Departure
(ave.)	16.25		16.08		13.41		12.3	
1977	11.43	-4.82	14.59	-1.49	11.94	-1.47	13.16	0.86
1978	28.31	12.06	31.42	15.34	22.95	9.54	24.77	12.47
1979	15.64	-0.61	18.24	2.16	13.88	0.47	15.04	2.74
1980	17.7	1.45	18.78	2.7	13.97	0.56	16.06	3.76
1981	15.25	-1	15.69	-0.39	12.81	-0.6	12.8	0.5
1982	17.52	1.27	20.07	3.99	14.28	0.87	13.97	1.67
1983	36.87	20.62	37.79	21.71	24.04	10.63	22.92	10.62
1984	9.96	-6.29	12.52	-3.56	7.93	-5.48	8.59	-3.71
1985	9.43	-6.82	12.86	-3.22	8.69	-4.72	7.81	-4.49
1986	13.92	-2.33	18.93	2.85	13.43	0.02	15.48	3.18
1987	11.44	-4.81	14.17	-1.91	8.87	-4.54	10.19	-2.11
1988	12.55	-3.7	14.73	-1.35	11.91	-1.5	12	-0.3
1989	11.04	-5.21	11.86	-4.22	6.18	-7.23	7.46	-4.84
1990	10.48	-5.77	8.03	-8.05	5.94	-7.47	8.42	-3.88
1991	14.09	-2.16	17.16	1.08	12.72	-0.69	13.73	1.43
1992	17.74	1.49	17.23	1.15	14.16	0.75	13.63	1.33
Cumulative departure Fall 1976 to Fall 1992:		-6.63		26.79		-10.86		19.23

The Woodlands

Model Hydrologic Balance Adjustments

Year	Nipomo (038) Rainfall (inches)	Effective Model Rainfall (inches)	Model Cumulative Departure (inches)
(ave.)	16.08	15	
1977	14.59	12.26	-2.74
1978	31.42	26.39	11.39
1979	18.24	15.32	0.32
1980	18.78	15.78	0.78
1981	15.69	13.18	-1.82
1982	20.07	16.86	1.86
1983	37.79	31.74	16.74
1984	12.52	10.52	-4.48
1985	12.86	10.8	-4.2
1986	18.93	15.9	0.9
1987	14.17	11.9	-3.1
1988	14.73	12.37	-2.63
1989	11.86	9.96	-5.04
1990	8.03	6.75	-8.25
1991	17.16	14.41	-0.59
1992	17.23	14.47	-0.53

Cumulative Departure (1977-1992) -1.39

Based on Average Rainfall on Mesa of 15 inches
Reference: Average annual precipitation map 1936-1967
Figure 2, SLO County Historical Precip. Data, April 1978

Effective model precipitation is 84% of Nipomo (038)

The Woodlands

ZoneBudget Report
Model Calibration
1977-1992

Stress		Period	Mesa Storage (af)			acre-feet
Period	Season	Ends	Out	In	Change	Storage
0		1976.9				55200
1	wet	1977.4	1562	1095	-467	54733
2	dry	1977.9	2558	294	-2264	52469
3	wet	1978.4	252	2080	1828	54297
4	dry	1978.9	1283	179	-1104	53193
5	wet	1979.4	174	1195	1021	54214
6	dry	1979.9	1192	274	-918	53296
7	wet	1980.4	110	1835	1725	55021
8	dry	1980.9	1067	295	-772	54249
9	wet	1981.4	73	2046	1973	56222
10	dry	1981.9	1242	152	-1090	55132
11	wet	1982.4	45	1885	1840	56972
12	dry	1982.9	816	127	-689	56283
13	wet	1983.4	20	1897	1877	58160
14	dry	1983.9	729	181	-548	57612
15	wet	1984.4	11	3976	3965	61577
16	dry	1984.9	1156	573	-583	60994
17	wet	1985.4	26	2081	2055	63049
18	dry	1985.9	1745	192	-1553	61496
19	wet	1986.4	27	1523	1496	62992
20	dry	1986.9	1729	77	-1652	61340
21	wet	1987.4	171	806	635	61975
22	dry	1987.9	2373	30	-2343	59632
23	wet	1988.4	276	881	605	60237
24	dry	1988.9	2721	11	-2710	57527
25	wet	1989.4	433	725	292	57819
26	dry	1989.9	2418	20	-2398	55421
27	wet	1990.4	679	439	-240	55181
28	dry	1990.9	3428	0	-3428	51753
29	wet	1991.4	493	1203	710	52463
30	dry	1991.9	2264	0	-2264	50199
31	wet	1992.4	292	1172	880	51079
32	dry	1992.9	1878	4	-1874	49205
					average	56431

The Woodlands

ZoneBudget Report
Model Calibration
1977-1992

Stress Period	Season	Period Ends	Subsurface flow (af) Nipomo Mesa to SMV			Subsurface flow (af) SMV to Nipomo Mesa			Flow Difference acre-feet
			Flow	HDB	Total	Flow	HDB	Total	
1	wet	1977.4	206180	45708.0	1056	720790	46.6	3022	1966
2	dry	1977.9	229120	3656.2	976	467430	28836.0	2081	1105
3	wet	1978.4	165590	1480.8	700	931410	44495.0	4091	3391
4	dry	1978.9	146100	16324.0	681	656830	644.5	2756	2075
5	wet	1979.4	157470	14338.0	720	782710	10850.0	3327	2607
6	dry	1979.9	153850	0.0	645	726690	24250.0	3148	2503
7	wet	1980.4	157000	6700.7	686	1051400	19068.0	4488	3802
8	dry	1980.9	161510	827.9	681	900690	15834.0	3843	3162
9	wet	1981.4	170310	2137.6	723	1148100	40423.0	4983	4260
10	dry	1981.9	176650	12994.0	795	872870	5820.0	3684	2889
11	wet	1982.4	178610	6329.7	775	1198400	8170.8	5059	4284
12	dry	1982.9	182050	14815.0	825	1015800	1958.5	4267	3442
13	wet	1983.4	180070	5523.3	778	1182300	13359.0	5013	4235
14	dry	1983.9	178740	10517.0	793	1131400	4134.3	4761	3968
15	wet	1984.4	258240	6125.5	1108	1813500	123440.0	8121	7013
16	dry	1984.9	253130	52974.0	1283	1284000	8523.4	5419	4136
17	wet	1985.4	264850	7311.0	1141	1545400	31732.0	6612	5471
18	dry	1985.9	272320	66873.0	1422	1166500	0.0	4891	3469
19	wet	1986.4	242720	4753.1	1038	1377500	13940.0	5834	4796
20	dry	1986.9	298390	36982.0	1406	1135000	0.0	4758	3352
21	wet	1987.4	272170	16310.0	1209	1189900	3860.2	5005	3796
22	dry	1987.9	273770	73911.0	1458	1073500	0.0	4501	3043
23	wet	1988.4	240350	40976.0	1179	1207000	0.0	5060	3881
24	dry	1988.9	260360	67876.0	1376	968660	0.0	4061	2685
25	wet	1989.4	224380	46512.0	1136	1058300	0.0	4437	3301
26	dry	1989.9	245750	34734.0	1176	854620	1571.9	3590	2414
27	wet	1990.4	260270	33674.0	1232	913660	271.3	3832	2600
28	dry	1990.9	252730	41903.0	1235	621730	0.0	2607	1372
29	wet	1991.4	187570	28045.0	904	982970	0.0	4121	3217
30	dry	1991.9	181060	25773.0	867	830080	0.0	3480	2613
31	wet	1992.4	157850	3135.5	675	913250	2893.3	3841	3166
32	dry	1992.9	165880	10431.0	739	831290	0.0	3485	2746
							Average		3336.25

APPENDIX B

WATER DEMAND CALCULATIONS

The Woodlands
Water Duty Factors

			Water Duty Factors			
Land Use	#Units	acres	unit	#units	afy/unit	Source
RESIDENTIAL						
1-acre lots	49	49.0	lot	49.0	1.50	AG City (1994)
10-20,000 sf lots	169	77.6	lot	169.0	0.79	AG City (1994)
7-9,000 sf lots	381	78.7	lot	381.0	0.50	AG City (1994)
5-7,000 sf lots	563	90.5	lot	563.0	0.37	SLO City (1987)
5,000 sf lots	24	2.8	lot	24.0	0.37	SLO City (1987)
subtotal	1186					
GOLF						
18 Holes		131.0	acre	131.0	2.50	BLGC (1994)
18 Holes		127.0	acre	127.0	2.50	BLGC (1994)
Practice area		15.0	acre	15.0	2.50	BLGC (1994)
Ponds		22.3	acre	22.3	4.70	C&A (1995)
Clubhouse	2	1.6	facility	2.0	6.40	C&A (1995)
Maintenance Areas		4.0	facility	2.0	3.40	C&A (1995)
HOTEL/RESORT		17.5				
rooms	170		room	170.0	0.15	SB City (1989)
casitas	20		unit	20.0	0.30	SLO City (1987)
mixed use (w/conference center)			acre	1.5	2.10	C&A (1995)
VILLAGE CORE (indoor use)						
Commercial/mixed uses		3.0	acre	3.0	2.10	SLO City (1987)
Multi-Family		5.0	room	150.0	0.17	SB City (1989)
RV STORAGE		2.0	none (no water use)			
SCHOOL		10.0	student	350.0	0.03	C&A (1995)
PARKS						
Active Use		10.0	acre	10.0	2.10	C&A (1995)
Passive with 9 acre Habitat Preserve		14.0	acre	21.0	1.00	SB City (1989)
Neigborhood		14.6	acre	11.0	1.70	SLO City (1987)
SEWAGE TREATMENT		2.0	facility	1.0	0.50	C&A (1995)
ROADS		40.0	none (no water use)			
MISCELLANEOUS LANDSCAPE ZONES						
Natural/Open Space		223.0	none (no water use)			
Accented planting (incl. Village)		16.4	acre	19.0	1.50	SB City (1989)
TOTAL ACRES		957.0				

References:

AG City (1994): City of Arroyo Grande, Draft Water Demand Neutralization Ordinance (Exhibit A)
BLGC (1994): Verbal communication with Black Lake Golf Course superintendent
C&A (1995): Cleath & Associates research and/or in-house estimate
SB City (1989): City of Santa Barbara Water Demand Factor and Conservation Study
SLO (1987): City of San Luis Obispo Water Use Factors

The Woodlands - PHASE I (years 1-8)

Golf Course and Domestic Water Demand Components

golf = golf course irrigation and ponds only dom = all non-golf water demand

Month	gross golf demand	gross dom outdoor	gross dom indoor	gross dom total	gross demand total	reclaim water supply	net golf demand	reclaim water storage	net dom demand	net project demand	golf supply gpm	dom supply gpm	tot supply gpm
	acre-feet												
Jan	7.54	2.90	12.07	14.97	22.51	9.66	0.00	2.12	14.97	14.97	0.00	109.30	109.30
Feb	9.84	3.55	12.07	15.62	25.46	9.66	0.00	-0.18	15.62	15.62	0.00	126.20	126.20
Mar	22.06	7.14	12.59	19.73	41.79	10.07	6.49	-5.50	19.73	26.22	47.40	144.00	191.40
Apr	35.18	10.75	13.13	23.88	59.06	10.50	24.68		23.88	48.56	186.10	180.10	366.20
May	49.21	14.67	13.64	28.31	77.52	10.91	38.30		28.31	66.61	279.60	206.60	486.20
Jun	51.26	15.25	14.17	29.42	80.68	11.34	39.92		29.42	69.34	301.10	221.90	523.00
Jul	50.60	15.01	14.17	29.18	79.78	11.34	39.26		29.18	68.44	286.60	213.00	499.60
Aug	50.49	15.00	14.17	29.17	79.66	11.34	39.15		29.17	68.32	285.80	212.90	498.70
Sep	44.16	13.14	13.64	26.78	70.94	10.91	33.25		26.78	60.03	250.80	202.00	452.80
Oct	33.05	9.92	13.13	23.05	56.10	10.50	22.55		23.05	45.60	164.60	168.20	332.80
Nov	18.16	5.78	12.59	18.37	36.53	10.07	8.09		18.37	26.46	61.00	138.60	199.60
Dec	6.10	2.40	12.07	14.47	20.57	9.66	0.00	3.56	14.47	14.47	0.00	105.60	105.60
totals	377.66	115.51	157.42	272.93	650.59	125.95	251.69	0.00	272.93	524.62			
averages											155.00	169.00	324.00

The Woodlands - PHASE II (years 9-16)
Golf Course and Domestic Water Demand Components

golf = golf course irrigation and ponds only

dom = all non-golf water demand

Month	gross golf demand	gross dom outdoor	gross dom indoor	gross dom total	gross demand total	reclaim water supply	net golf demand	reclaim water storage	net dom demand	net project demand	golf supply gpm	dom supply gpm	tot supply gpm
							acre-feet						
Jan	15.02	6.47	25.43	31.90	46.92	20.34	0.00	5.32	31.90	31.90	0.00	232.80	232.80
Feb	19.59	7.98	25.43	33.41	53.00	20.34	0.00	0.75	33.41	33.41	0.00	270.00	270.00
Mar	43.94	15.99	26.50	42.49	86.43	21.20	8.49	-14.25	42.49	50.98	62.00	310.10	372.10
Apr	70.09	24.06	27.60	51.66	121.75	22.08	48.01		51.66	99.67	362.10	389.60	751.70
May	98.02	32.86	28.66	61.52	159.54	22.93	75.09		61.52	136.61	548.10	449.00	997.10
Jun	102.14	34.18	29.15	63.33	165.47	23.32	78.82		63.33	142.15	594.50	477.70	1072.20
Jul	100.81	33.66	29.15	62.81	163.62	23.32	77.49		62.81	140.30	565.60	458.50	1024.10
Aug	100.59	33.59	29.15	62.74	163.33	23.32	77.27		62.74	140.01	564.00	457.90	1021.90
Sep	87.99	29.46	28.66	58.12	146.11	22.93	65.06		58.12	123.18	490.70	438.40	929.10
Oct	65.83	22.25	27.60	49.85	115.68	22.08	43.75		49.85	93.60	319.30	363.90	683.20
Nov	36.18	12.94	26.50	39.44	75.62	21.20	14.98		39.44	54.42	113.00	297.50	410.50
Dec	12.16	5.39	25.43	30.82	42.98	20.34	0.00	8.18	30.82	30.82	0.00	225.00	225.00
totals	752.34	258.81	329.32	588.13	1340.47	263.41	488.96	0.00	588.13	1077.09			
averages											302.00	364.00	666.00

The Woodlands - PHASE III (years 17+)
Golf Course and Domestic Water Demand Components

golf = golf course irrigation and ponds only

dom = all non-golf water demand

Month	gross golf demand	gross dom outdoor	gross dom indoor	gross dom total	gross demand total	reclaim water supply	net golf demand	reclaim water storage	net dom demand	net project demand	golf supply gpm	dom supply gpm	tot supply gpm
	acre-feet												
Jan	15.89	8.86	33.41	42.27	58.16	26.73	0.00	10.84	42.27	42.27	0.00	308.50	308.50
Feb	20.67	10.92	33.41	44.33	65.00	26.73	0.00	6.06	44.33	44.33	0.00	358.20	358.20
Mar	46.09	21.85	34.83	56.68	102.77	27.86	0.00	-18.23	56.68	56.68	0.00	413.70	413.70
Apr	73.32	32.90	36.30	69.20	142.52	29.04	31.76	-12.52	69.20	100.96	239.50	521.90	761.40
May	102.44	44.91	37.68	82.59	185.03	30.14	72.30		82.59	154.89	527.70	602.80	1130.50
Jun	106.73	46.70	38.53	85.23	191.96	30.82	75.91		85.23	161.14	572.50	642.80	1215.30
Jul	105.33	46.00	38.53	84.53	189.86	30.82	74.51		84.53	159.04	543.90	617.00	1160.90
Aug	105.10	45.91	38.53	84.44	189.54	30.82	74.28		84.44	158.72	542.20	616.30	1158.50
Sep	91.94	40.25	37.68	77.93	169.87	30.14	61.80		77.93	139.73	466.10	587.80	1053.90
Oct	68.82	30.40	36.30	66.70	135.52	29.04	39.78		66.70	106.48	290.40	486.80	777.20
Nov	37.92	17.68	34.83	52.51	90.43	27.86	10.06		52.51	62.57	75.90	396.00	471.90
Dec	12.88	7.35	33.41	40.76	53.64	26.73	0.00	13.85	40.76	40.76	0.00	297.50	297.50
totals	787.12	353.76	433.42	787.18	1574.30	346.75	440.40	0.00	787.18	1227.58			
averages											272.00	487.00	759.00

The Woodlands
Example Production Plan - PHASE I

Net Demand		Pumpage (continuous gpm)				
Month	GPM	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	109	109				109
Feb	126	126				126
Mar	191	144		47		191
Apr	366	180		186		366
May	486	207		279		486
Jun	523	222		301		523
Jul	500	213		287		500
Aug	499	213		286		499
Sep	453	202		251		453
Oct	333	168		165		333
Nov	200	139		61		200
Dec	106	106				106
Average	324	169	0	155	0	324

Net Demand		Pumpage (acre-feet)				
Month	AFY	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	14.9	14.9				14.9
Feb	15.6	15.6				15.6
Mar	26.2	19.7		6.4		26.1
Apr	48.5	23.9		24.7		48.6
May	66.6	28.4		38.2		66.6
Jun	69.3	29.4		39.9		69.3
Jul	68.5	29.2		39.3		68.5
Aug	68.4	29.2		39.2		68.4
Sep	60.1	26.8		33.3		60.1
Oct	45.6	23.0		22.6		45.6
Nov	26.5	18.4		8.1		26.5
Dec	14.5	14.5				14.5
Total	524.7	273.0	0.0	251.7	0.0	524.7

The Woodlands

Example Production Plan - PHASE II

Net Demand		Pumpage (continuous gpm)				
Month	GPM	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	233	233				233
Feb	270	270				270
Mar	372	310		62		372
Apr	752	390		362		752
May	997	449		548		997
Jun	1072	478		594		1072
Jul	1024	458		566		1024
Aug	1022	458		564		1022
Sep	929	438		491		929
Oct	683	364		319		683
Nov	411	298		113		411
Dec	225	225				225
Average	666	364	0	302	0	666

Net Demand		Pumpage (acre-feet)				
Month	AFY	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	31.9	31.9				31.9
Feb	33.4	33.4				33.4
Mar	51.0	42.5		8.5		51.0
Apr	99.7	51.7		48.0		99.7
May	136.6	61.5		75.1		136.6
Jun	142.1	63.4		78.8		142.2
Jul	140.3	62.7		77.5		140.2
Aug	140.0	62.7		77.3		140.0
Sep	123.2	58.1		65.1		123.2
Oct	93.6	49.9		43.7		93.6
Nov	54.5	39.5		15.0		54.5
Dec	30.8	30.8				30.8
Total	1077.1	588.1	0.0	489.0	0.0	1077.1

The Woodlands
Example Production Plan - PHASE III

Net Demand		Pumpage (continuous gpm)				
Month	GPM	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	308	308				308
Feb	358	358				358
Mar	414	414				414
Apr	761	522		239		761
May	1131	500	103	528		1131
Jun	1215	500	143	572		1215
Jul	1161	500	117	544		1161
Aug	1158	500	116	542		1158
Sep	1054	588		466		1054
Oct	777	487		290		777
Nov	472	396		76		472
Dec	298	298				298
Average	759	448	40	271	0	759

Net Demand		Pumpage (acre-feet)				
Month	AFY	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	42.2	42.2				42.2
Feb	44.3	44.3				44.3
Mar	56.7	56.7				56.7
Apr	100.9	69.2		31.7		100.9
May	155.0	68.5	14.1	72.3		154.9
Jun	161.1	66.3	19.0	75.8		161.1
Jul	159.1	68.5	16.0	74.5		159.0
Aug	158.7	68.5	15.9	74.3		158.7
Sep	139.7	78.0		61.8		139.8
Oct	106.5	66.7		39.7		106.4
Nov	62.6	52.5		10.1		62.6
Dec	40.8	40.8				40.8
Total	1227.6	722.2	65.0	440.3	0.0	1227.5

The Woodlands - PHASE I (years 1-8)

Monthly Demand Curves (acre-feet)
Based on monthly reference ET values for Nipomo Mesa

Outdoor Water Demand

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	6.66	0.52	0.64	0.70	0.51	0.88	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.21	0.27	10.44
Feb	8.75	0.64	0.78	0.86	0.63	1.09	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.25	0.33	13.39
Mar	19.88	1.28	1.57	1.73	1.26	2.18	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.51	0.67	29.20
Apr	31.90	1.93	2.36	2.60	1.90	3.28	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.77	1.01	45.93
May	44.73	2.63	3.22	3.55	2.59	4.48	0.00	0.25	0.00	0.00	0.00	0.00	0.00	1.05	1.38	63.88
Jun	46.61	2.74	3.35	3.69	2.69	4.65	0.00	0.26	0.00	0.00	0.00	0.00	0.00	1.09	1.43	66.51
Jul	46.02	2.69	3.30	3.63	2.65	4.58	0.00	0.26	0.00	0.00	0.00	0.00	0.00	1.07	1.41	65.61
Aug	45.92	2.69	3.30	3.62	2.65	4.57	0.00	0.26	0.00	0.00	0.00	0.00	0.00	1.07	1.41	65.49
Sep	40.15	2.36	2.89	3.18	2.32	4.01	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.94	1.23	57.30
Oct	30.02	1.76	2.18	2.40	1.75	3.03	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.71	0.93	42.97
Nov	16.40	1.04	1.27	1.40	1.02	1.76	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.41	0.54	23.94
Dec	5.37	0.43	0.53	0.58	0.42	0.73	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.17	0.23	8.50
subttl	342.41	20.72	25.40	27.93	20.40	35.25	0.00	1.98	0.00	0.00	0.00	0.00	0.00	8.25	10.83	493.17

Indoor Water Demand

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.00	6.81	2.92	1.31	0.39	0.00	0.49	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.07
Feb	0.00	6.81	2.92	1.31	0.39	0.00	0.49	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.07
Mar	0.00	7.10	3.05	1.37	0.41	0.00	0.51	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.59
Apr	0.00	7.40	3.18	1.43	0.43	0.00	0.53	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.13
May	0.00	7.70	3.30	1.48	0.44	0.00	0.55	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.64
Jun	0.00	7.99	3.43	1.54	0.46	0.00	0.58	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.17
Jul	0.00	7.99	3.43	1.54	0.46	0.00	0.58	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.17
Aug	0.00	7.99	3.43	1.54	0.46	0.00	0.58	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.17
Sep	0.00	7.70	3.30	1.48	0.44	0.00	0.55	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.64
Oct	0.00	7.40	3.18	1.43	0.43	0.00	0.53	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.13
Nov	0.00	7.10	3.05	1.37	0.41	0.00	0.51	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.59
Dec	0.00	6.81	2.92	1.31	0.39	0.00	0.49	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.07
subttl	0.00	88.80	38.10	17.10	5.10	0.00	6.40	1.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	157.42
total	342.41	109.52	63.50	45.03	25.50	35.25	6.40	3.90	0.00	0.00	0.00	0.00	0.00	8.25	10.83	650.59

The Woodlands - PHASE I (years 1-8)

Wastewater supply (acre-feet)
Indoor 0.80

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.00	5.45	2.34	1.05	0.31	0.00	0.39	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.66
Feb	0.00	5.45	2.34	1.05	0.31	0.00	0.39	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.66
Mar	0.00	5.68	2.44	1.10	0.33	0.00	0.41	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.07
Apr	0.00	5.92	2.54	1.14	0.34	0.00	0.42	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.50
May	0.00	6.16	2.64	1.18	0.35	0.00	0.44	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.91
Jun	0.00	6.39	2.74	1.23	0.37	0.00	0.46	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.34
Jul	0.00	6.39	2.74	1.23	0.37	0.00	0.46	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.34
Aug	0.00	6.39	2.74	1.23	0.37	0.00	0.46	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.34
Sep	0.00	6.16	2.64	1.18	0.35	0.00	0.44	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.91
Oct	0.00	5.92	2.54	1.14	0.34	0.00	0.42	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.50
Nov	0.00	5.68	2.44	1.10	0.33	0.00	0.41	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.07
Dec	0.00	5.45	2.34	1.05	0.31	0.00	0.39	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.66
	0.00	71.04	30.49	13.69	4.09	0.00	5.11	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	125.95

Return Flow to ground water (acre-feet)

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.67	0.10	0.13	0.14	0.10	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.05	1.24
Feb	0.88	0.13	0.16	0.17	0.13	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.05	0.07	1.60
Mar	1.99	0.26	0.31	0.35	0.25	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.10	0.13	3.41
Apr	3.19	0.39	0.47	0.52	0.38	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.15	0.20	5.34
May	4.47	0.53	0.64	0.71	0.52	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.21	0.28	7.41
Jun	4.66	0.55	0.67	0.74	0.54	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.22	0.29	7.72
Jul	4.60	0.54	0.66	0.73	0.53	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.21	0.28	7.60
Aug	4.59	0.54	0.66	0.72	0.53	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.21	0.28	7.58
Sep	4.02	0.47	0.58	0.64	0.48	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.19	0.25	6.65
Oct	3.00	0.36	0.44	0.48	0.35	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.14	0.19	4.99
Nov	1.64	0.21	0.25	0.28	0.20	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.08	0.11	2.79
Dec	0.54	0.09	0.11	0.12	0.08	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.05	1.03
subttl	34.25	4.17	5.08	5.60	4.07	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00	1.63	2.18	57.38

The Woodlands - PHASE I (years 1-8)

Water Consumption (acre-feet)
Indoor 0.20

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.00	1.36	0.58	0.26	0.08	0.00	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.41
Feb	0.00	1.36	0.58	0.26	0.08	0.00	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.41
Mar	0.00	1.42	0.61	0.27	0.08	0.00	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.52
Apr	0.00	1.48	0.64	0.29	0.09	0.00	0.11	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63
May	0.00	1.54	0.66	0.30	0.09	0.00	0.11	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.73
Jun	0.00	1.60	0.69	0.31	0.09	0.00	0.12	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83
Jul	0.00	1.60	0.69	0.31	0.09	0.00	0.12	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83
Aug	0.00	1.60	0.69	0.31	0.09	0.00	0.12	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83
Sep	0.00	1.54	0.66	0.30	0.09	0.00	0.11	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.73
Oct	0.00	1.48	0.64	0.29	0.09	0.00	0.11	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63
Nov	0.00	1.42	0.61	0.27	0.08	0.00	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.52
Dec	0.00	1.36	0.58	0.26	0.08	0.00	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.41
subttl	0.00	17.76	7.62	3.42	1.02	0.00	1.28	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.49

Water Consumption (acre-feet)
Outdoor 0.80

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	5.99	0.42	0.51	0.56	0.41	0.88	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.17	0.22	9.19
Feb	7.88	0.51	0.62	0.69	0.50	1.09	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.20	0.26	11.81
Mar	17.89	1.02	1.26	1.38	1.01	2.18	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.41	0.54	25.78
Apr	28.71	1.54	1.89	2.08	1.52	3.28	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.62	0.81	40.59
May	40.26	2.10	2.58	2.84	2.07	4.48	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.84	1.10	56.47
Jun	41.95	2.19	2.68	2.95	2.15	4.65	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.87	1.14	58.80
Jul	41.42	2.15	2.64	2.90	2.12	4.58	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.86	1.13	58.01
Aug	41.33	2.15	2.64	2.90	2.12	4.57	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.86	1.13	57.90
Sep	36.14	1.89	2.31	2.54	1.86	4.01	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.75	0.98	50.66
Oct	27.02	1.42	1.74	1.92	1.40	3.03	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.57	0.74	37.98
Nov	14.76	0.83	1.02	1.12	0.82	1.76	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.33	0.43	21.14
Dec	4.83	0.34	0.42	0.46	0.34	0.73	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.14	0.18	7.48
subttl	308.17	16.56	20.31	22.35	16.31	35.24	0.00	1.58	0.00	0.00	0.00	0.00	0.00	6.60	8.67	435.82
total	308.17	34.34	27.93	25.77	17.33	35.24	1.28	1.96	0.00	0.00	0.00	0.00	0.00	6.60	8.67	467.31

The Woodlands - PHASE II (years 9-16)

Monthly Demand Curves (acre-feet)
Based on monthly reference ET values for Nipomo Mesa

Outdoor Water Demand

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	13.27	0.86	1.27	1.38	0.99	1.75	0.00	0.09	0.00	0.00	0.24	0.03	0.13	0.41	1.07	21.49
Feb	17.43	1.06	1.57	1.71	1.22	2.16	0.00	0.11	0.00	0.00	0.29	0.03	0.16	0.51	1.32	27.57
Mar	39.61	2.13	3.14	3.42	2.45	4.33	0.00	0.23	0.00	0.00	0.58	0.06	0.32	1.02	2.64	59.93
Apr	63.58	3.20	4.72	5.15	3.68	6.51	0.00	0.34	0.00	0.00	0.88	0.10	0.49	1.53	3.97	94.15
May	89.13	4.37	6.45	7.03	5.03	8.89	0.00	0.47	0.00	0.00	1.20	0.13	0.67	2.09	5.42	130.88
Jun	92.89	4.55	6.71	7.31	5.23	9.25	0.00	0.49	0.00	0.00	1.25	0.14	0.69	2.18	5.63	136.32
Jul	91.70	4.48	6.61	7.20	5.15	9.11	0.00	0.48	0.00	0.00	1.23	0.13	0.68	2.15	5.55	134.47
Aug	91.50	4.47	6.59	7.19	5.14	9.09	0.00	0.48	0.00	0.00	1.23	0.13	0.68	2.14	5.54	134.18
Sep	80.02	3.92	5.78	6.30	4.51	7.97	0.00	0.42	0.00	0.00	1.08	0.12	0.60	1.88	4.85	117.45
Oct	59.81	2.98	4.37	4.76	3.40	6.02	0.00	0.32	0.00	0.00	0.81	0.09	0.45	1.42	3.67	88.08
Nov	32.68	1.72	2.54	2.77	1.98	3.50	0.00	0.19	0.00	0.00	0.47	0.05	0.26	0.83	2.13	49.12
Dec	10.70	0.72	1.06	1.15	0.82	1.46	0.00	0.08	0.00	0.00	0.20	0.02	0.11	0.34	0.89	17.55
subttl	682.31	34.44	50.80	55.37	39.60	70.03	0.00	3.70	0.00	0.00	9.45	1.04	5.25	16.50	42.66	1011.15

Indoor Water Demand

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.00	11.32	5.84	2.60	0.76	0.00	0.98	0.28	0.24	0.98	1.69	0.16	0.58	0.00	0.00	25.43
Feb	0.00	11.32	5.84	2.60	0.76	0.00	0.98	0.28	0.24	0.98	1.69	0.16	0.58	0.00	0.00	25.43
Mar	0.00	11.81	6.10	2.71	0.79	0.00	1.02	0.29	0.25	1.02	1.76	0.17	0.58	0.00	0.00	26.50
Apr	0.00	12.30	6.35	2.83	0.83	0.00	1.07	0.30	0.26	1.06	1.84	0.18	0.58	0.00	0.00	27.60
May	0.00	12.79	6.60	2.94	0.86	0.00	1.11	0.31	0.27	1.11	1.91	0.18	0.58	0.00	0.00	28.66
Jun	0.00	13.28	6.86	3.05	0.89	0.00	1.15	0.32	0.28	1.15	1.98	0.19	0.00	0.00	0.00	29.15
Jul	0.00	13.28	6.86	3.05	0.89	0.00	1.15	0.32	0.28	1.15	1.98	0.19	0.00	0.00	0.00	29.15
Aug	0.00	13.28	6.86	3.05	0.89	0.00	1.15	0.32	0.28	1.15	1.98	0.19	0.00	0.00	0.00	29.15
Sep	0.00	12.79	6.60	2.94	0.86	0.00	1.11	0.31	0.27	1.11	1.91	0.18	0.58	0.00	0.00	28.66
Oct	0.00	12.30	6.35	2.83	0.83	0.00	1.07	0.30	0.26	1.06	1.84	0.18	0.58	0.00	0.00	27.60
Nov	0.00	11.81	6.10	2.71	0.79	0.00	1.02	0.29	0.25	1.02	1.76	0.17	0.58	0.00	0.00	26.50
Dec	0.00	11.32	5.84	2.60	0.76	0.00	0.98	0.28	0.24	0.98	1.69	0.16	0.58	0.00	0.00	25.43
subttl	0.00	147.60	76.20	33.90	9.90	0.00	12.80	3.60	3.15	12.75	22.05	2.12	5.25	0.00	0.00	329.32
total	682.31	182.04	127.00	89.27	49.50	70.03	12.80	7.30	3.15	12.75	31.50	3.16	10.50	16.50	42.66	1340.47

The Woodlands - PHASE II (years 9-16)

Wastewater supply (acre-feet)

Indoor 0.80

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.00	9.06	4.67	2.08	0.61	0.00	0.78	0.22	0.19	0.78	1.35	0.13	0.46	0.00	0.00	20.34
Feb	0.00	9.06	4.67	2.08	0.61	0.00	0.78	0.22	0.19	0.78	1.35	0.13	0.46	0.00	0.00	20.34
Mar	0.00	9.45	4.88	2.17	0.63	0.00	0.82	0.23	0.20	0.82	1.41	0.14	0.46	0.00	0.00	21.20
Apr	0.00	9.84	5.08	2.26	0.66	0.00	0.86	0.24	0.21	0.85	1.47	0.14	0.46	0.00	0.00	22.08
May	0.00	10.23	5.28	2.35	0.69	0.00	0.89	0.25	0.22	0.89	1.53	0.14	0.46	0.00	0.00	22.93
Jun	0.00	10.62	5.49	2.44	0.71	0.00	0.92	0.26	0.22	0.92	1.58	0.15	0.00	0.00	0.00	23.32
Jul	0.00	10.62	5.49	2.44	0.71	0.00	0.92	0.26	0.22	0.92	1.58	0.15	0.00	0.00	0.00	23.32
Aug	0.00	10.62	5.49	2.44	0.71	0.00	0.92	0.26	0.22	0.92	1.58	0.15	0.00	0.00	0.00	23.32
Sep	0.00	10.23	5.28	2.35	0.69	0.00	0.89	0.25	0.22	0.89	1.53	0.14	0.46	0.00	0.00	22.93
Oct	0.00	9.84	5.08	2.26	0.66	0.00	0.86	0.24	0.21	0.85	1.47	0.14	0.46	0.00	0.00	22.08
Nov	0.00	9.45	4.88	2.17	0.63	0.00	0.82	0.23	0.20	0.82	1.41	0.14	0.46	0.00	0.00	21.20
Dec	0.00	9.06	4.67	2.08	0.61	0.00	0.78	0.22	0.19	0.78	1.35	0.13	0.46	0.00	0.00	20.34
	0.00	118.08	60.96	27.13	7.93	0.00	10.23	2.88	2.50	10.22	17.62	1.69	4.18	0.00	0.00	263.41

Return Flow to ground water (acre-feet)

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	1.33	0.17	0.25	0.28	0.20	0.00	0.00	0.02	0.00	0.00	0.05	0.01	0.03	0.08	0.21	2.63
Feb	1.74	0.21	0.31	0.34	0.24	0.00	0.00	0.02	0.00	0.00	0.06	0.01	0.03	0.10	0.26	3.32
Mar	3.96	0.43	0.63	0.68	0.49	0.00	0.00	0.05	0.00	0.00	0.12	0.01	0.06	0.20	0.53	7.16
Apr	6.36	0.64	0.94	1.03	0.74	0.00	0.00	0.07	0.00	0.00	0.18	0.02	0.10	0.31	0.79	11.18
May	8.91	0.87	1.29	1.41	1.01	0.00	0.00	0.09	0.00	0.00	0.24	0.03	0.13	0.42	1.06	15.48
Jun	9.29	0.91	1.34	1.46	1.05	0.00	0.00	0.10	0.00	0.00	0.25	0.03	0.14	0.44	1.13	16.14
Jul	9.17	0.90	1.32	1.44	1.03	0.00	0.00	0.10	0.00	0.00	0.25	0.03	0.14	0.43	1.11	15.92
Aug	9.15	0.89	1.32	1.44	1.03	0.00	0.00	0.10	0.00	0.00	0.25	0.03	0.14	0.43	1.11	15.89
Sep	8.00	0.78	1.16	1.26	0.90	0.00	0.00	0.08	0.00	0.00	0.22	0.02	0.12	0.38	0.97	13.89
Oct	5.98	0.59	0.87	0.95	0.68	0.00	0.00	0.06	0.00	0.00	0.16	0.02	0.09	0.28	0.73	10.41
Nov	3.27	0.34	0.51	0.55	0.40	0.00	0.00	0.04	0.00	0.00	0.09	0.01	0.05	0.17	0.43	5.86
Dec	1.07	0.14	0.21	0.23	0.16	0.00	0.00	0.02	0.00	0.00	0.04	0.00	0.02	0.07	0.18	2.14
subttl	68.23	6.87	10.15	11.07	7.93	0.00	0.00	0.75	0.00	0.00	1.91	0.22	1.05	3.31	8.53	120.02

The Woodlands - PHASE II (years 9-16)

Water Consumption (acre-feet)
Indoor 0.20

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.00	2.26	1.17	0.52	0.15	0.00	0.20	0.06	0.05	0.20	0.34	0.03	0.12	0.00	0.00	5.09
Feb	0.00	2.26	1.17	0.52	0.15	0.00	0.20	0.06	0.05	0.20	0.34	0.03	0.12	0.00	0.00	5.09
Mar	0.00	2.36	1.22	0.54	0.16	0.00	0.20	0.06	0.05	0.20	0.35	0.03	0.12	0.00	0.00	5.30
Apr	0.00	2.46	1.27	0.57	0.17	0.00	0.21	0.06	0.05	0.21	0.37	0.04	0.12	0.00	0.00	5.52
May	0.00	2.56	1.32	0.59	0.17	0.00	0.22	0.06	0.05	0.22	0.38	0.04	0.12	0.00	0.00	5.73
Jun	0.00	2.66	1.37	0.61	0.18	0.00	0.23	0.06	0.06	0.23	0.40	0.04	0.00	0.00	0.00	5.83
Jul	0.00	2.66	1.37	0.61	0.18	0.00	0.23	0.06	0.06	0.23	0.40	0.04	0.00	0.00	0.00	5.83
Aug	0.00	2.66	1.37	0.61	0.18	0.00	0.23	0.06	0.06	0.23	0.40	0.04	0.00	0.00	0.00	5.83
Sep	0.00	2.56	1.32	0.59	0.17	0.00	0.22	0.06	0.05	0.22	0.38	0.04	0.12	0.00	0.00	5.73
Oct	0.00	2.46	1.27	0.57	0.17	0.00	0.21	0.06	0.05	0.21	0.37	0.04	0.12	0.00	0.00	5.52
Nov	0.00	2.36	1.22	0.54	0.16	0.00	0.20	0.06	0.05	0.20	0.35	0.03	0.12	0.00	0.00	5.30
Dec	0.00	2.26	1.17	0.52	0.15	0.00	0.20	0.06	0.05	0.20	0.34	0.03	0.12	0.00	0.00	5.09
subttl	0.00	29.52	15.24	6.78	1.98	0.00	2.56	0.72	0.62	2.55	4.41	0.42	1.04	0.00	0.00	65.85

Water Consumption (acre-feet)
Outdoor 0.80

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	asst living	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	11.94	0.69	1.02	1.10	0.79	1.75	0.00	0.07	0.00	0.00	0.19	0.02	0.10	0.33	0.86	18.87
Feb	15.69	0.85	1.26	1.37	0.98	2.16	0.00	0.09	0.00	0.00	0.23	0.02	0.13	0.41	1.06	24.23
Mar	35.65	1.70	2.51	2.74	1.96	4.33	0.00	0.18	0.00	0.00	0.46	0.05	0.26	0.82	2.11	52.77
Apr	57.22	2.56	3.78	4.12	2.94	6.51	0.00	0.27	0.00	0.00	0.70	0.08	0.39	1.22	3.18	82.98
May	80.22	3.50	5.16	5.62	4.02	8.89	0.00	0.38	0.00	0.00	0.96	0.10	0.54	1.67	4.34	115.40
Jun	83.60	3.64	5.37	5.85	4.18	9.25	0.00	0.39	0.00	0.00	1.00	0.11	0.55	1.74	4.50	120.20
Jul	82.53	3.58	5.29	5.78	4.12	9.11	0.00	0.38	0.00	0.00	0.98	0.10	0.54	1.72	4.44	118.57
Aug	82.35	3.58	5.27	5.75	4.11	9.09	0.00	0.38	0.00	0.00	0.98	0.10	0.54	1.71	4.43	118.31
Sep	72.02	3.14	4.62	5.04	3.61	7.97	0.00	0.34	0.00	0.00	0.86	0.10	0.48	1.50	3.88	103.56
Oct	53.83	2.37	3.50	3.81	2.72	6.02	0.00	0.26	0.00	0.00	0.65	0.07	0.36	1.14	2.94	77.65
Nov	29.41	1.38	2.03	2.22	1.58	3.50	0.00	0.15	0.00	0.00	0.38	0.04	0.21	0.66	1.70	43.26
Dec	9.63	0.56	0.85	0.92	0.66	1.46	0.00	0.06	0.00	0.00	0.16	0.02	0.09	0.27	0.71	15.40
subttl	614.09	27.55	40.65	44.30	31.68	70.04	0.00	2.96	0.00	0.00	7.57	0.82	4.19	13.20	34.14	891.19
total	614.09	57.07	55.89	51.08	33.66	70.04	2.56	3.68	0.62	2.55	11.97	1.25	5.24	13.20	34.14	957.04

The Woodlands - PHASE III (years 17+)

Monthly Demand Curves (acre-feet)
Based on monthly reference ET values for Nipomo Mesa

Outdoor Water Demand

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	13.27	1.03	1.91	2.07	1.47	2.62	0.00	0.09	0.00	0.00	0.24	0.03	0.13	0.62	1.27	24.75
Feb	17.43	1.27	2.35	2.56	1.82	3.24	0.00	0.11	0.00	0.00	0.29	0.03	0.16	0.76	1.57	31.59
Mar	39.61	2.54	4.71	5.12	3.63	6.48	0.00	0.23	0.00	0.00	0.58	0.06	0.32	1.52	3.14	67.94
Apr	63.58	3.82	7.08	7.70	5.47	9.74	0.00	0.34	0.00	0.00	0.88	0.10	0.49	2.29	4.73	106.22
May	89.13	5.22	9.67	10.51	7.47	13.31	0.00	0.47	0.00	0.00	1.20	0.13	0.67	3.12	6.45	147.35
Jun	92.89	5.42	10.06	10.93	7.76	13.84	0.00	0.49	0.00	0.00	1.25	0.14	0.69	3.25	6.71	153.43
Jul	91.70	5.34	9.91	10.77	7.65	13.63	0.00	0.48	0.00	0.00	1.23	0.13	0.68	3.20	6.61	151.33
Aug	91.50	5.33	9.89	10.75	7.63	13.60	0.00	0.48	0.00	0.00	1.23	0.13	0.68	3.19	6.60	151.01
Sep	80.02	4.67	8.67	9.42	6.69	11.92	0.00	0.42	0.00	0.00	1.08	0.12	0.60	2.80	5.78	132.19
Oct	59.61	3.53	6.55	7.12	5.05	9.01	0.00	0.32	0.00	0.00	0.81	0.09	0.45	2.11	4.37	99.22
Nov	32.68	2.05	3.81	4.14	2.94	5.24	0.00	0.19	0.00	0.00	0.47	0.05	0.26	1.23	2.54	55.60
Dec	10.70	0.85	1.58	1.72	1.22	2.18	0.00	0.08	0.00	0.00	0.20	0.02	0.11	0.51	1.06	20.23
subttl	682.31	41.09	76.20	82.81	58.80	104.81	0.00	3.70	0.00	0.00	9.45	1.04	5.25	24.60	50.82	1140.88

Indoor Water Demand

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.00	13.50	8.76	3.89	1.13	0.00	0.96	0.28	0.48	1.96	1.69	0.16	0.58	0.00	0.00	33.41
Feb	0.00	13.50	8.76	3.89	1.13	0.00	0.98	0.28	0.48	1.96	1.69	0.16	0.58	0.00	0.00	33.41
Mar	0.00	14.09	9.14	4.06	1.18	0.00	1.02	0.29	0.50	2.04	1.76	0.17	0.58	0.00	0.00	34.83
Apr	0.00	14.68	9.53	4.23	1.23	0.00	1.07	0.30	0.53	2.13	1.84	0.18	0.58	0.00	0.00	36.30
May	0.00	15.26	9.91	4.39	1.27	0.00	1.11	0.31	0.55	2.21	1.91	0.18	0.58	0.00	0.00	37.68
Jun	0.00	15.85	10.29	4.56	1.32	0.00	1.15	0.32	0.57	2.30	1.98	0.19	0.00	0.00	0.00	38.53
Jul	0.00	15.85	10.29	4.56	1.32	0.00	1.15	0.32	0.57	2.30	1.98	0.19	0.00	0.00	0.00	38.53
Aug	0.00	15.85	10.29	4.56	1.32	0.00	1.15	0.32	0.57	2.30	1.98	0.19	0.00	0.00	0.00	38.53
Sep	0.00	15.26	9.91	4.39	1.27	0.00	1.11	0.31	0.55	2.21	1.91	0.18	0.58	0.00	0.00	37.68
Oct	0.00	14.68	9.53	4.23	1.23	0.00	1.07	0.30	0.53	2.13	1.84	0.18	0.58	0.00	0.00	36.30
Nov	0.00	14.09	9.14	4.06	1.18	0.00	1.02	0.29	0.50	2.04	1.76	0.17	0.58	0.00	0.00	34.83
Dec	0.00	13.50	8.76	3.89	1.13	0.00	0.96	0.28	0.48	1.96	1.69	0.16	0.58	0.00	0.00	33.41
subttl	0.00	176.10	114.30	50.70	14.70	0.00	12.80	3.60	6.30	25.50	22.05	2.12	5.25	0.00	0.00	433.42
total	682.31	217.19	190.50	133.51	73.50	104.81	12.80	7.30	6.30	25.50	31.50	3.16	10.50	24.60	50.82	1574.30

The Woodlands - PHASE III (years 17+)

Wastewater supply (acre-feet)

Indoor 0.80

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.00	10.80	7.01	3.11	0.90	0.00	0.78	0.22	0.38	1.57	1.35	0.13	0.46	0.00	0.00	26.73
Feb	0.00	10.80	7.01	3.11	0.90	0.00	0.78	0.22	0.38	1.57	1.35	0.13	0.46	0.00	0.00	26.73
Mar	0.00	11.27	7.31	3.25	0.94	0.00	0.82	0.23	0.40	1.63	1.41	0.14	0.46	0.00	0.00	27.86
Apr	0.00	11.74	7.62	3.38	0.98	0.00	0.86	0.24	0.42	1.70	1.47	0.14	0.46	0.00	0.00	29.04
May	0.00	12.21	7.93	3.51	1.02	0.00	0.89	0.25	0.44	1.77	1.53	0.14	0.46	0.00	0.00	30.14
Jun	0.00	12.68	8.23	3.65	1.06	0.00	0.92	0.26	0.46	1.84	1.58	0.15	0.00	0.00	0.00	30 82
Jul	0.00	12.68	8.23	3.65	1.06	0.00	0.92	0.26	0.46	1.84	1.58	0.15	0.00	0.00	0.00	30.82
Aug	0.00	12.68	8.23	3.65	1.06	0.00	0.92	0.26	0.46	1.84	1.58	0.15	0.00	0.00	0.00	30.82
Sep	0.00	12.21	7.93	3.51	1.02	0.00	0.89	0.25	0.44	1.77	1.53	0.14	0.46	0.00	0.00	30.14
Oct	0.00	11.74	7.62	3.38	0.98	0.00	0.86	0.24	0.42	1.70	1.47	0.14	0.46	0.00	0.00	29.04
Nov	0.00	11.27	7.31	3.25	0.94	0.00	0.82	0.23	0.40	1.63	1.41	0.14	0.46	0.00	0.00	27.86
Dec	0.00	10.80	7.01	3.11	0.90	0.00	0.78	0.22	0.38	1.57	1.35	0.13	0.46	0.00	0.00	26.73
	0.00	140.89	91.45	40.57	11.77	0.00	10.23	2.88	5.05	20.43	17.62	1.69	4.18	0.00	0.00	346.75

Return Flow to ground water (acre-feet)

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	1.33	0.21	0.38	0.41	0.29	0.00	0.00	0.02	0.00	0.00	0.05	0.01	0.03	0.12	0.25	3.10
Feb	1.74	0.25	0.47	0.51	0.36	0.00	0.00	0.02	0.00	0.00	0.06	0.01	0.03	0.15	0.31	3 91
Mar	3.96	0.51	0.94	1.02	0.73	0.00	0.00	0.05	0.00	0.00	0.12	0.01	0.06	0.30	0.63	8.33
Apr	6.36	0.76	1.42	1.54	1.09	0.00	0.00	0.07	0.00	0.00	0.18	0.02	0.10	0.46	0.95	12.95
May	8.91	1.04	1.93	2.10	1.49	0.00	0.00	0.09	0.00	0.00	0.24	0.03	0.13	0.62	1.29	17.87
Jun	9.29	1.08	2.01	2.19	1.55	0.00	0.00	0.10	0.00	0.00	0.25	0.03	0.14	0.65	1.34	18.63
Jul	9.17	1.07	1.98	2.15	1.53	0.00	0.00	0.10	0.00	0.00	0.25	0.03	0.14	0.64	1.32	18.38
Aug	9.15	1.07	1.98	2.15	1.53	0.00	0.00	0.10	0.00	0.00	0.25	0.03	0.14	0.64	1.32	18.36
Sep	8.00	0.93	1.73	1.88	1.34	0.00	0.00	0.08	0.00	0.00	0.22	0.02	0.12	0.56	1.16	16.04
Oct	5.98	0.71	1.31	1.42	1.01	0.00	0.00	0.06	0.00	0.00	0.16	0.02	0.09	0.42	0.87	12 05
Nov	3.27	0.41	0.76	0.83	0.59	0.00	0.00	0.04	0.00	0.00	0.09	0.01	0.05	0.25	0.51	6.81
Dec	1.07	0.17	0.32	0.34	0.24	0.00	0.00	0.02	0.00	0.00	0.04	0.00	0.02	0.10	0.21	2.53
subttl	68.23	8.21	15.23	16.54	11.75	0.00	0.00	0.75	0.00	0.00	1.91	0.22	1.05	4.91	10.16	136.96

The Woodlands - PHASE III (years 17+)

Water Consumption (acre-feet)
Indoor 0.20

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	0.00	2.70	1.75	0.78	0.23	0.00	0.20	0.06	0.10	0.39	0.34	0.03	0.12	0.00	0.00	6.68
Feb	0.00	2.70	1.75	0.78	0.23	0.00	0.20	0.06	0.10	0.39	0.34	0.03	0.12	0.00	0.00	6.68
Mar	0.00	2.82	1.83	0.81	0.24	0.00	0.20	0.06	0.10	0.41	0.35	0.03	0.12	0.00	0.00	6.97
Apr	0.00	2.94	1.91	0.85	0.25	0.00	0.21	0.06	0.11	0.43	0.37	0.04	0.12	0.00	0.00	7.26
May	0.00	3.05	1.98	0.88	0.25	0.00	0.22	0.06	0.11	0.44	0.38	0.04	0.12	0.00	0.00	7.54
Jun	0.00	3.17	2.06	0.91	0.26	0.00	0.23	0.06	0.11	0.46	0.40	0.04	0.00	0.00	0.00	7.71
Jul	0.00	3.17	2.06	0.91	0.26	0.00	0.23	0.06	0.11	0.46	0.40	0.04	0.00	0.00	0.00	7.71
Aug	0.00	3.17	2.06	0.91	0.26	0.00	0.23	0.06	0.11	0.46	0.40	0.04	0.00	0.00	0.00	7.71
Sep	0.00	3.05	1.98	0.88	0.25	0.00	0.22	0.06	0.11	0.44	0.38	0.04	0.12	0.00	0.00	7.54
Oct	0.00	2.94	1.91	0.85	0.25	0.00	0.21	0.06	0.11	0.43	0.37	0.04	0.12	0.00	0.00	7.26
Nov	0.00	2.82	1.83	0.81	0.24	0.00	0.20	0.06	0.10	0.41	0.35	0.03	0.12	0.00	0.00	6.97
Dec	0.00	2.70	1.75	0.78	0.23	0.00	0.20	0.06	0.10	0.39	0.34	0.03	0.12	0.00	0.00	6.68
subttl	0.00	35.22	22.86	10.14	2.94	0.00	2.56	0.72	1.26	5.11	4.41	0.42	1.04	0.00	0.00	86.69

Water Consumption (acre-feet)
Outdoor 0.80

Month	golf	5-7K sf	7-9K sf	10-20K sf	1-acre	ponds	club	Maint/WWTP	village	multi-family	hotel/cas.	resort	school	landscape	parks	Subttl
Jan	11.94	0.82	1.53	1.66	1.18	2.62	0.00	0.07	0.00	0.00	0.19	0.02	0.10	0.50	1.02	21.65
Feb	15.69	1.02	1.88	2.05	1.46	3.24	0.00	0.09	0.00	0.00	0.23	0.02	0.13	0.61	1.26	27.66
Mar	35.65	2.03	3.77	4.10	2.90	6.48	0.00	0.18	0.00	0.00	0.46	0.05	0.26	1.22	2.51	59.61
Apr	57.22	3.06	5.66	6.16	4.38	9.74	0.00	0.27	0.00	0.00	0.70	0.08	0.39	1.83	3.78	93.28
May	80.22	4.18	7.74	8.41	5.98	13.31	0.00	0.36	0.00	0.00	0.96	0.10	0.54	2.50	5.16	129.46
Jun	83.60	4.34	8.05	8.74	6.21	13.84	0.00	0.39	0.00	0.00	1.00	0.11	0.55	2.60	5.37	134.80
Jul	82.53	4.27	7.93	8.62	6.12	13.63	0.00	0.38	0.00	0.00	0.98	0.10	0.54	2.56	5.29	132.96
Aug	82.35	4.26	7.91	8.60	6.10	13.60	0.00	0.38	0.00	0.00	0.98	0.10	0.54	2.55	5.28	132.68
Sep	72.02	3.74	6.94	7.54	5.35	11.92	0.00	0.34	0.00	0.00	0.86	0.10	0.48	2.24	4.62	116.14
Oct	53.83	2.82	5.24	5.70	4.04	9.01	0.00	0.26	0.00	0.00	0.65	0.07	0.36	1.69	3.50	87.16
Nov	29.41	1.64	3.05	3.31	2.35	5.24	0.00	0.15	0.00	0.00	0.38	0.04	0.21	0.98	2.03	48.60
Dec	9.63	0.68	1.26	1.38	0.98	2.18	0.00	0.06	0.00	0.00	0.16	0.02	0.09	0.41	0.85	17.69
subttl	614.09	32.86	60.95	66.25	47.04	104.81	0.00	2.96	0.00	0.00	7.57	0.82	4.19	19.68	40.66	1001.88
total	614.09	68.08	83.81	76.39	49.98	104.81	2.56	3.68	1.26	5.11	11.97	1.25	5.24	19.68	40.66	1088.57

APPENDIX C:

WATER QUALITY CALCULATIONS

The Woodlands - PHASE I (years 1-8)
Basin Pickup Calculations

Constituent	WW Pickup (mg/l)	WW Imports (tons)	Fert Imports (tons)	Total Imports (tons)	Total Exports (tons)	Basin Pickup (tons)	Recharge Initial (mg/l)	Basin Pickup (mg/l)	Recharge Final (mg/l)
N	18	3.10	7.90	11.00	10.38	0.62	0.65	1.24	1.89
P	2.6	0.40	3.03	3.43	3.43	0.00	0	0.00	0.00
K	10	1.70	0.00	1.70	0.00	1.70	0.44	3.39	3.83
Ca	15	2.60	3.90	6.50	0.00	6.50	13.34	12.96	26.30
Mg	7	1.20	0.00	1.20	0.00	1.20	4.58	2.39	6.97
S	10	1.70	0.00	1.70	0.00	1.70	9.61	3.39	13.00
B	0.2	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.03
Cl	75	12.90	0.00	12.90	0.00	12.90	14.96	25.73	40.69
Na	70	12.00	0.00	12.00	0.00	12.00	10.56	23.93	34.49
TDS	320	54.80	48.20	103.00	56.50	46.50	98.38	92.75	191.13

Constants used:

1233619	af into liters		superphosphate
2.2E-06	mg into lbs		Ca2((H2P(O4))2*H2O
2.719619	mg/L into lbs/af	wght	292.1
126	afy of wastewater	%Ca	0.27
137	Irrigated acres	%P	0.21
736	ton/af into mg/l		
98	percent nitrogen uptake by plants		
10	percent of WW as return flow		
4.43	N into N03 for TDS		Potassium Chloride
3.07	P onto P04 for TDS		KCl
3	S into S04 for TDS	wght	74.55
312	afy perc	%Cl	0.48
57	afy return flow	%K	0.52
369	total afy recharge		

Golf Course Nitrogen Fertilizer

	acres	pounds per acre	pounds	tons
Greens and tees	13.7	348.48	4774	2.387
Fairways	68.5	174.24	11935	5.9675
Rough	54.8	87.12	4774	2.387
total	137		21483	10.7415

Fertilizer Demand

	golf courses			non-golf course areas		
	fertil require demand	total irrig supply	fertil import	fertil require demand	total irrig supply	fertil import
	----------------------------(tons)----------------------------					
N	10.74	4.63	6.11	3.13	1.34	1.79
P	2.69	0.44	2.25	0.78	0.00	0.78
K	2.69	3.41	0.00	0.78	0.74	0.00
Ca						
Mg						
S	0.96	34.01	0.00	0.75	13.74	0.00
B						
Cl						
Na						
TDS						

Non-Golf Course Fertilized Acreage

	acres	non-golf fert.
golf w/practice area	137	0
improvements	138	59
parks	11.9	7.4
misc. landscaping	5.5	5.5
ponds	7.5	0
subttl	299.9	71.9
open space	657.1	

The Woodlands - PHASE I (years 1-8)
Water Quality Calculations

Constituent	Hwy 1	Dawn	Mesa	Home	Pickup	Ave WW Qual	Irrigation Quality (includes WW contributions) Ave Dom Qual	Ave Golf Qual	golf irr tons	dom irr tons	Return Flow Quality (WW contributions not included) return flow	Rain Qual	Initial Perc
	(mg/l)										(mg/l)		
N	3.61	0.7	2.8	0.9	18	21.61	3.61	9.01	4.63	1.34	3.22	0.2	0.65
P	0	0	0	0	2.6	2.6	0	0.86	0.44	0	0	0	0
K	2	3.8	4	3.7	10	12	2	6.64	3.41	0.74	2.96	0	0.44
Ca	54	120	115	150	15	69	54	99.82	51.27	20.03	83.28	1	13.34
Mg	21	38	29	43	7	28	21	28.67	14.72	7.79	24.84	1	4.58
S	37.04	83.07	75.66	113.49	10	47.04	37.04	66.22	34.01	13.74	55.58	1.5	9.61
B	0	0.44	0.38	0.75	0.2	0.2	0	0.32	0.16	0	0.18	0	0.03
Cl	42	68	56	58	75	117	42	76.13	39.1	15.58	48.72	9	14.96
Na	43	48	41	53	70	113	43	64.76	33.26	15.95	42.04	5	10.56
TDS	442	700	616	840	320	762	442	664.18	341.11	163.95	525.52	23	98.38
Hardness	220	456	408	552	70	290	220	369.06	189.54	81.6	310.24	17	60.99
Pump (afy)	273	0	252	0		126	273	378					
Dom (%)	1	0											
Golf (%)			0.67	0		0.33							
return flow without WW (afy)							23	21.4					
return flow without WW (%)							0.52	0.48					
Total recharge											57	312	
Ttl recharge (%)											0.15	0.85	

Sodium Hazard

			dS/m
SAR WW	2.9	EC WW	1.19
SAR DOM	1.26	EC DOM	0.69
SAR IRR	1.05	EC IRR	1.04

The Woodlands - PHASE II (years 9-16)
Basin Pickup Calculations

Constituent	WW Pickup (mg/l)	WW imports (tons)	Fert imports (tons)	Total imports (tons)	Total Exports (tons)	Basin Pickup (tons)	Recharge initial (mg/l)	Basin Pickup (mg/l)	Recharge Final (mg/l)
N	18	6.40	16.17	22.57	21.28	1.29	0.99	2.03	3.02
P	2.6	0.90	6.23	7.13	7.13	0.00	0	0.00	0.00
K	10	3.60	0.00	3.60	0.00	3.60	0.77	5.69	6.46
Ca	15	5.40	8.00	13.40	0.00	13.40	22.39	21.16	43.55
Mg	7	2.50	0.00	2.50	0.00	2.50	7.2	3.95	11.15
S	10	3.60	0.00	3.60	0.00	3.60	15.56	5.69	21.25
B	0.2	0.10	0.00	0.10	0.00	0.10	0.05	0.16	0.21
Cl	75	26.80	0.00	26.80	0.00	26.80	19.33	42.33	61.66
Na	70	25.00	0.00	25.00	0.00	25.00	14.63	39.46	54.11
TDS	320	114.40	98.70	213.10	116.20	96.90	153.66	153.04	306.70

Constants used:

1233619	af into liters		superphosphate
2.2E-06	mg into lbs		Ca2((H2P(O4))2*H2O
2.719619	mg/L into lbs/af	wght	292.1
283	afy of wastewater	%Ca	0.27
273	irrigated acres	%P	0.21
736	ton/af into mg/l		
96	percent nitrogen uptake by plants		
10	percent of WW as return flow		
4.43	N into N03 for TDS		Potassium Chloride
3.07	P onto P04 for TDS		KCl
3	S into S04 for TDS	wght	74.55
346	afy perc	%Cl	0.48
120	afy return flow	%K	0.52
466	total afy recharge		

Golf Course Nitrogen Fertilizer	acres	pounds per acre	pounds	tons
Greens and tees	27.3	348.48	9514	4.757
Fairways	136.5	174.24	23784	11.892
Rough	109.2	87.12	9514	4.757
total	273		42812	21.406

Fertilizer Demand	golf courses fertil require demand	golf courses total irrig supply	golf courses fertil import	non-golf course areas fertil require demand	non-golf course areas total irrig supply	non-golf course areas fertil import
	(tons)					
N	21.41	9.58	11.83	7.22	2.88	4.34
P	5.35	0.93	4.42	1.61	0.00	1.61
K	5.35	6.95	0.00	1.61	1.60	0.00
Ca						
Mg						
S	0.96	67.07	0.00	0.75	29.59	0.00
B						
Cl						
Na						
TDS						

Non-Golf Course Fertilized Acreage	acres	non-golf fert.
golf w/practice area	273	0
improvements	287	125
parks	33.6	29.6
misc. landscaping	11	11
ponds	15	0
subttl	619.6	165.6
open space	337.2	

The Woodlands - PHASE II (years 9-16)
Water Quality Calculations

Constituent	Hwy 1	Dawn	Mesa	Home	Pickup	Ave WW Qual	Irrigation Quality (includes WW contributions) Ave Dom Qual	Ave Golf Qual	golf irr tons	dom irr tons	Return Flow Quality (WW contributions not included) return flow	Rain Qual	Initial Perc
	(mg/l)										(mg/l)		
N	3.61	0.7	2.8	0.9	18	21.61	3.61	9.36	9.58	2.68	3.22	0.2	0.99
P	0	0	0	0	2.6	2.6	0	0.91	0.93	0	0	0	0
K	2	3.8	4	3.7	10	12	2	6.8	6.95	1.6	2.96	0	0.77
Ca	54	120	115	150	15	69	54	98.9	101.05	43.14	83.28	1	22.39
Mg	21	38	29	43	7	28	21	28.65	29.27	16.78	24.84	1	7.2
S	37.04	83.07	75.66	113.49	10	47.04	37.04	65.64	67.07	29.59	55.58	1.5	15.56
B	0	0.44	0.38	0.75	0.2	0.2	0	0.32	0.33	0	0.18	0	0.05
Cl	42	68	56	58	75	117	42	77.35	79.03	33.55	48.72	9	19.33
Na	43	48	41	53	70	113	43	66.2	67.64	34.35	42.04	5	14.63
TDS	442	700	616	840	320	762	442	667.1	681.6	353.12	525.52	23	153.66
Hardness	220	456	408	552	70	290	220	366.7	374.67	175.76	310.24	17	93.24
Pump (afy)	588	0	489	0		263	588	752					
Dom (%)	1	0											
Golf (%)			0.65	0		0.35							
return flow without WW (afy)							23	21.4					
return flow without WW (%)							0.52	0.48					
Total recharge											120	346	
Ttl recharge (%)											0.26	0.74	

Sodium Hazard				dS/m
	SAR WW	2.9	EC WW	1.19
	SAR DOM	1.26	EC DOM	0.69
	SAR IRR	1.52	EC IRR	1.04

The Woodlands - PHASE III (years 17+)
Basin Pickup Calculations

Constituent	WW Pickup (mg/l)	WW Imports (tons)	Fert Imports (tons)	Total Imports (tons)	Total Exports (tons)	Basin Pickup (tons)	Recharge Initial (mg/l)	Basin Pickup (mg/l)	Recharge Final (mg/l)
N	18	8.50	15.34	23.84	22.38	1.46	0.98	2.13	3.11
P	2.6	1.20	6.45	7.65	7.65	0.00	0	0.00	0.00
K	10	4.70	0.00	4.70	0.00	4.70	0.82	6.82	7.64
Ca	15	7.10	8.30	15.40	0.00	15.40	23.96	22.36	46.32
Mg	7	3.30	0.00	3.30	0.00	3.30	7.63	4.79	12.42
S	10	4.70	0.00	4.70	0.00	4.70	16.62	6.82	23.44
B	0.2	0.10	0.00	0.10	0.00	0.10	0.05	0.15	0.20
Cl	75	35.30	0.00	35.30	0.00	35.30	20.02	51.24	71.26
Na	70	32.90	0.00	32.90	0.00	32.90	15.06	47.76	62.82
TDS	320	150.60	96.10	246.70	122.60	124.10	161.58	180.15	341.73

Constants used:

1233619	af into liters		superphosphate
2.2E-06	mg into lbs		Ca2((H2P(O4))2*H2O
2.719619	mg/L into lbs/af	wght	252.1
346	afy of wastewater	%Ca	0.27
273	irrigated acres	%P	0.21
736	ton/af into mg/l		
98	percent nitrogen uptake by plants		
10	percent of WW as return flow		
4.43	N into N03 for TDS		Potassium Chloride
3.07	P onto P04 for TDS		KCl
3	S into S04 for TDS	wght	74.55
368	afy perc	%Cl	0.48
139	afy return flow	%K	0.52
507	total afy recharge		

Golf Course Nitrogen Fertilizer	acres	pounds per acre	pounds	tons
Greens and tees	27.3	348.48	9514	4.757
Fairways	136.5	174.24	23784	11.892
Rough	109.2	87.12	9514	4.757
total	273		42812	21.406

Fertilizer Demand

	golf courses			non-golf course areas		
	fertil require demand	total irrig supply	fertil import	fertil require demand	total irrig supply	fertil import
	-----------------------------	------------(tons)------------	-----------------------------			
N	21.41	11.73	9.68	9.28	3.61	5.67
P	5.35	1.22	4.13	2.32	0.00	2.32
K	5.35	6.07	0.00	2.32	2.29	0.00
Ca						
Mg						
S	0.96	69.06	0.00	0.75	43.54	0.00
B						
Cl						
Na						
TDS						

Non-Golf Course Fertilized Acreage	acres	non-golf fert.
golf w/practice area	273	0
improvements	384	167
parks	38.6	29.6
misc. landscaping	16.4	16.4
ponds	22.3	0
subttl	734.3	213
open space	222.7	

The Woodlands - PHASE III (years 17+)

Water Quality Calculations

Constituent							Irrigation Quality (includes WW contributions)				Return Flow Quality (WW contributions not included)		
	Hwy 1	Dawn	Mesa	Home	Pickup	Ave WW Qual	Ave Dom Qual	Ave Golf Qual	golf irr tons	dom irr tons	return flow	Rain Qual	Initial Perc
	(mg/l)										(mg/l)		
N	3.61	0.7	2.8	0.9	18	21.38	3.38	10.98	11.73	3.61	3.1	0.2	0.98
P	0	0	0	0	2.8	2.6	0	1.14	1.22	0	0	0	0
K	2	3.8	4	3.7	10	12.1	2.14	7.58	8.07	2.29	3.03	0	0.82
Ca	54	120	115	150	15	74	59.28	96.96	103.55	63.39	86.03	1	23.96
Mg	21	38	29	43	7	29	22.36	29	30.97	23.91	25.55	1	7.63
S	37.04	83.07	75.66	113.49	10	50.72	40.72	64.69	69.06	43.54	57.49	1.5	16.62
B	0	0.44	0.38	0.75	0.2	0.24	0.04	0.32	0.34	0.04	0.2	0	0.05
Cl	42	68	56	58	75	119	44.08	83.72	89.41	47.13	49.8	9	20.02
Na	43	48	41	53	70	113	43.4	72.68	77.62	46.41	42.25	5	15.06
TDS	442	700	616	840	320	783	462.64	689.48	736.32	494.7	536.25	23	161.58
Hardness	220	456	408	552	70	309	238.88	364.44	389.2	255.43	320.06	17	98.83
Pump (afy)	722	65	440	0		346	787	786					
Dom (%)	0.92	0.08											
Golf (%)			0.56	0		0.44							
return flow without WW (afy)							23	21.4					
return flow without WW (%)							0.52	0.48					
Total recharge											139	368	
Ttl recharge (%)											0.27	0.73	

Sodium Hazard				
				dS/m
	SAR WW	2.82	EC WW	1.22
	SAR DOM	1.22	EC DOM	0.72
	SAR IRR	1.72	EC IRR	1.08

The Woodlands - Phase I
Ground Water Recharge Beneath Site

Average Precip (ft)
1.17

Approx acreage (16 model grid areas)
367

Perc of precip (uncovered areas)
0.25

Perc of precip for covered areas (concentrated runoff)
0.6

Average percolation of precip for uncovered lands (afy)
85

Average percolation of precip for covered lands (afy)
54

Improvements	acres	% covered	covered
Village		70	0
Hotel/Resort		50	0
Residential	116.8	50	58.4
RV Storage	2	0	0
Public school	0	50	0
Maint/WWTP	3	80	2.4
Clubhouses	0.8	100	0.8
Roads	15	100	15
TOTAL (Phase I only)	137.6		76.6

Return flow (Phase I only)
57 afy

Total recharge beneath 957-acre site (Phase I completed)
369 afy WATER QUALITY CALCULATIONS INPUT

Adjusted perc of precip with covered areas (Phase I area only)
0.324 MODEL INPUT

The Woodlands - Phase II
Ground Water Recharge Beneath Site

Average Precip (ft)
1.17

Approx acreage (15 model grid areas)
344

Perc of precip (uncovered areas)
0.25

Perc of precip for covered areas (concentrated runoff)
0.6

Average percolation of precip for uncovered lands (afy)
76

Average percolation of precip for covered lands (afy)
59

Improvements	acres	% covere	acres covered
Village	4	70	2.8
Hotel/Resort	17.5	50	8.75
Residential	99	50	49.5
Public school	10	50	5
Maint/WWTP	3	80	2.4
Clubhouses	0.8	100	0.8
Roads	15	100	15
TOTAL (Phase II only)	149.3		84.25

Return flow (Phase II only)
63 afy

Total recharge beneath 957-acre site (Phases I, II completed)
466 afy WATER QUALITY CALCULATIONS INPUT

Adjusted perc of precip with covered areas (Phase II area only)
0.335 MODEL INPUT

The Woodlands - Phase III
Ground Water Recharge Beneath Site

Average Precip (ft)
1.17

Approx acreage (957 acres - Phases I, II; approx 11 model grid areas)
246

Perc of precip (uncovered areas)
0.25

Perc of precip for covered areas (concentrated runoff)
0.6

Average percolation of precip for uncovered lands (afy)
56

Average percolation of precip for covered lands (afy)
38

Improvements	acres	% covered	acres covered
Village	4	70	2.8
Hotel/Resort	0	50	0
Residential	83	50	41.5
Public school	0	50	0
Maint/WWTP	0	80	0
Clubhouses	0	100	0
Roads	10	100	10
TOTAL (Phase III only)	97		54.3

Return flow (Phase III only)
19 afy

Total recharge beneath 957-acre site (Phases I, II, III completed)
507 afy WATER QUALITY CALCULATIONS INPUT

Adjusted perc of precip with covered areas (Phase III area only)
0.327 MODEL INPUT

USI

WATER RESOURCES MANAGEMENT STUDY ADDENDUM

FOR

THE WOODLANDS

SEPTEMBER 1997

Timothy S. Cleath
Exp 10/31/99

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INTRODUCTION

Cleath & Associates has revised the estimated impacts to water resources due to The Woodlands project as reported in the Water Resources Management Study dated April 1996. These revisions are based on incorporating changes to the project description and the effects on ground water recharge of eucalyptus removal during development. The basis for the revisions, along with revised water-related calculations and tables for the proposed project and for several project alternatives, are presented in this addendum to the 1996 Water Resources Management Study.

PROJECT DESCRIPTION

The Woodlands development program consists of two phases over a 10 to 15 year period. At buildout, the project would include 1,320 residential units spread over 235 acres, 27 acres of commercial uses including a village center and a 500-room hotel resort, 22 acres for a business park, and 587 acres in recreation and open space, including two 18-hole golf courses, several parks, a habitat preserve for the Monarch Butterfly, open space buffers around the site perimeter and land left unimproved.

Three project alternatives have also been fully evaluated herein; an expanded commercial/business park alternative and two rural village alternatives. The expanded commercial/business park alternative increases the size of the proposed business park from 22 to 46 acres, with a corresponding decrease in the proposed residential acreage from 235 to 211 acres, although the number of residential units remains 1,320. The rural village alternatives both include a total of 957 residential units, one with a 22-acre business park and the other with a 46-acre business park. A summary of The Woodlands development program at buildout with the changes for each alternative is presented in Table 1.

PROJECT WATER DEMAND

Tables presenting a summary of the project water demand at buildout and for each project alternative are found in appendices A through D. The estimated percentage of indoor and outdoor use is listed, along with the estimated consumption for each use. Figure 1 summarizes the water use for the project and all three alternatives in a simplified flow diagram.

Gross water demand for the proposed project is estimated at 1,639 acre-feet per year (afy) of which 1,102 afy is consumed, 139 afy percolates back to ground water (return flow) and 398 afy is available as wastewater supply. Gross water demand for the expanded commercial/business park alternative is estimated at 1,654 afy of which 1,098 afy is consumed, 137 afy percolates back to ground water and 419 afy is available as wastewater supply. Gross water demand for the rural village alternative is estimated at 1,532 afy of which 1081 afy is consumed, 139 afy percolates back to ground water and 312 afy is available as wastewater supply. Gross water demand for the rural village with expanded business park

TABLE 1

Project Description at Buildout
The Woodlands

Land Use	Unit Type	Project		Alt. 1		Alt. 2		Alt. 3	
		Units	Acres	Units	Acres	Units	Acres	Units	Acres
RESIDENTIAL LAND USE									
0.3-1 acre lots	D.U.	48	33						
10-14,000 sf lots	D.U.	72	20						
7-9,999 sf lots	D.U.	437	85						
4-6,999 sf lots	D.U.	683	93						
High density	D.U.	80	4						
SUBTOTAL		1320	235	1320	211	957	235	957	211
VILLAGE CENTER									
Commercial/mixed uses	acre	3	3						
Village green/pedestrian areas	acre	6	6						
HOTEL/RESORT									
Hotel/restaurant	room	500	16						
Conference Center/mixed uses	acre	2	2						
BUSINESS PARK	acre	22	22		46		22		46
GOLF COURSES AND FACILITIES									
36 Holes	acre	260	260						
2 Clubhouses	facility	2	3						
Practice area	acre	15	15						
Ponds	acre	22	22						
PARKS									
Neighborhood/buffer	acre	30	30						
Habitat Preserve	acre	11	11						
Public park	acre	12	12						
UNIMPROVED/OPEN SPACE	acre	234	234						
PUBLIC FACILITIES									
School	student	350	10						
Wastewater/Maint. facility	facility	1	10						
ROADS/EASEMENTS (NON-IRRIG)	acre	66	66						
TOTAL ACREAGE			957						

Alternatives:
Alt. 1 = Expanded commercial/business park
Alt. 2 = Rural Village
Alt. 3 = Rural Village with expanded commercial/business park

alternative is estimated at 1,547 afy of which 1076 afy is consumed, 137 afy percolates back to ground water and 334 afy is available as wastewater supply.

EUCALYPTUS WATER USE

As mentioned above, the 1996 Water Resources Management Study has been revised to also incorporate the effects that eucalyptus removal would have on ground water recharge beneath the site. Existing vegetation at The Woodlands is approximately 90 percent Eucalyptus Globulus (863 acres out of 957 total acres). A survey of information on eucalyptus water use was performed through literature review and consultation with several botanists and agriculturalists. The results of the survey are presented in correspondence to USI Properties dated June 10, 1997 (Appendix E).

E. Globulus water demand exceeds the available rainfall on the Nipomo Mesa. Plants which cannot tap ground water ("dry-feet" eucalyptus) supplement rainfall with water derived from fog-drip. In "dry-feet" eucalyptus plantations, such as found at The Woodlands, eucalyptus develop a dense mat of shallow roots which intertwine with the roots of adjacent plants in the grove. The root mat is capable of storing excess water for later use by the plant. The eucalyptus groves on the property will use a high percentage of the rainfall (80 to 90 percent), supplemented by fog drip. Virtually all rainfall not lost to direct evaporation is intercepted by the groves.

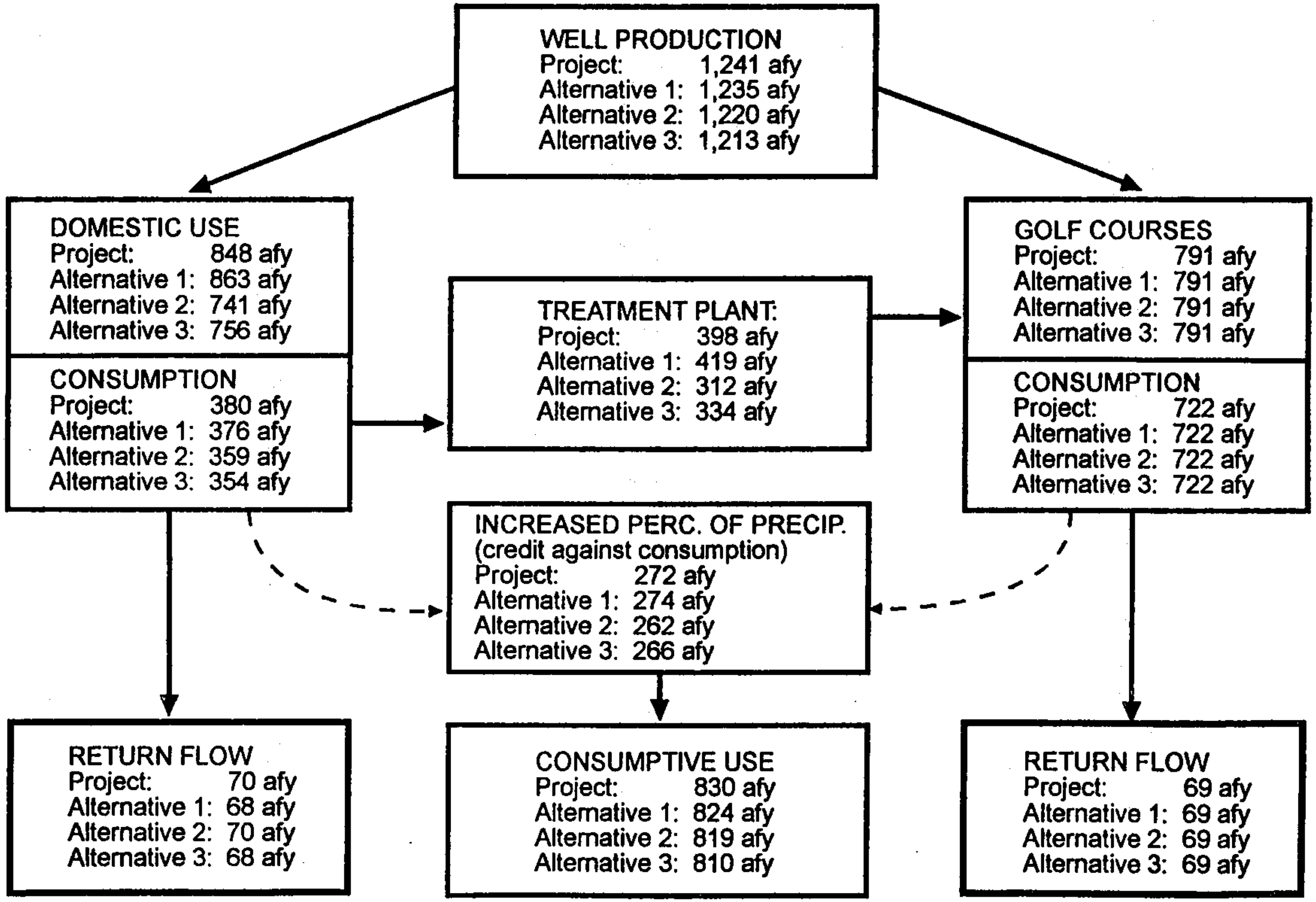
EFFECTS OF EUCALYPTUS REMOVAL

Eucalyptus removal at The Woodlands will increase the amount of recharge to ground water beneath the site. This is due to the increased percolation of precipitation following development. The eucalyptus, when in plantation, is able to utilize rainfall more efficiently than any other plant. Therefore, project improvements used to replace the eucalyptus, such as turf grass, will increase the amount of rainfall reaching ground water. This benefit to the ground water basin recharge from eucalyptus removal was not incorporated into previous work by Cleath & Associates. The changes in ground water recharge and resulting changes in consumptive use of the project due to the effect of eucalyptus removal are quantified below and used for revising the potential impacts to water resources attributable to the project.

Ground Water Recharge Beneath Site

Cleath & Associates' estimate of the average percolation of precipitation on the Nipomo Mesa is 25 percent. The average annual rainfall on the Nipomo Mesa is 15 inches. The average annual rainfall at the Nipomo gage used for ground water modeling is 16 inches, however, precipitation at the Nipomo gage between 1977 and 1992 (the hydrologic cycle used in modeling) averaged 17.8 inches. Therefore, as discussed in the 1996 Water Resources Management Study (page 34), the value for average

FIGURE 1
WATER USE DIAGRAM - THE WOODLANDS



Alternative 1 - Expanded Commercial/Business Park
Alternative 2 - Rural Village
Alternative 3 - Rural Village with Expanded Business Park

percolation of precipitation on the Nipomo Mesa was adjusted down in the model from 25 percent to 21 percent to compensate for the use of the Nipomo rainfall gage data and the cumulative departure from average seen at that gage over the hydrologic model period from 1977 to 1992. Ground water recharge calculations contained in the appendices of both this addendum and the 1996 Water Resources Management Study use the actual percolation of precipitation estimate of 25 percent because the average rainfall estimate used is site specific (14 inches per year at The Woodlands based on County mean seasonal precipitation maps for 1897-98 to 1946-47 and 1935-36 to 1966-67).

To incorporate the effects of eucalyptus removal on ground water recharge, the acreage remaining in eucalyptus following development is assumed to be roughly equal to the unimproved area, open space buffer, and habitat preserve combined (approximately 245 acres of eucalyptus remaining for the project and all three alternatives). The resulting estimates of total recharge to ground water at the site following development, including return flows, are: 438 afy for the project and the expanded commercial/business park alternative, 428 afy for the rural village alternative, and 430 afy total recharge to ground water for the rural village expanded business park alternative (calculations in Appendices A through D):

The above recharge figures are all less than the 507 afy previously estimated for ground water recharge following project development shown on page C-9 of the 1996 Water Resources Management Study. This is due to changes in the project description and to incorporating the effects of eucalyptus removal. Average annual ground water recharge beneath the site during the baseline (existing conditions) model run was 279 afy. The revised estimate for existing conditions, considering eucalyptus water use, is only 27 afy. Impacts to water resources are based on the difference between existing conditions (baseline) and project conditions. The net increase in total recharge to ground water at the site due to development is summarized below in Table 2.

Table 2
Ground Water Recharge -The Woodlands

Project Alternative (buildout)	Existing Conditions Site Recharge (afy)		Project Conditions Site Recharge (afy)		Recharge Increase due to Project (afy)	
	1996 Study	1997 Addendum	1996 Study	1997 Addendum	1996 Study	1997 Addendum
Proposed	279	27	507	438	228	411
Alt. 1				438		411
Alt. 2				428		401
Alt. 3				430		403

NOTES:
Alt. 1 - Expanded commercial/business park alternative
Alt. 2 - Rural village alterative
Alt. 3 - Rural village expanded business park alternative

Consumptive Water Use

The consumptive water use of the project is the amount of water removed from the basin due to the project. In the 1996 Water Resources Management Study, the total ground water production was estimated at 1,228 afy and the amount of total recharge to ground water at buildout was estimated at 507 afy, of which 279 afy was baseline recharge which existed prior to project development. Therefore, the consumptive water use of the project in the 1996 Study was 1,000 afy (1,228 afy - 507 afy +279 afy). Table 3 shows the revised consumptive use of the project and the alternatives based on the ground water production figures in Figure 1 and the increased recharge figures due to the project in Table 2 (also equal to gross water consumption minus increased percolation of precipitation as shown in Figure 1).

Table 3
Consumptive Water Use - The Woodlands

Project (Buildout)	Consumptive Water Use (afy)		Percent reduction from 1996 Study
	1996 Study	1997 Addendum	
Proposed project	1000	830	17.0%
Alternative 1		824	17.6%
Alternative 2		819	18.1%
Alternative 3		810	19.0%

NOTES: Alt. 1 - Expanded commercial/business park alternative
Alt. 2 - Rural village alterative
Alt. 3 - Rural village expanded business park alternative

It may seem unusual that the expanded commercial/business park alternative consumes less water than the proposed project, or that the rural village expanded business park alternative consumes less water than the rural village alternative. This reduction in water consumption with expansion of the business park acreage is due to a corresponding reduction in residential (irrigated) acreage. The residential landscape acreage consumes more water per acre than the business park due to the large wastewater component from the business park which is recycled for golf course irrigation (see Project Water Use table in Appendix A).

REVISED IMPACTS TO GROUND WATER RESOURCES

The potential impacts to ground water resources from The Woodlands project may be divided into three categories; impacts to ground water quality, water level interference between on- and off-site wells, and impacts to ground water in storage. Each of these were analyzed in the 1996 Water Resources Management Study and are revised below for the proposed project and alternatives.

Potential Impacts to Ground Water Quality

The potential impacts to ground water quality have been expressed in the Water Resources Management Study in terms of "basin pickup". Basin pickup represents the quantity of each water quality constituent that is imported onto the site due to the project and eventually leaches to ground water. The amount of basin pickup is expressed in tons per year.

Potential water quality impacts have also been expressed in terms of percolating water quality beneath the site. Table 4 presents the basin pickup and revised percolating water quality estimates for the project (calculations in Appendix A). The basin pickup and water quality estimates for project alternatives, which are similar to the project estimates, may be found in Appendices B, C, and D.

Table 4

Estimated Ground Water Basin Mineral Pickup - The Woodlands

Analyte	Imports (tons/yr)			Exports (Tons/yr)	Basin Pickup (Tons/yr)	Percolating Water Quality (Project)		
	Reclaimed Water	Fertilizer	Total			Initial (mg/L)	Pickup (mg/L)	Final (mg/L)
N	9.7	12.3	22.0	20.6	1.5	1.1	2.45	3.56
P	1.4	5.9	7.3	7.3	0.0	0.00	0.00	0.00
K	5.4	0.0	5.4	0.0	5.4	0.98	9.07	10.05
Ca	8.1	7.5	15.6	0.0	15.6	28.65	26.21	54.86
Mg	3.8	0.0	3.8	0.0	3.8	8.97	6.39	15.36
S	5.4	0.0	5.4	0.0	5.4	19.72	9.07	28.79
B	0.1	0.0	0.1	0.0	0.1	0.07	0.17	0.24
Cl	40.6	0.0	40.6	0.0	40.6	22.23	68.22	90.45
Na	37.9	0.0	37.9	0.0	37.9	16.95	63.69	80.64
TDS	173.2	80.0	253.2	113.3	139.9	188.96	235.08	424.04

A comparison of water quality constituents in percolating water estimated above with existing water quality at the site shows the percolating water quality to be generally similar to the existing water quality (Appendix F). The estimated average concentrations of water quality constituents in the final recharge water do not exceed drinking water standards.

Interference Analyses

The ground water flow model used in the 1996 Water Resources Management Study estimated project impacts by comparing the baseline scenario to the project scenario. The revised estimates of potential water level interference at neighboring wells have been proportioned based on changes to the consumptive water use of the project listed in Table 3.

The revised consumptive use figures are 17% to 19% lower than the estimate used in the 1996 Water Resources Management Study. The amount of water level interference at neighboring wells attributable to the project, therefore, should be about 17% to 19% less than previously estimated for model stress period 66 (Fall 2025), based on a proportional relationship between discharge and drawdown. Table 5 presents the revised figures for water level interference at specific neighboring wells during the period of lowest water levels (model stress period 66).

Table 5
Water Level Interference Impacts - The Woodlands

Well Number	Water level interference due to project: Baseline minus Project drawdown (feet)				
	1996 Study	1997 Project	Alt. 1	Alt. 2	Alt .3
11N/35W-10La	-3.43	-2.85	-2.83	-2.81	-2.78
11N/35W-14Nb	-4.59	-3.81	-3.78	-3.76	-3.72
11N/35W-15G	-3.84	-3.19	-3.16	-3.14	-3.11
11N/35W-16Kx	-2.88	-2.39	-2.37	-2.36	-2.33
11N/35W-21Ja	-1.00	-0.83	-0.82	-0.82	-0.81
11N/35W-22Ga	-2.85	-2.37	-2.35	-2.33	-2.31

NOTES:
Alt. 1 - Expanded commercial/business park alternative
Alt. 2 - Rural village alterative
Alt. 3 - Rural village expanded business park alternative

Note that Table 4 reports the <u>difference</u> between baseline and project scenario water level drawdown. These revised water level interference estimates should closely approximate the difference between actual model results for each scenario, despite the potential effects of boundary conditions and model re-calibration on individually redefined baseline and project scenario runs. Estimated static ground water elevations in neighboring wells during stress period 66 would be about 10 to 23 feet above mean sea level without the project, and about 7 to 19 feet above mean sea level with the project, based on the modeling performed in the 1996 Ground Water Resources Management Study.

Potential Impacts to Ground Water in Storage

The changes in consumptive water use due to project revisions and the effects of eucalyptus removal have also been used to revise the estimated impacts to ground water in storage. The potential impacts to ground water in storage attributable to the project and to alternative 3 (the rural village expanded business park project) are presented in Table 6 below. The estimated impacts for alternatives 1 and 2 would lie between these two scenarios in proportion to their consumptive use values in Table 3.

Table 6
Ground Water in Storage Impacts - The Woodlands

Scenario		Difference in Storage: Baseline storage minus project storage (af)					
Cycle	Year	1996 Study		1997 Project		Alternative 3	
		Storage	Change	Storage	Change	Storage	Change
End of calibration	1992	0		0		0	
End of 1st cycle	2008	-1313	-1313	-1090	-1090	-1064	-1064
End of 2nd cycle	2024	-1778	-465	-1476	-386	-1440	-376
End of 3rd cycle	2040	-1844	-66	-1531	-55	-1494	-54

The revised estimates indicate that after the first hydrologic cycle of 16 years (buildout) there will be 1,090 acre-feet less useable ground water in storage beneath the Nipomo Mesa due to the project (using 1992 production as baseline). At the end of the second cycle, there would be 1,476 acre-feet less ground water in storage due to the project, equivalent to an additional loss of 386 acre-feet (24 afy loss over the 16-year cycle) due to the project. Similarly, there would be an additional 55 acre-feet of loss in storage due to the project at the end of the third cycle (about 3.4 afy additional loss in storage). Note that these are differences between baseline and project ground water in storage. Due to the potential effects of boundary conditions and model re-calibration on redefined baseline and project scenario runs, the revised differences between the runs are approximations of model results.

As previously discussed in the Water Resources Management Study (page 51), the biggest losses to ground water in storage beneath the Nipomo Mesa have taken place historically and future losses will be less despite increased production. This phenomena is due to the increase in subsurface ground water inflow and decrease in subsurface outflow which results from lowering the water levels beneath the Nipomo Mesa.

CONCLUSIONS

The project description revisions and estimated effects of eucalyptus removal on ground water recharge beneath the site have resulted in a decrease in the project's consumptive water use by about 17 percent from the 1996 Ground Water Resources Study (up to 19 percent decrease for the project alternatives). This decrease in consumptive water use results in several changes to the impacts assessment performed in the 1996 Water Resources Management Study. Revised conclusions regarding water demand and the estimated impacts to water resources for development at The Woodlands are presented as follows.

- Project water demand at buildout is estimated at 1,639 afy gross, of which 398 afy is supplied by reclaimed water generated on-site and the remaining 1,241 afy is supplied by ground water wells. Water demand for the golf courses (and lakes) is 791 afy; 398 afy reclaimed water and 393 afy ground water. The balance of ground water production, 848 afy, satisfies domestic water demand, which includes all uses other than golf course irrigation. Domestic water use consumes 380 afy, return flow from domestic supply irrigation is 70 afy, and 398 afy is reclaimed for golf course irrigation. Golf course irrigation consumes 722 afy, leaving 69 afy as return flow.

- In addition to return flows from applied water, site development involves eucalyptus removal and results in an increase in recharge from percolation of precipitation beneath the site, compared to existing conditions. Under existing conditions, total recharge beneath the site is estimated at 27 afy. Under project conditions, total recharge is estimated at 438 afy, an increase of 411 afy, of which 272 afy is increased percolation of precipitation and 139 afy is return flow from applied water. The total consumptive water use of the project is estimated at 830 afy.

- Estimated gross water demand for the expanded commercial/business park project alternative (1,654 afy) is greater than the gross water demand for the proposed project, however, the expanded commercial/business park alternative results in less consumptive water use (824 afy) than the project due to the wastewater component of the business park and the reduction in residential acreage.

- Estimated gross water demand for the rural village project alternative is 1,532 afy with 819 afy consumptive use. The gross water demand for the rural village expanded business park is estimated at 1,547 afy with 810 afy consumptive water use.

- The estimated average quality of recharge water percolating to ground water at the site following development would generally be similar to the existing water quality beneath the site. The estimated average concentrations of water quality constituents in the final recharge water do not exceed drinking water standards.

- Interference effects from project-related pumpage on neighboring wells is estimated at a maximum of 3.8 feet of drawdown during years when water levels are lowest. Production in neighboring wells should not be significantly impacted from project-related pumpage at The Woodlands, based on the modeled water level elevations and the available data on perforated intervals.

- Future ground water in storage beneath the Nipomo Mesa is estimated to decline an additional 68 afy during the first 16 years of project development compared to estimated declines based on maintaining 1992 production levels in the area. Declines in storage attributable to the project within subsequent 16 year cycles are estimated to be 24 afy during the second cycle and less than 4 afy decline in storage during the third 16 year cycle.

APPENDIX A:

Project Calculations

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oject Water Use at Buildout

The Woodlands

Element Description	Type Unit	Number Units	Water Demand						Water Consumed					Return flow	Wastewater
			Duty Factor	indoor		outdoor		total	indoor		outdoor		total		
			(afy/unit)	%	afy	%	afy	afy	%	afy	%	afy	afy	afy	afy
Resid. 4K-6,999 sf	D.U.	683.0	0.37	81.0	204.7	19.0	48.0	252.7	20.0	40.9	80.0	38.4	79.3	9.6	163.8
Resid. 7K-9,999 sf	D.U.	437.0	0.50	60.0	131.1	40.0	87.4	218.5	20.0	26.2	80.0	69.9	96.1	17.5	104.9
Resid. 10K-14,000 sf	D.U.	72.0	0.79	38.0	21.6	62.0	35.3	56.9	20.0	4.3	80.0	28.2	32.5	7.1	17.3
Resid. 0.3-1 acre	D.U.	48.0	1.50	20.0	14.4	80.0	57.6	72.0	20.0	2.9	80.0	46.1	49.0	11.5	11.5
Multi-family	D.U.	80.0	0.22	100.0	17.6	0.0	0.0	17.6	20.0	3.5	0.0	0.0	3.5	0.0	14.1
Village: mixed use	acre	3.0	2.10	100.0	6.3	0.0	0.0	6.3	20.0	1.3	0.0	0.0	1.3	0.0	5.0
Village: Landscaping	acre	2.0	1.50	0.0	0.0	100.0	3.0	3.0	20.0	0.0	80.0	2.4	2.4	0.6	0.0
Resort: Hotel	room	500.0	0.15	70.0	52.5	30.0	22.5	75.0	20.0	10.5	80.0	18.0	28.5	4.5	42.0
Resort: mixed use	acre	2.0	2.10	70.0	2.9	30.0	1.3	4.2	20.0	0.6	80.0	1.0	1.6	0.3	2.3
Business Park	acre	22.0	1.60	70.0	24.6	30.0	10.6	35.2	20.0	4.9	80.0	8.5	13.4	2.1	19.7
Golf (36 holes+practice)	acre	275.0	2.50	0.0	0.0	100.0	687.5	687.5	0.0	0.0	90.0	618.8	618.8	68.8	0.0
Ponds	acre	22.0	4.70	0.0	0.0	100.0	103.4	103.4	0.0	0.0	100.0	103.4	103.4	0.0	0.0
Golf Clubhouse	facility	2.0	6.40	100.0	12.8	0.0	0.0	12.8	20.0	2.6	0.0	0.0	2.6	0.0	10.2
Schools	student	350.0	0.03	50.0	5.3	50.0	5.3	10.6	20.0	1.1	80.0	4.2	5.3	1.1	4.2
Maint/WWTP	lump	1.0	7.30	49.0	3.6	51.0	3.7	7.3	20.0	0.7	80.0	3.0	3.7	0.7	2.9
Parks - neighborhood	acre	30.0	1.70	0.0	0.0	100.0	51.0	51.0	0.0	0.0	80.0	40.8	40.8	10.2	0.0
Parks - public	acre	12.0	2.10	0.0	0.0	100.0	25.2	25.2	0.0	0.0	80.0	20.2	20.2	5.0	0.0
TOTAL					497.4		1141.8	1639.2		99.5		1002.9	1102.4	138.9	397.9

The Woodlands - Proposed project
Ground Water Recharge Beneath Site

Average Precip (ft)
1.17

Approx acreage
957
221 covered
245 uncovered (eucalyptus plantation)
491 uncovered (golf, parks, other)

Perc of precip (uncovered areas - except Eucalyptus)
0.25

Perc of precip (uncovered areas - Eucalyptus)
0

Perc of precip for covered areas (concentrated runoff)
0.6

Average percolation of precip for uncovered lands (afy)
144

Average percolation of precip for covered lands (afy)
155

Improvements	acres	% covered	covered
Village Center	9	75	6.75
Hotel/Resort	18	75	13.5
Residential	235	50	117.5
Business Park	22	75	16.5
Public school	10	75	7.5
Maint/WWTP	10	75	7.5
Clubhouses	3	75	2.25
Roads/easements	66	75	49.5
TOTAL	373		221

Return flow
139 afy

Total recharge beneath 957-acre site
438 afy WATER QUALITY CALCULATIONS INPUT

Adjusted perc of precip with covered areas
0.267

The Woodlands
Example Production Plan - Buildout

Net Demand		Pumpage (continuous gpm)				
Month	GPM	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	315	315				315
Feb	361	361				361
Mar	422	422				422
Apr	768	500		268		768
May	1144	500	144	500		1144
Jun	1228	500	228	500		1228
Jul	1174	500	174	500		1174
Aug	1174	500	174	500		1174
Sep	1067	567		500		1067
Oct	783	500		283		783
Nov	476	476				476
Dec	299	299				299
Average	769	454	60	255	0	769

Net Demand		Pumpage (acre-feet)				
Month	AFY	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	43.2	43.2				43.2
Feb	44.7	44.7				44.7
Mar	57.8	57.8				57.8
Apr	101.8	66.3		35.5		101.8
May	156.7	68.5	19.7	68.5		156.7
Jun	162.8	66.3	30.2	66.3		162.8
Jul	160.8	68.5	23.8	68.5		160.8
Aug	160.8	68.5	23.8	68.5		160.8
Sep	141.5	75.2		66.3		141.5
Oct	107.3	68.5		38.8		107.3
Nov	63.1	63.1				63.1
Dec	41.0	41.0				41.0
Total	1241.5	731.6	97.5	412.4	0.0	1241.5

The Woodlands - Buildout
Water Quality Calculations

Constituent							Irrigation Quality (includes WW contributions)				Return Flow Quality (WW contributions not included)		
	Hwy 1	Dawn	Mesa	Home	Pickup	Ave WW Qual	Ave Dom Qual	Ave Golf Qual	golf irr tons	dom irr tons	return flow	Rain Qual	Initial Perc
	(mg/l)										(mg/l)		
N	3.61	0.7	2.8	0.9	18	21.26	3.26	11.85	13.04	3.68	3.04	0.2	1.11
P	0	0	0	0	2.6	2.6	0	1.27	1.4	0	0	0	0
K	2	3.8	4	3.7	10	12.2	2.22	8.02	8.83	2.5	3.07	0	0.98
Ca	54	120	115	150	15	77	61.92	96.38	106.07	69.83	87.4	1	28.65
Mg	21	38	29	43	7	30	23.04	29.49	32.46	25.98	25.9	1	8.97
S	37.04	83.07	75.66	113.49	10	52.56	42.56	64.34	70.81	48	58.45	1.5	19.72
B	0	0.44	0.38	0.75	0.2	0.25	0.05	0.32	0.35	0.06	0.21	0	0.07
Cl	42	68	56	58	75	120	45.12	87.36	96.14	50.88	50.34	9	22.23
Na	43	48	41	53	70	114	43.6	76.77	84.49	49.17	42.35	5	16.95
TDS	442	700	616	840	320	793	472.96	702.73	773.38	533.37	541.62	23	188.96
Hardness	220	456	408	552	70	318	248.32	363.9	400.49	280.03	324.97	17	115.55
Pump (afy)	732	98	412	0		398	830	810					
Dom (%)	0.88	0.12											
Golf (%)			0.51	0		0.49							
return flow without WW (afy)							23	21.4					
return flow without WW (%)							0.52	0.48					
Total recharge											139	299	
Ttl recharge (%)											0.32	0.68	

Sodium Hazard

			dS/m
SAR WW	2.79	EC WW	1.24
SAR DOM	1.2	EC DOM	0.74
SAR IRR	1.84	EC IRR	1.1

.he Woodlands - Project
Basin Pickup Calculations

Constituent	WW Pickup (mg/l)	WW Imports (tons)	Fert Imports (tons)	Total Imports (tons)	Total Exports (tons)	Basin Pickup (tons)	Recharge Initial (mg/l)	Basin Pickup (mg/l)	Recharge Final (mg/l)
N	18	9.70	12.31	22.01	20.55	1.46	1.11	2.45	3.56
P	2.6	1.40	5.86	7.26	7.26	0.00	0	0.00	0.00
K	10	5.40	0.00	5.40	0.00	5.40	0.98	9.07	10.05
Ca	15	8.10	7.50	15.60	0.00	15.60	28.65	26.21	54.86
Mg	7	3.80	0.00	3.80	0.00	3.80	8.97	6.39	15.36
S	10	5.40	0.00	5.40	0.00	5.40	19.72	9.07	28.79
B	0.2	0.10	0.00	0.10	0.00	0.10	0.07	0.17	0.24
Cl	75	40.60	0.00	40.60	0.00	40.60	22.23	68.22	90.45
Na	70	37.90	0.00	37.90	0.00	37.90	16.95	63.69	80.64
TDS	320	173.20	80.00	253.20	113.30	139.90	188.96	235.08	.424.04

Constants used:

1233619	af into liters		superphosphate
2.2E-06	mg into lbs		Ca2((H2P(O4))2*H2O
2.719619	mg/L into lbs/af	wght	292.1
398	afy of wastewater	%Ca	0.27
275	irrigated acres	%P	0.21
736	ton/af into mg/l		
96	percent nitrogen uptake by plants		
10	percent of WW as return flow		
4.43	N into N03 for TDS		Potassium Chloride
3.07	P onto P04 for TDS		KCl
3	S into S04 for TDS	wght	74.55
299	afy perc	%Cl	0.48
139	afy return flow	%K	0.52
438	total afy recharge		

Golf Course Nitrogen Fertilizer

	acres	pounds per acre	pounds	tons
Greens and tees	27.3	348.48	9514	4,757
Fairways	136.5	174.24	23784	11,892
Rough	109.2	87.12	9514	4,757
total	275		42812	21,406

Fertilizer Demand

	golf courses			non-golf course areas		
	fertil require demand	total irrig supply	fertil import	fertil require demand	total irrig supply	fertil import
	(tons)					
N	21.41	13.04	8.37	7.62	3.68	3.94
P	5.35	1.4	3.95	1.91	0.00	1.91
K	5.35	8.83	0.00	1.91	2.50	0.00
Ca						
Mg						
S	0.96	70.81	0.00	0.61	48.00	0.00
B						
Cl						
Na						

Non-Golf Course Fertilized Acreage

	acres	non-golf fert.
golf w/practice area	275	0
improvements	373	133
parks	42	42
ponds	22	0
subttl	712	175
open space	245	

APPENDIX B:

Expanded Commercial/Business Park Alternative Calculations

Expanded Commercial/Business Park Alternative

The Woodlands

Element Description	Type Unit	Number Units	Water Demand						Water Consumed					Return flow	Wastew
			Duty Factor	indoor		outdoor		total	indoor		outdoor		total		
			(afy/unit)	%	afy	%	afy	afy	%	afy	%	afy	afy	afy	afy
Residential (indoor)	D.U.	1320.0	0.295	100.0	389.4	0.0	0.0	389.4	20.0	77.9	80.0	0.0	77.9	0.0	311.5
Residential (outdoor)	acre	211.0	0.97	0.0	0.0	100.0	204.7	204.7	20.0	0.0	80.0	163.8	163.8	40.9	0.0
Village: mixed use	acre	3.0	2.10	100.0	6.3	0.0	0.0	6.3	20.0	1.3	0.0	0.0	1.3	0.0	5.0
Village: Landscaping	acre	2.0	1.50	0.0	0.0	100.0	3.0	3.0	20.0	0.0	80.0	2.4	2.4	0.6	0.0
Resort: Hotel	room	500.0	0.15	70.0	52.5	30.0	22.5	75.0	20.0	10.5	80.0	18.0	28.5	4.5	42.0
Resort: mixed use	acre	2.0	2.10	70.0	2.9	30.0	1.3	4.2	20.0	0.6	80.0	1.0	1.6	0.3	2.3
Business Park	acre	46.0	1.60	70.0	51.5	30.0	22.1	73.6	20.0	10.3	80.0	17.7	28.0	4.4	41.2
Golf Courses/practice	acre	275.0	2.50	0.0	0.0	100.0	687.5	687.5	0.0	0.0	90.0	618.8	618.8	68.8	0.0
Ponds	acre	22.0	4.70	0.0	0.0	100.0	103.4	103.4	0.0	0.0	100.0	103.4	103.4	0.0	0.0
Golf Clubhouse	facility	2.0	6.40	100.0	12.8	0.0	0.0	12.8	20.0	2.6	0.0	0.0	2.6	0.0	10.2
Schools	student	350.0	0.03	50.0	5.3	50.0	5.3	10.6	20.0	1.1	80.0	4.2	5.3	1.1	4.2
Maint/WWTP	lump	1.0	7.30	49.0	3.6	51.0	3.7	7.3	20.0	0.7	80.0	3.0	3.7	0.7	2.9
Parks - neighborhood	acre	30.0	1.70	0.0	0.0	100.0	51.0	51.0	0.0	0.0	80.0	40.8	40.8	10.2	0.0
Parks - public	acre	12.0	2.10	0.0	0.0	100.0	25.2	25.2	0.0	0.0	80.0	20.2	20.2	5.0	0.0
TOTAL					524.3		1129.7	1654.0		105.0		993.3	1098.3	136.5	419.4

The Woodlands - Expanded Commercial/Business Alternative
Ground Water Recharge Beneath Site

Average Precip (ft)
1.17

Approx acreage
957
227 covered
245 uncovered (eucalyptus)
485 uncovered (golf, parks, other)

Perc of precip (uncovered areas - except Eucalyptus)
0.25

Perc of precip (uncovered areas - Eucalyptus)
0

Perc of precip for covered areas (concentrated runoff)
0.6

Average percolation of precip for uncovered lands(afy)
142

Average percolation of precip for covered lands (afy)
159

Improvements	acres	% covere	acres covered
Village Center	9	75	6.75
Hotel/Resort	18	75	13.5
Residential	211	50	105.5
Business Park	46	75	34.5
Public school	10	75	7.5
Maint/WWTP	10	75	7.5
Clubhouses	3	75	2.25
Roads/easements	66	75	49.5
TOTAL	373		227

Return flow
137 afy

Total recharge beneath 957-acre site (Phase II completed)
438 afy WATER QUALITY CALCULATIONS INPUT

Adjusted perc of precip with covered areas (Phase II area only)
0.269

The Woodlands

Example Production Plan - Expanded Comm./Bus. Park

Net Demand		Pumpage (continuous gpm)				
Month	GPM	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	313	313				313
Feb	359	359				359
Mar	420	420				420
Apr	764	500		264		764
May	1138	500	138	500		1138
Jun	1222	500	222	500		1222
Jul	1169	500	169	500		1169
Aug	1169	500	169	500		1169
Sep	1062	562		500		1062
Oct	779	500		279		779
Nov	474	474				474
Dec	298	298				298
Average	766	453	59	254	0	766

Net Demand		Pumpage (acre-feet)				
Month	AFY	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	42.9	42.9				42.9
Feb	44.4	44.4				44.4
Mar	57.5	57.5				57.5
Apr	101.3	66.3		35.0		101.3
May	155.9	68.5	18.9	68.5		155.9
Jun	162.0	66.3	29.4	66.3		162.0
Jul	160.2	68.5	23.2	68.5		160.2
Aug	160.2	68.5	23.2	68.5		160.2
Sep	140.8	74.5		66.3		140.8
Oct	106.7	68.5		38.2		106.7
Nov	62.8	62.8				62.8
Dec	40.8	40.8				40.8
Total	1235.5	729.5	94.7	411.3	0.0	1235.5

The Woodlands - Expanded Commercial/Business Park Alternative
Water Quality Calculations

Constituent	Hwy 1	Dawn	Mesa	Home	Pickup	Ave WW Qual	Irrigation Quality (includes WW contributions) Ave Dom Qual	Ave Golf Qual	golf irr tons	dom irr tons	Return Flow Quality (WW contributions not included) return flow	Rain Qual	Initial Perc
	(mg/l)										(mg/l)		
N	3.61	0.7	2.8	0.9	18	21.26	3.26	12.03	13.57	3.65	3.04	0.2	1.08
P	0	0	0	0	2.6	2.6	0	1.3	1.47	0	0	0	0
K	2	3.8	4	3.7	10	12.2	2.22	8.1	9.13	2.49	3.07	0	0.95
Ca	54	120	115	150	15	77	61.92	96	108.26	69.41	87.4	1	27.78
Mg	21	38	29	43	7	30	23.04	29.5	33.27	25.83	25.9	1	8.72
S	37.04	83.07	75.66	113.49	10	52.56	42.56	64.11	72.3	47.71	58.45	1.5	19.15
B	0	0.44	0.38	0.75	0.2	0.25	0.05	0.32	0.36	0.06	0.21	0	0.07
Cl	42	68	56	58	75	120	45.12	88	99.24	50.58	50.34	9	21.82
Na	43	48	41	53	70	114	43.6	77.5	87.4	48.87	42.35	5	16.58
TDS	442	700	616	840	320	793	472.96	704.5	794.48	530.15	541.62	23	183.77
Hardness	220	456	408	552	70	318	248.32	363	409.36	278.35	324.97	17	112.47
Pump (afy)	730	95	411	0		419	825	830					
Dom (%)	0.88	0.12											
Golf (%)			0.5	0		0.5							
return flow without WW (afy)							23	21.4					
return flow without WW (%)							0.52	0.48					
Total recharge											137	301	
Ttl recharge (%)											0.31	0.69	

Sodium Hazard

			dS/m
SAR WW	2.79	EC WW	1.24
SAR DOM	1.2	EC DOM	0.74
SAR IRR	1.88	EC IRR	1.1

Basin Pickup Calculations

Constituent	WW Pickup (mg/l)	WW Imports (tons)	Fert Imports (tons)	Total Imports (tons)	Total Exports (tons)	Basin Pickup (tons)	Recharge Initial (mg/l)	Basin Pickup (mg/l)	Recharge Final (mg/l)
N	18	10.30	11.72	22.02	20.52	1.50	1.08	2.52	3.60
P	2.6	1.50	5.77	7.27	7.27	0.00	0	0.00	0.00
K	10	5.70	0.00	5.70	0.00	5.70	0.95	9.58	10.53
Ca	15	8.50	7.40	15.90	0.00	15.90	27.78	26.72	54.50
Mg	7	4.00	0.00	4.00	0.00	4.00	8.72	6.72	15.44
S	10	5.70	0.00	5.70	0.00	5.70	19.15	9.58	28.73
B	0.2	0.10	0.00	0.10	0.00	0.10	0.07	0.17	0.24
Cl	75	42.70	0.00	42.70	0.00	42.70	21.82	71.75	93.57
Na	70	39.90	0.00	39.90	0.00	39.90	16.58	67.05	83.63
TDS	320	182.30	77.00	259.30	113.20	146.10	183.77	245.50	429.27

Constants used:

1233619	af into liters		superphosphate
2.2E-06	mg into lbs		Ca2((H2P(O4))2*H2O
2.719619	mg/L into lbs/af	wght	292.1
419	afy of wastewater	%Ca	0.27
275	irrigated acres	%P	0.21
736	ton/af into mg/l		
96	percent nitrogen uptake by plants		
10	percent of WW as return flow		
4.43	N into N03 for TDS		Potassium Chloride
3.07	P onto P04 for TDS		KCl
3	S into S04 for TDS	wght	74.55
301	afy perc	%Cl	0.48
137	afy return flow	%K	0.52
438	total afy recharge		

Golf Course Nitrogen Fertilizer	acres	pounds per acre	pounds	tons
Greens and tees	27.3	348.48	9514	4.757
Fairways	136.5	174.24	23784	11.892
Rough	109.2	87.12	9514	4.757
total	275		42812	21.406

Non-Golf Course Fertilized Acreage	acres	non-golf fert.
golf w/practice area	275	0
improvements	373	131
parks	42	42
ponds	22	0
subttl	712	173
open space	245	

Fertilizer Demand	golf courses			non-golf course areas		
	fertil require demand	total irrig supply	fertil import	fertil require demand	total irrig supply	fertil import
	(tons)					
N	21.41	13.57	7.84	7.54	3.65	3.89
P	5.35	1.47	3.88	1.88	0.00	1.88
K	5.35	9.13	0.00	1.88	2.49	0.00
Ca						
Mg						
S	0.96	72.3	0.00	0.61	47.71	0.00
B						
Cl						
Na						
TDS						

APPENDIX C:

Rural Village Alternative Calculations

Rural Village Alternative

The Woodlands

Element Description	Type Unit	Number Units	Water Demand						Water Consumed					Return flow afy	Wastew afy
			Duty Factor (afy/unit)	indoor		outdoor		total afy	indoor		outdoor		total afy		
				%	afy	%	afy		%	afy	%	afy			
Residential (indoor)	D.U.	957.0	0.295	100.0	282.3	0.0	0.0	282.3	20.0	56.5	80.0	0.0	56.5	0.0	225.8
Residential (outdoor)	acre	235.0	0.97	0.0	0.0	100.0	228.0	228.0	20.0	0.0	80.0	182.4	182.4	45.6	0.0
Village: mixed use	acre	3.0	2.10	100.0	6.3	0.0	0.0	6.3	20.0	1.3	0.0	0.0	1.3	0.0	5.0
Village: Landscaping	acre	2.0	1.50	0.0	0.0	100.0	3.0	3.0	20.0	0.0	80.0	2.4	2.4	0.6	0.0
Resort: Hotel	room	500.0	0.15	70.0	52.5	30.0	22.5	75.0	20.0	10.5	80.0	18.0	28.5	4.5	42.0
Resort: mixed use	acre	2.0	2.10	70.0	2.9	30.0	1.3	4.2	20.0	0.6	80.0	1.0	1.6	0.3	2.3
Business Park	acre	22.0	1.60	70.0	24.6	30.0	10.6	35.2	20.0	4.9	80.0	8.5	13.4	2.1	19.7
Golf Courses/practice	acre	275.0	2.50	0.0	0.0	100.0	687.5	687.5	0.0	0.0	90.0	618.8	618.8	68.8	0.0
Ponds	acre	22.0	4.70	0.0	0.0	100.0	103.4	103.4	0.0	0.0	100.0	103.4	103.4	0.0	0.0
Golf Clubhouse	facility	2.0	6.40	100.0	12.8	0.0	0.0	12.8	20.0	2.6	0.0	0.0	2.6	0.0	10.2
Schools	student	350.0	0.03	50.0	5.3	50.0	5.3	10.6	20.0	1.1	80.0	4.2	5.3	1.1	4.2
Maint/WWTP	lump	1.0	7.30	49.0	3.6	51.0	3.7	7.3	20.0	0.7	80.0	3.0	3.7	0.7	2.9
Parks - neighborhood	acre	30.0	1.70	0.0	0.0	100.0	51.0	51.0	0.0	0.0	80.0	40.8	40.8	10.2	0.0
Parks - public	acre	12.0	2.10	0.0	0.0	100.0	25.2	25.2	0.0	0.0	80.0	20.2	20.2	5.0	0.0
TOTAL					390.3		1141.5	1531.8		78.2		1002.7	1080.9	138.9	312.2

The Woodlands - Rural Village Alternative
Ground Water Recharge Beneath Site

Average Precip (ft)
1.17

Approx acreage
957
197.5 covered
245 uncovered (eucalyptus)
514.5 uncovered (golf, parks, other)

Perc of precip (uncovered areas - except Eucalyptus)
0.25

Perc of precip (uncovered areas - Eucalyptus)
0

Perc of precip for covered areas (concentrated runoff)
0.6

Average percolation of precip for uncovered lands(afy)
150

Average percolation of precip for covered lands (afy)
139

Improvements	acres	% covered	acres covered
Village Center	9	75	6.75
Hotel/Resort	18	75	13.5
Residential	235	40	94
Business Park	22	75	16.5
Public school	10	75	7.5
Maint/WWTP	10	75	7.5
Clubhouses	3	75	2.25
Roads/easements	66	75	49.5
TOTAL	373		197.5

Return flow
139 afy

Total recharge beneath 957-acre site
428 afy WATER QUALITY CALCULATIONS INPUT

Adjusted perc of precip with covered areas
0.258

The Woodlands

Example Production Plan - Rural Village

Net Demand		Pumpage (continuous gpm)				
Month	GPM	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	310	310				310
Feb	355	355				355
Mar	415	415				415
Apr	755	500		255		755
May	1125	500	125	500		1125
Jun	1208	500	208	500		1208
Jul	1155	500	155	500		1155
Aug	1155	500	155	500		1155
Sep	1049	549		500		1049
Oct	770	500		270		770
Nov	468	468				468
Dec	294	294				294
Average	757	450	54	253	0	757

Net Demand		Pumpage (acre-feet)				
Month	AFY	Hwy 1	Dawn	Mesa	Homestead	Total
Jan	42.5	42.5				42.5
Feb	43.9	43.9				43.9
Mar	56.9	56.9				56.9
Apr	100.1	66.3		33.8		100.1
May	154.1	68.5	17.1	68.5		154.1
Jun	160.2	66.3	27.6	66.3		160.2
Jul	158.2	68.5	21.2	68.5		158.2
Aug	158.2	68.5	21.2	68.5		158.2
Sep	139.1	72.8		66.3		139.1
Oct	105.5	68.5		37.0		105.5
Nov	62.0	62.0				62.0
Dec	40.3	40.3				40.3
Total	1221.0	725.0	87.1	408.9	0.0	1221.0

The Woodlands - Rural Village Alternative
Water Quality Calculations

Constituent	Hwy 1	Dawn	Mesa	Home	Pickup	Ave WW Qual	Irrigation Quality (includes WW contributions) Ave Dom Qual	Ave Golf Qual	golf irr tons	dom irr tons	Return Flow Quality (WW contributions not included) return flow	Rain Qual	Initial Perc
	(mg/l)										(mg/l)		
N	3.61	0.7	2.8	0.9	18	21.29	3.29	10.75	10.53	3.63	3.05	0.2	1.11
P	0	0	0	0	2.6	2.6	0	1.12	1.1	0	0	0	0
K	2	3.8	4	3.7	10	12.2	2.2	7.53	7.38	2.43	3.06	0	0.98
Ca	54	120	115	150	15	76	61.26	98.23	96.23	67.59	87.06	1	28.54
Mg	21	38	29	43	7	30	22.87	29.43	28.83	25.23	25.81	1	8.94
S	37.04	83.07	75.66	113.49	10	52.1	42.1	65.53	64.19	46.45	58.21	1.5	19.65
B	0	0.44	0.38	0.75	0.2	0.25	0.05	0.32	0.31	0.06	0.21	0	0.07
Cl	42	68	56	58	75	120	44.86	83.52	81.82	49.49	50.21	9	22.19
Na	43	48	41	53	70	114	43.55	72.39	70.91	48.05	42.33	5	16.95
TDS	442	700	616	840	320	790	470.38	690.82	676.74	518.95	540.28	23	188.53
Hardness	220	456	408	552	70	316	245.96	368.44	360.93	271.36	323.74	17	115.16
Pump (afy)	725	87	409	0		312	812	721					
Dom (%)	0.89	0.11											
Golf (%)			0.57	0		0.43							
return flow without WW (afy)							23	21.4					
return flow without WW (%)							0.52	0.48					
Total recharge											139	289	
Ttl recharge (%)											0.32	0.68	

Sodium Hazard

			dS/m
SAR WW	2.8	EC WW	1.23
SAR DOM	1.21	EC DOM	0.73
SAR IRR	1.63	EC IRR	1.08

The Woodlands - Rural Village Alternative
Basin Pickup Calculations

Constituent	WW Pickup (mg/l)	WW Imports (tons)	Fert Imports (tons)	Total Imports (tons)	Total Exports (tons)	Basin Pickup (tons)	Recharge Initial (mg/l)	Basin Pickup (mg/l)	Recharge Final (mg/l)
N	18	7.60	15.83	23.43	22.03	1.40	1.11	2.40	3.51
P	2.6	1.10	6.40	7.50	7.50	0.00	0	0.00	0.00
K	10	4.20	0.00	4.20	0.00	4.20	0.98	7.22	8.20
Ca	15	6.40	8.20	14.60	0.00	14.60	28.54	25.11	53.65
Mg	7	3.00	0.00	3.00	0.00	3.00	8.94	5.16	14.10
S	10	4.20	0.00	4.20	0.00	4.20	19.65	7.22	26.87
B	0.2	0.10	0.00	0.10	0.00	0.10	0.07	0.17	0.24
Cl	75	31.80	0.00	31.80	0.00	31.80	22.19	54.68	76.87
Na	70	29.70	0.00	29.70	0.00	29.70	16.95	51.07	68.02
TDS	320	135.80	98.00	233.80	120.60	113.20	188.53	194.66	383.19

Constants used:

1233619	af into liters		superphosphate
2.2E-06	mg into lbs		Ca2((H2P(O4))2*H2O
2.719619	mg/L into lbs/af	wght	292.1
312	afy of wastewater	%Ca	0.27
275	irrigated acres	%P	0.21
736	ton/af into mg/l		
96	percent nitrogen uptake by plants		
10	percent of WW as return flow		
4.43	N into N03 for TDS		Potassium Chloride
3.07	P onto P04 for TDS		KCl
3	S into S04 for TDS	wght	74.55
289	afy perc	%Cl	0.48
139	afy return flow	%K	0.52
428	total afy recharge		

Golf Course Nitrogen Fertilizer	acres	pounds per acre	pounds	tons
Greens and tees	27.3	348.48	9514	4.757
Fairways	136.5	174.24	23784	11.892
Rough	109.2	87.12	9514	4.757
total	275		42812	21.406

Non-Golf Course Fertilized Acreage	acres	non-golf fert.
golf w/practice area	275	0
improvements	373	155
parks	42	42
ponds	22	0
subttl	712	197
open space	245	

Fertilizer Demand	golf courses			non-golf course areas		
	fertil require demand	total irrig supply	fertil import	fertil require demand	total irrig supply	fertil import
	(tons)					
N	21.41	10.53	10.88	8.58	3.63	4.95
P	5.35	1.1	4.25	2.15	0.00	2.15
K	5.35	7.38	0.00	2.15	2.43	0.00
Ca						
Mg						
S	0.96	64.19	0.00	0.69	46.45	0.00
B						
Cl						
Na						

APPENDIX D:

Rural Village Expanded Business Park Alternative

Rural Village with Expanded Business Park Alternative

The Woodlands

Element Description	Type Unit	Number Units	Water Demand						Water Consumed					Return flow	Wastew
			Duty Factor	indoor		outdoor		total	indoor		outdoor		total		
			(afy/unit)	%	afy	%	afy	afy	%	afy	%	afy	afy	afy	afy
Residential (indoor)	D.U.	957.0	0.295	100.0	282.3	0.0	0.0	282.3	20.0	56.5	80.0	0.0	56.5	0.0	225.8
Residential (outdoor)	acre	211.0	0.97	0.0	0.0	100.0	204.7	204.7	20.0	0.0	80.0	163.8	163.8	40.9	0.0
Village: mixed use	acre	3.0	2.10	100.0	6.3	0.0	0.0	6.3	20.0	1.3	0.0	0.0	1.3	0.0	5.0
Village: Landscaping	acre	2.0	1.50	0.0	0.0	100.0	3.0	3.0	20.0	0.0	80.0	2.4	2.4	0.6	0.0
Resort: Hotel	room	500.0	0.15	70.0	52.5	30.0	22.5	75.0	20.0	10.5	80.0	18.0	28.5	4.5	42.0
Resort: mixed use	acre	2.0	2.10	70.0	2.9	30.0	1.3	4.2	20.0	0.6	80.0	1.0	1.6	0.3	2.3
Business Park	acre	46.0	1.60	70.0	51.5	30.0	22.1	73.6	20.0	10.3	80.0	17.7	28.0	4.4	41.2
Golf Courses/practice	acre	275.0	2.50	0.0	0.0	100.0	687.5	687.5	0.0	0.0	90.0	618.8	618.8	68.8	0.0
Ponds	acre	22.0	4.70	0.0	0.0	100.0	103.4	103.4	0.0	0.0	100.0	103.4	103.4	0.0	0.0
Golf Clubhouse	facility	2.0	6.40	100.0	12.8	0.0	0.0	12.8	20.0	2.6	0.0	0.0	2.6	0.0	10.2
Schools	student	350.0	0.03	50.0	5.3	50.0	5.3	10.6	20.0	1.1	80.0	4.2	5.3	1.1	4.2
Maint/WWTP	lump	1.0	7.30	49.0	3.6	51.0	3.7	7.3	20.0	0.7	80.0	3.0	3.7	0.7	2.9
Parks - neighborhood	acre	30.0	1.70	0.0	0.0	100.0	51.0	51.0	0.0	0.0	80.0	40.8	40.8	10.2	0.0
Parks - public	acre	12.0	2.10	0.0	0.0	100.0	25.2	25.2	0.0	0.0	80.0	20.2	20.2	5.0	0.0
TOTAL					417.2		1129.7	1546.9		83.6		993.3	1076.9	136.5	333.8

The Woodlands - Rural Village with Expanded Business Park
Ground Water Recharge Beneath Site

Average Precip (ft)
1.17

Approx acreage

957	
205.9	covered
245	uncovered (eucalyptus)
506.1	uncovered (golf, parks, other)

Perc of precip (uncovered areas - except Eucalyptus)
0.25

Perc of precip (uncovered areas - Eucalyptus)
0

Perc of precip for covered areas (concentrated runoff)
0.6

Average percolation of precip for uncovered lands(afy)
148

Average percolation of precip for covered lands (afy)
145

Improvements	acres	% covere	acres covered
Village Center	9	75	6.75
Hotel/Resort	18	75	13.5
Residential	211	40	84.4
Business Park	46	75	34.5
Public school	10	75	7.5
Maint/WWTP	10	75	7.5
Clubhouses	3	75	2.25
Roads/easements	66	75	49.5
TOTAL	373		205.9

Return flow
137 afy

Total recharge beneath 957-acre site
430 afy WATER QUALITY CALCULATIONS INPUT

Adjusted perc of precip with covered areas
0.262

The Woodlands
Example Production Plan - Rural Village Expanded Business Park

Net Demand		Pumpage (continuous gpm)				
Month	GPM	Hwy 1	Dawn	Mesa	Homestea	Total
Jan	308	308				308
Feb	353	353				353
Mar	413	413				413
Apr	750	500		250		750
May	1118	500	118	500		1118
Jun	1200	500	200	500		1200
Jul	1148	500	148	500		1148
Aug	1148	500	148	500		1148
Sep	1043	543		500		1043
Oct	765	500		265		765
Nov	465	465				465
Dec	293	293				293
Average	752	448	52	252	0	752

Net Demand		Pumpage (acre-feet)				
Month	AFY	Hwy 1	Dawn	Mesa	Homestea	Total
Jan	42.2	42.2				42.2
Feb	43.7	43.7				43.7
Mar	56.6	56.6				56.6
Apr	99.4	66.3		33.2		99.5
May	153.2	68.5	16.2	68.5		153.2
Jun	159.1	66.3	26.5	66.3		159.1
Jul	157.3	68.5	20.3	68.5		157.3
Aug	157.3	68.5	20.3	68.5		157.3
Sep	138.3	72.0		66.3		138.3
Oct	104.8	68.5		36.3		104.8
Nov	61.7	61.7				61.7
Dec	40.1	40.1				40.1
Total	1213.7	722.9	83.3	407.5	0.0	1213.7

The Woodlands - Rural Village Expanded Business Park Alternative

Water Quality Calculations

Constituent	Hwy 1	Dawn	Mesa	Home	Pickup	Ave WW Qual	Irrigation Quality (includes WW contributions) Ave Dom Qual	Ave Golf Qual	golf irr tons	dom irr tons	Return Flow Quality (WW contributions not included) return flow	Rain Qual	Initial Perc
					(mg/l)							(mg/l)	
N	3.61	0.7	2.8	0.9	18	21.32	3.32	11.13	11.22	3.64	3.07	0.2	1.12
P	0	0	0	0	2.6	2.6	0	1.17	1.18	0	0	0	0
K	2	3.8	4	3.7	10	12.2	2.18	7.69	7.75	2.39	3.05	0	0.98
Ca	54	120	115	150	15	76	60.6	97.45	98.24	66.36	88.71	1	28.43
Mg	21	38	29	43	7	30	22.7	29.45	29.69	24.86	25.72	1	8.91
S	37.04	83.07	75.66	113.49	10	51.64	41.64	64.85	65.38	45.6	57.97	1.5	19.57
B	0	0.44	0.38	0.75	0.2	0.24	0.04	0.32	0.32	0.04	0.2	0	0.06
Cl	42	68	56	58	75	120	44.6	84.8	85.49	48.84	50.07	9	22.14
Na	43	48	41	53	70	114	43.5	73.85	74.45	47.64	42.3	5	16.94
TDS	442	700	616	840	320	788	467.8	693.4	699.05	512.29	538.94	23	188.1
Hardness	220	456	408	552	70	314	243.6	365.7	368.68	266.77	322.51	17	114.76
Pump (afy)	723	83	408	0		334	806	742					
Dom (%)	0.9	0.1											
Golf (%)			0.55	0		0.45							
return flow without WW (afy)							23	21.4					
return flow without WW (%)							0.52	0.48					
Total recharge											137	293	
Ttl recharge (%)											0.32	0.68	

Sodium Hazard

			dS/m
SAR WW	2.8	EC WW	1.23
SAR DOM	1.21	EC DOM	0.73
SAR IRR	1.69	EC IRR	1.08

The Woodlands - Rural Village Expanded Business Park Alternative
Basin Pickup Calculations

Constituent	WW Pickup (mg/l)	WW Imports (tons)	Fert Imports (tons)	Total Imports (tons)	Total Exports (tons)	Basin Pickup (tons)	Recharge Initial (mg/l)	Basin Pickup (mg/l)	Recharge Final (mg/l)
N	18	8.20	15.00	23.20	21.78	1.42	1.12	2.42	3.54
P	2.6	1.20	6.28	7.48	7.48	0.00	0	0.00	0.00
K	10	4.50	0.00	4.50	0.00	4.50	0.98	7.70	8.68
Ca	15	6.80	8.10	14.90	0.00	14.90	28.43	25.50	53.93
Mg	7	3.20	0.00	3.20	0.00	3.20	8.91	5.48	14.39
S	10	4.50	0.00	4.50	0.00	4.50	19.57	7.70	27.27
B	0.2	0.10	0.00	0.10	0.00	0.10	0.06	0.17	0.23
Cl	75	34.10	0.00	34.10	0.00	34.10	22.14	58.37	80.51
Na	70	31.80	0.00	31.80	0.00	31.80	16.94	54.43	71.37
TDS	320	145.30	93.80	239.10	119.50	119.60	188.1	204.71	392.81

Constants used:

1233619	af into liters		superphosphate
2.2E-06	mg into lbs		Ca2((H2P(O4))2*H2O
2.719619	mg/L into lbs/af	wght	292.1
334	afy of wastewater	%Ca	0.27
275	irrigated acres	%P	0.21
736	ton/af into mg/l		
96	percent nitrogen uptake by plants		
10	percent of WW as return flow		
4.43	N into N03 for TDS		Potassium Chloride
3.07	P onto P04 for TDS		KCl
3	S into S04 for TDS	wght	74.55
293	afy perc	%Cl	0.48
137	afy return flow	%K	0.52
430	total afy recharge		

Golf Course Nitrogen Fertilizer

	acres	pounds per acre	pounds	tons
Greens and tees	27.3	348.48	9514	4.757
Fairways	136.5	174.24	23784	11.892
Rough	109.2	87.12	9514	4.757
total	275		42812	21.406

Fertilizer Demand

	golf courses			non-golf course areas		
	fertil require demand	total irrig supply	fertil import	fertil require demand	total irrig supply	fertil import
	(tons)					
N	21.41	11.22	10.19	8.45	3.64	4.81
P	5.35	1.18	4.17	2.11	0.00	2.11
K	5.35	7.75	0.00	2.11	2.39	0.00
Ca						
Mg						
S	0.96	65.38	0.00	0.68	45.60	0.00
B						
Cl						
Na						
TDS						

Non-Golf Course Fertilized Acreage

	acres	non-golf fert.
golf w/practice area	275	0
improvements	373	152
parks	42	42
ponds	22	0
subttl	712	194
open space	245	

APPENDIX E:

Correspondence to USI Dated June 10, 1997

Cleath & Associates
Engineering Geologists
Ground Water
(805) 543-1413
1390 Oceanaire Drive
San Luis Obispo
California 93405

June 10, 1997

Mr. Keith McCoy
USI Properties
353 Sacramento Street, Suite 1160
San Francisco, CA 94111

SUBJECT: Eucalyptus Water Use on The Woodlands, Nipomo Mesa, San Luis Obispo County, California.

Dear Mr. McCoy:

In response to your request, Cleath & Associates has researched information on the eucalyptus planted at The Woodlands with respect to water use.

The information gathered was obtained by consulting with several botanists and agriculturalists and reviewing various references on eucalyptus and their water use (list of references attached). The one reference which addresses eucalyptus water use on the Nipomo Mesa is the Black Lake Canyon Geologic and Hydrologic Study prepared by Dr. David Chipping, a professor of geology at California Polytechnic State University in 1994.

Water use is based on plant physiology, climatic conditions, and soils and water availability. Since the eucalyptus grove on the property was planted for the purpose of harvesting the wood, the history of the grove also provides a background for this assessment of water use.

HISTORY OF EUCALYPTUS GROVE

The Woodlands property on the Nipomo Mesa is vegetated with 863 acres of Eucalyptus globulus species trees, which were originally planted during the period from 1910 to 1914 as a source of wood for various uses from railroad ties to furniture. The trees on this property have been harvested at least once, probably in the 1940's when Flintkote (a company which was a predecessor of what is now USI) needed wood for pallets and ship building during World War II. Since that time, no significant harvesting of these trees has occurred.

The original plantings were initially grown in lath green houses and transplanted on site. No evidence of irrigation systems have been found on site. Only one well is known to have existed on the property before the 1950's, and this is thought to have been used for domestic purposes because the well is located near the old farmstead.

WATER SOURCES

The atmospheric sources of water supplying the eucalyptus are the rainfall and fog. The rainfall averages about 15 inches per year with at least one inch of rainfall per month between November and April and at least 2 inches per month of rainfall between December and March, on average. The days when fog reduces visibility to one-quarter mile or less at the Santa Maria weather station occur mainly during the period from August through October when 10-12 days have fog. The remainder of the year, the monthly average fog days range from 4-8 days, for an annual average of 86.7 days per year.

PLANT PHYSIOLOGY

The E. globulus species is one of the fastest growing trees known. It is an evergreen which flowers from September to December. The leaves are sensitive to the climate and coil and turn on edge toward the sun to minimize evapotranspiration during hot days. The leaves also function to allow light rainfall and fog to reach the shallow roots.

There are extensive shallow roots which form a dense mat near the surface. These roots are effective receptors of atmospheric water and shallow water. The roots for this tree species generally are within 6 feet of ground surface (up to a maximum of 20 feet) and spread out and intertwine with other tree roots. This mat of roots can spread out over 40 feet from the branch tips of each individual tree.

WATER CONSUMPTION

Water demand for E. globulus is between 20 and 60 inches, although the trees can survive with as little as 4-8 inches of rain per year. Where insufficient water is available, the trees become stressed.

Fog drip is known to be a significant source of water for these trees, with water use from fog amounting to more than twice as much as any other tree. The amount of water obtained from this source has not been determined.

A previous report describing eucalyptus water use on the Nipomo Mesa (Chipping, 1994) found that the water use should be 17.7 inches and that 100 percent of rainfall up to this demand amount was used by the tree. This water consumption figure is reasonable but somewhat less than the 20-60 inch range which was described in the references found in our research.

The root mat from eucalyptus tree groves appear to be extensive and the trees are capable of storing excess water, so that much of the rainfall in this area could be utilized.

CONCLUSION

The eucalyptus grove on the property will use a high percentage of the rainfall which is supplemented by fog drip; probably between 80 and 90 percent of rainfall. Given 15 inches of average annual rainfall on the property, this would equate to at least one acre-foot of water per acre being supplied to the trees from rainfall; corresponding to a total water use of 863 acre-feet per year based on the existing eucalyptus acreage.

Sincerely,

Timothy S Cleath

Timothy S. Cleath, HG 81
Certified Hydrogeologist

REGISTERED GEOLOGIST
TIMOTHY S. CLEATH
No. HG 81
CERTIFIED HYDROGEOLOGIST
Exp 10/31/97
STATE OF CALIFORNIA

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APPENDIX F:

Existing Water Quality
(Table 7 from 1996 Ground Water Management Study)

drawdown. The added lift will also increase pumping costs from about 2-3 dollars per year for private domestic wells to about $1,000.00 per year for NCSD's Eureka well.

Sea water intrusion beneath the Nipomo Mesa will not result from the cumulative project impacts based on ground water flow modeling and water level data from beach observation wells.

PH PROPERTY DEVELOPMENT COMPANY

WATER RESOURCES IMPACTS STUDIES

FOR

THE WOODLANDS

DECEMBER 1997

CLEATH & ASSOCIATES
1390 Oceanaire Drive
San Luis Obispo, CA 93405

(805) 543-1413

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Cleath & Associates has performed an evaluation of impacts on the water resources of the Santa Maria Valley due to The Woodlands project. Cumulative project impacts for 28 approved or pending projects on the Nipomo Mesa, inclusive of The Woodlands, have also been evaluated.

Potential water quality impacts to the Santa Maria Valley from both the project and cumulative projects are minimized by a confining layer in the valley adjacent to the project which restricts return flow to the main aquifer zones and by the northwest ground water flow direction (away from the valley) in the main aquifer zones. In addition, the vast majority of potential development on the cumulative projects list will utilize community wastewater treatment and disposal which will reduce potential ground water quality impacts to Nipomo Mesa.

Estimated ground water level interference in the Santa Maria Valley due to cumulative projects will be less than a foot during drought. Water level interference on the Nipomo Mesa due to cumulative projects will be close to 5 feet and result in the expansion of the existing pumping depression between The Woodlands, Cypress Ridge, and Black Lake Golf Course. There is sufficient water available in storage to continue pumping at local wells through drought periods, however, the pumps in some wells may need to be upgraded or set deeper to allow for the greater lift and lower pumping water levels.

Sea water intrusion into the Nipomo Mesa will not result from the cumulative project impacts based on water level data from beach observation wells and projected water level changes.

An estimated 415 acre-feet per year (afy) of ground water, on average, will flow through the subsurface from the Santa Maria Valley into the southern Nipomo Mesa as a direct result of The Woodlands project. The respective inflow figure due to cumulative projects is estimated at 730 afy. Long-term ground water availability is not a problem provided that the Santa Maria ground water basin continues to recover during the wet cycles. Wet-cycle recovery is predicted by the model, however, the model relies on long-term stability of water levels in the Oso Flaco area. Long-term stability in basin ground water levels is documented in a 1997 study by Santa Maria Valley Water Conservation District consultant Luhdorff & Scalmanini. Thus, wet-cycle recoveries of water levels should continue.

Impacts to flow in the Santa Maria River due to The Woodlands project will occur as reductions or delays in stream flow in the years following extended drought. Project impacts, however, are secondary to the much greater existing impacts from Twitchell Reservoir operations and valley agricultural pumpage. In addition, the importation of State water by the City of Santa Maria will decrease ground water pumpage and/or increase wastewater recharge to the basin long-term, offsetting any impacts on stream flow by the project.

INTRODUCTION

The work performed to date by Cleath & Associates on impacts to water resources from The Woodlands project has addressed issues related to ground water quality, drought impacts and long-term ground water availability for ground water users in the southern Nipomo Mesa. These prior studies have found that a portion of the ground water recharge to the southern Nipomo Mesa comes from the Santa Maria Valley. This report discusses in the project impacts on the water resources in the Santa Maria Valley and addresses the issue of potential basin overdraft. The cumulative impacts of pending or approved projects on the Nipomo Mesa are also evaluated herein.

POTENTIAL IMPACTS TO THE SANTA MARIA VALLEY

For discussion purposes the Oso Flaco area is defined herein as that portion of the Santa Maria Valley within San Luis Obispo County. Water resources impacts of concern in the Oso Flaco area involve four issues: 1) water quality, 2) water level interference, 3) Long-term ground water availability and, 4) flow in the Santa Maria River. Each of these issues are addressed below following a brief review of pertinent hydrogeologic conditions.

The main water bearing zones beneath The Woodlands are within sands and gravels of the Paso Robles Formation and the Careaga Sand. These aquifer zones extend to the south into the Santa Maria Valley and are part of the Santa Maria ground water basin. Ground water flow between the Santa Maria Valley and the southern Nipomo Mesa is controlled by the hydraulic gradients within individual aquifer zones.

In prior work, Cleath & Associates modeled the ground water basin as two layers (Layer 1 and Layer 2), with a shallow aquifer and a deep aquifer separated by an aquitard. The main water bearing zones are within the deep aquifer (Layer 2). The larger production wells such as those at The Woodlands, Nipomo Community Services District wells, and irrigation wells on the Nipomo Mesa and in the Oso Flaco area are completed in multiple zones within the deep aquifer. In the Oso Flaco area, model Layer 2 includes the lower member of the alluvium which is valley fill and does not extend beneath the Nipomo Mesa.

The regional aquitard which separates the shallow ground water in Layer 1 from the deeper zones in Layer 2 creates a pressure area in the Santa Maria Valley west of Bonita School Road (flowing wells exist toward the coast). This aquitard was inferred to connect within perching layers in older dune sands beneath the Nipomo Mesa for modeling purposes. The aquitard does not form a contiguous layer beneath the Nipomo Mesa, however, and recharge to the deeper aquifers from percolation of precipitation occurs. Recharge to the deeper aquifers in the Oso Flaco area occurs primarily through subsurface inflow from the east where a less restrictive hydraulic connection exists with the Santa Maria River.

Water Quality Impacts

The Woodlands project will result in a net import of mineral salts into the ground water basin. Some of these imported salts will leach to ground water. Regional ground water flow patterns indicate shallow (semi-perched) ground water probably moves southwest toward the Oso Flaco area and out to sea. However, the shallow ground water in the Oso Flaco area flows above the regional aquitard and is not tapped by irrigation wells.

As mentioned previously, the regional aquitard thins beneath the Nipomo Mesa and does not prevent the percolation of precipitation or return flows from the project from reaching the main aquifer zones. Regional flow patterns in ground water indicate that water in the deep aquifer zones is moving into the Nipomo Mesa from the Oso Flaco area. Therefore, leachate from the project that reaches the deeper aquifer zones will not move into the Oso Flaco area but will likely be recycled back into the project wells or continue to move northwest toward the ocean. The estimated quality of the leachate reaching ground water beneath the project will not exceed drinking water standards.

Water Level Interference

The difference in water levels with and without the project in the Oso Flaco was estimated in the 1997 Addendum to the Water Resources Management Study. The water level drawdown attributable to the project during the period of lowest water levels at the closest Oso Flaco area well (well 11N/35W-21Ja) would be less than one foot. Wells in the Oso Flaco area typically have more than 100 feet of static water column above their perforated intervals. Water level interference in the Santa Maria Valley (and in the Cienega Valley to the north) is further minimized by the high permeability and storage capacity of alluvial deposits.

Long-Term Ground Water Availability

One of the main sources of recharge to the southern Nipomo Mesa is inflow from the Santa Maria Valley. Some of the ground water production for the project will come from the Oso Flaco area. The other main sources of ground water is reduced ocean outflow and induced recharge from removal of the eucalyptus and site development. Calculations presented in the 1997 Addendum show 830 acre feet per year (afy) of water is consumed by the project (after induced recharge credit). A review of the results of modeling indicate that about half of the project consumptive use would be derived from increased inflow and half from decreased outflow. The water consumed by the project originating from the Santa Maria Valley subarea of the Santa Maria ground water basin is estimated at about 415 afy. The resulting impacts to long-term ground water availability in the Santa Maria Valley is evaluated herein with respect to the overall status of the Santa Maria ground water basin.

The most recent published report which discusses basin-wide issues is by consulting engineers Luhdorff and Scalmanini (Engineers report, Special Assessments for Ground-Water Management, June 1997). This report was prepared for the Santa Maria Valley Water Conservation District (SMVWCD) which includes the lands in the Oso Flaco area being evaluated for impacts from The Woodlands project.

According to the Luhdorff and Scalmanini Report (page 6), "The repeated recovery of ground-water levels to near-historic high levels in most of the basin, including during the most recent recovery between 1991 and 1996, does not support the conclusion that the basin is and has been in overdraft; instead, it indicates a long-term stability comprised of periodic ground-water level declines and recoveries." The report also concludes on page 7 that, "...hydrologic conditions in the basin have not induced salt water intrusion and, thus, overdraft conditions due to salt water intrusion do not appear to have existed historically".

Given the repeated cycles of recovery of ground water in storage in the Santa Maria ground water basin as shown in water level hydrographs (i.e. no continuing water level declines), the impacts to water availability in the Oso Flaco area from The Woodlands project are restricted to the amount of water level interference which occurs during periods of drought. As previously discussed, this interference is estimated to not exceed one foot during the period of lowest water levels.

Impacts on Flow in the Santa Maria River

A portion of the estimated 415 afy of ground water moving from the Oso Flaco area toward The Woodlands due to the project will ultimately come from ground water recharge of Santa Maria River flows east of the pressure area. Another portion would be from leakage through the regional aquitard from agricultural return flows that otherwise cycle into Oso Flaco and Little Oso Flaco Lakes or outflow to the ocean. It is assumed for worst-case analysis that almost all the water produced from the Santa Maria Valley area, or about 400 afy , would be replaced by recharge from the Santa Maria River.
The Woodlands is over two miles distant from the Santa Maria River and there is a confining layer beneath the river opposite the project. Therefore, the recharge from the river would replenish the ground water basin in accordance with the basin-wide trends for stream seepage. These trends favor increased recharge during periods of lower ground water in storage.

Santa Maria River stream flow is already influenced to a large degree by agricultural pumpage in the Santa Maria Valley. Existing conditions are such that there is no stream flow during extended drought. When rains finally arrive, stream flow will be predicated on the mounding of percolating water beneath the river channel. The entire storage deficit of the basin need not be overcome before stream flow occur. The impacts of the project on stream flow will tend to be spread out over several years following the drought.

Twitchell Reservoir also controls stream flow in the Santa Maria River. The dam is used in part to impound flows on the Cuyama River which would otherwise be lost to the ocean during periods of high runoff. These inflows are subsequently released at lower flow rates designed to promote seepage into the basin from the Santa Maria stream channel when combined with Sisquoc River flows. Although stream flow is reduced during impoundments at Twitchell Reservoir, the mounding of percolating water beneath the river channel from reservoir releases can increase the amount of stream flow from subsequent runoff events coming into the basin along the Sisquoc River. The net reduction of stream flow due to Twitchell Reservoir operations depends on the timing of impounds, releases and precipitation. The impacts to stream flow by The Woodlands project would be secondary to the impacts resulting from both reservoir operations and agricultural pumpage.

In addition, impacts on stream flow will be completely offset by the recent importation of State water by the City of Santa Maria. The reduction in ground water production by the City will result in higher basin-wide water levels. Even if State water deliveries are cut back during extended drought conditions and the City resumes full ground water production, the added amount of ground water in storage at the onset of drought due to imported water will offset any losses during the drought attributable to the project. The Woodlands project will not reduce or delay the onset of flows in the Santa Maria River compared to historical flows.

CUMULATIVE IMPACTS

Besides The Woodlands, there are over two dozen other project currently pending or approved for development on the Nipomo Mesa (Appendix). The cumulative impacts of these projects are evaluated herein with respect to the following issues: 1) water quality, 2) water level interference, 3) long-term ground water availability, and 4) flow in the Santa Maria River.

As part of evaluating cumulative impacts, an update of the 1992 baseline water production used in modeling efforts has been performed. In 1992, the total model area water production was estimated at 18,690 afy, of which about 7,500 afy was Nipomo Mesa water production (the rest is in the Oso Flaco area and Cienega Valley portions of the model). Since 1992, the increase in model area production is assumed to correspond to the increase in domestic water production on the Nipomo Mesa. Agricultural and industrial ground water production within model boundaries has not changed significantly.

Nipomo Community Services District (NCSD) water production has increased from approximately 1,450 acre feet in 1992 to approximately 2,100 acre feet in 1997; a 45% growth. Increases in ground water production by other purveyors on the Nipomo Mesa and private users are probably closer to half of the pace of NCSD growth. The total increase in domestic water production is estimated at 1,160 afy (from about 3,770 acre-feet in 1992 to 4,930 acre-feet in 1997). An estimated half of the total increase is consumed, or about 580 afy, and the remainder recharges the ground water basin.

Long-term ground water storage losses and associated water level declines under the 1997 baseline condition will be about 60 percent of those losses originally modeled for The Woodlands project scenario (consideration of the revised baseline impacts is necessary when estimating future water level elevations). Note that the differences between baseline impacts and those due to The Woodlands, however, will be similar or less than modeled (the proportion of additional pumpage for The Woodlands compared to baseline is lower).

Cumulative Water Quality Impacts

An increase in the salinity of the ground water results from percolated wastewater and irrigation return flow which are a part of nearly all of the cumulative projects. The Woodlands and Cypress Ridge developments both include wastewater treatment plants that will recycle treated wastewater for golf course irrigation and reduce the need for conventional fertilizers. Adherence to best management practices for the use of pesticides and other potentially harmful chemicals for golf course maintenance is also a part of these projects. Therefore, the quality of wastewater and irrigation return flows reaching ground water is not expected to exceed drinking water standards.

Other commercial development include expansion of several greenhouses. Applications of nitrogen fertilizers are such that plant uptake is maximized and leaching potential is minimized. Covered operations offer even greater control of leachate quantity and quality. The majority of greenhouse products are shipped off the Nipomo Mesa, thereby exporting a portion of the greenhouse fertilizer used.

An estimated 153 additional residential lots pending or approved on the Nipomo Mesa would be within the Nipomo Community Services District (NCSD) and will contribute to the NCSD wastewater stream. NCSD wastewater treatment and disposal is regulated by the RWQCB. 137 of the potential new residences on the cumulative projects list would operate outside of regulated wastewater treatment and disposal facilities. These potential new residences would use on-site wastewater treatment and effluent disposal systems.

Cumulative Water Level Interference

The water level interference due to cumulative projects will be greater in some areas than that due to The Woodlands project alone. The area of greatest susceptibility to cumulative water level impacts is between the subject property, Cypress Ridge, and Black Lake Golf Course (BLGC), north of Camino Caballo, west of Pomeroy, and east of Highway 1 (Township 11N, Range 35W Sections 9 and 10). Not only would this area be between three of the largest developments on the Nipomo Mesa, but it is also the area most likely to see an increase in NCSD production to serve new projects. The other (non-NCSD) cumulative projects are expected to result in less than one foot of water level interference in this area.

Estimated water level interference in the Oso Flaco area will still be less than a foot due to the broad area of inflow and the high permeability of the lower alluvium in the valley.

The water level interference attributable to The Woodlands and Cypress Ridge in ground water wells is estimated to be between 3 and 4 feet in 11N/35W Sections 9 and 10, based on ground water modeling. The approximate 150 afy increase in NCSD water production to accommodate new projects is estimated to add about one more foot of drawdown to the local water table, resulting in about 4 to 5 feet total cumulative water level interference in 11N/35W Sections 9 and 10.

Historically, the water levels in this area have been between about 10 feet below mean sea level to about 40 feet above mean sea level. The lowest water levels are in a pumping depression in the east portion of 11N/35W Section 9. As previously mentioned, long-term ground water storage losses and associated water level declines under the 1997 baseline condition will be about 60 percent of those losses originally modeled for The Woodlands project scenario. Water levels in Sections 9 and 10 would drop an estimated 2 feet compared to 1992 baseline levels without any further development.

For example, the water level at Black Lake Golf Course (BLGC) well 11N/35W-10G01 was estimated to drop to close to mean sea level in a future drought (model stress period 66; 33 years after development) under the 1992 baseline production scenario. With adjustment for 1997 production, water levels would be expected to drop to about 2 feet below mean sea level near BLGC. Adding impacts from cumulative projects, including The Woodlands, the water level would be about 6-7 feet below mean sea level during the drought.

Construction details of 16 wells were reviewed to evaluate losses in well water productivity in the area. The perforated intervals of the shallowest wells generally begin about 15 to 20 feet below mean sea level and extend to at least 80 feet below mean sea level. Most wells in the area are perforated to depths in excess of 150 feet below mean sea level. There is sufficient aquifer thickness in the area to deepen the pumping water levels of wells and compensate for the lower static water levels. If pumping levels decline below the perforated interval in shallower wells, additional drawdown may be needed to offset upper aquifer dewatering. Pumping lifts could increase by about 10 feet to maintain the same production rate during drought following cumulative project impacts. The pump horsepower and pump depth settings at individual wells vary and it is possible that pumps which are at their limits of lift capability or are set relatively shallow would need to be upgraded and/or lowered during the drought condition.

Added energy costs for domestic well operation due to cumulative projects are estimated at 2-3 dollars per year. The maximum energy cost impact would be at NCSD well 11N/35W-09K05 (Eureka) which produced 983 acre-feet in the year ending June 30, 1997. For an average 10 additional feet of lift, assuming a 50 percent efficient pump and $0.10 per kilowatt-hour energy cost, the estimated annual cost increase to operate Eureka would be about $1,000.00.

Sea Water Intrusion

The potential cumulative impacts on sea water intrusion due to a larger and deeper pumping depression depends on changes to the hydraulic gradient at the coast. A pumping depression with water levels 10 feet below mean sea level over two miles from the coastline will not cause sea water intrusion if it does not extend to the ocean. A review of historical water levels in beach observation wells indicates that the pumping depression northwest of The Woodlands does not reach the ocean. Water levels in beach observation well PSBO-2 (11N/36W-12C01-3), due west of the pumping depression, are consistently over 5 feet above mean sea level. In fact, the piezometric surfaces in the deeper aquifer zones (piezometers 12C02 and 12C03) are generally greater than 10 feet above mean sea level. During the last two critical drought years (1976-77, 1990-91) the lowest water elevations were recorded in the shallow piezometer (12C01) at about 6 feet above mean sea level.

The results of ground water flow modeling show no water level interference due to ground water pumpage from the proposed projects west of the Southern Pacific railroad tracks (Highway 1 at Black Lake Canyon). The water level interference impacts from cumulative projects will not result in sea water intrusion into the Nipomo Mesa, based on the data from beach observation wells and ground water modeling.

Long-Term Ground Water Availability

Analysis of water level interference due to cumulative projects indicates that there is sufficient aquifer thickness to allow normal production through a drought, although the pumps in some wells may need to be upgraded or set deeper. Long-term ground water availability is not a problem provided that the basin continues to recover during the wet cycles.

Wet-cycle recovery is predicted by the model, however, the model relies on long-term stability of water levels in the Oso Flaco area. According to the 1997 report by SMVWCD consultant Luhdorff & Scalmanini (page 6), "A review of historical ground-water conditions as described above indicates that the basin has achieved a long-term stability in ground water levels. Thus, wet-cycle recoveries of water levels should continue.

The additional production due to cumulative projects will also result in impacts to Santa Maria River stream flow similar to the project impacts discussed previously. The estimated total consumptive use of cumulative projects, including The Woodlands, is about 1,460 afy. Assuming the same proportions of decreased outflow versus increased inflow for the cumulative projects as estimated for The Woodlands alone, the potential increase in ground water flow from the Santa Maria Valley to the Nipomo Mesa would be about 730 afy, of which an average 700 afy would potentially be replenished from the percolation of Santa Maria River water. The additional seepage from the river would be occur primarily in the years following an extended drought. Twitchell Reservoir operations and existing agricultural pumpage control stream flow to a much larger degree than cumulative project impacts, especially at the end of a drought period.

The cumulative project impacts on historical flows in the Santa Maria River will be completely offset by the increases to ground water in storage resulting from the importation of State water by the City of Santa Maria. Flow reductions would still occur due to cumulative project impacts, however, they would be applied against a higher flow average than has occurred historically.

CONCLUSIONS

An estimated 415 afy of ground water, will flow from the Santa Maria Valley into the southern Nipomo Mesa as a result of The Woodlands project. Potential water quality impacts to the Santa Maria Valley from the project are minimized by the confining layer in the valley, the northwest ground water flow direction in the lower aquifer zones, and the recycling of treated wastewater for turf grass irrigation.

Estimated water level interference in the Oso Flaco area will be less than a foot at the wells closest to the project. Long-term ground water availability in the Santa Maria ground water basin will continue following production at The Woodlands, as water levels in the basin have reached long-term stability according to the most recent published study.

Impacts to flow in the Santa Maria River due to The Woodlands project will occur as reductions or delays in stream flow in the years following extended drought periods. Impacts on historical flows, however, will be completely offset by the importation of State water by the City of Santa Maria which will increase wastewater recharge to the basin long-term. In addition, any impacts to stream flow by the project are secondary to the existing impacts from Twitchell Reservoir operations and agricultural pumpage.

The cumulative impacts of approved or pending projects on the Nipomo Mesa, inclusive of The Woodlands, will result in an estimated 730 afy, on average, of additional ground water inflow to the Nipomo Mesa from the Santa Maria Valley. The same conclusions listed above for the project impacts on water quality, water availability, and stream flow impacts in the Santa Maria Valley apply to the cumulative project impacts. Estimated water level interference in the Oso Flaco area will still be less than a foot due to the broad area of inflow and the high permeability of the lower alluvium in the valley.

Cumulative project impacts will result in the expansion of the existing pumping depression between The Woodlands, Cypress Ridge, and Black Lake Golf Course. During periods of extended drought, the water levels in portions of 11N/35W Sections 9 and 10 will drop to below mean sea level, approaching the shallowest perforated intervals in local wells which begin about 15 to 20 feet below mean sea level. Although there is sufficient water available in storage to continue pumping through the drought, the pumps in some wells may need to be upgraded or set deeper to allow greater lift and pumping level

Table 7. Water Quality Results

Analyte	Units	MCL	Production well (with sampling date)			
			Hwy 1 12/16/93	Dawn Rd. 8/6/94	Mesa Rd. 8/6/94	Homestead 8/6/94
pH	unit	none	6.9	7.7	7.6	7.2
EC	µmhos/cm	1600	610	1185	1060	1425
TDS	mg/l	1000	442	700	616	840
Total Hardness	mg/l	none	220	456	408	552
HCO_3	mg/l	none	95	211	173	221
Na	mg/l	none	43	48	41	53
K	mg/l	none	2	3.8	4	3.7
Ca	mg/l	none	54	120	115	150
Fe	mg/l	0.3	<0.02	0.14	0.14	0.14
Mn	mg/l	0.05	<0.005	<0.02	<0.02	<0.02
Mg	mg/l	none	21	38	29	43
SO_4	mg/l	500	140	314	286	429
Cl	mg/l	500	42	68	56	58
NO_3	mg/l	45	16	3.1	12.4	4
B	mg/l	none	<0.1	0.44	0.38	0.75

NOTES:
MCL = Maximum Contaminant Level (State of California)
EC = Electrical Conductance
TDS = Total Dissolved Solids
µmhos/cm = micromhos per centimeter
mg/l = milligrams per liter

APPENDIX:

Cumulative Projects List

Cumulative project list
Nipomo Mesa - December 1997

Name	Project Desc.	Add. lots	NCSD	Estimated Consumption (afy)
Woodlands	golf/resid.	1320	no	830
Cypress Ridge	golf/resid.	386	no	446
Black Lake	resid. lots	44	yes	22
Meier/Hermreck	resid. lots	70	yes	35
Choin	resid. lots	6	no	3
Teter	resid. lots	1	yes	0.5
Greenhart	greenhouse	n/a		19
Murphy	resid. lots	6	no	3
Koch	greenhouse	n/a		7
Katzenstein	resid. lots	4	no	2
Armstrong	resid. lots	27	yes	13.5
Neudoll	resid. lots	8	no	4
Shields & Shields	resid. lots	41	no	20.5
Lampe	resid. lots	7	yes	3.5
Buisck	resid. lots	not applicable - outside basin		
Sauer	resid. lots	11	no	5.5
Sejera/Thompson	resid. lots	not applicable - outside basin		
Chen Ting-Fong	resid. lots	37	no	18.5
Belsher & Becker	resid. lots	4	yes	2
Galloway	resid. lots	16	no	8
R. H. Newdoll	resid. lots	4	no	2
Newdoll Pardel	resid. lots	4	no	2
Pruit	mini-storage	n/a	yes	0
Ball Seed	greenhouse	n/a	no	10
	NCSD	153	total	1457
	other WWTP	1706		
	remainder	137		

Source List: SLO County Planning.
All water demand estimates and assignment to NCSD service are by Cleath & Assoc. for cumulative impacts analysis use only.