# Appendix D:
# Groundwater Quality Resources

# D-1: Expanded Groundwater Resources Analysis

# Expanded Groundwater Resources Analysis
# Prepared for the
# Draft EIR
# County of San Luis Obispo
# Los Osos Wastewater Project

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November 14, 2008

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# PREFACE

This Expanded Groundwater Resources Analysis corresponds to Section 5.2, Groundwater Resources, of the Los Osos Wastewater Project Draft EIR. For readability and reference, the numbering system for headings and page numbers in the following environmental analysis uses the same section number as that used in the Draft EIR.

This Groundwater Resources Analysis of the Los Osos Wastewater Project Draft EIR is a summary of a compendium of knowledge regarding groundwater resource issues statewide, as well as those issues applicable to San Luis Obispo County and specifically Los Osos. Since the body of knowledge is considerable and contained in numerous appendices, it would be difficult to present it entirely in this document and in a manner that is easily understood by the reader. In order to aid the reader in locating background information, this section is formatted to facilitate the retrieval of appended information by presenting the reader with references that address the issue at hand.

# 5.2 - GROUNDWATER RESOURCES

## 5.2.1 - Introduction

The Los Osos community has historically derived its entire water supply from groundwater sources. In the early 1970's groundwater was recognized as being impacted by seawater intrusion and elevated nitrate concentrations from overlying land uses (DWR, 1973). Over the last 30 years, substantial hydrogeological studies have been conducted on the natural water resources that occur in the vicinity of Los Osos. These published and unpublished sources derive substantial information from other historical studies and combine those findings with additional data to formulate the current understanding of the Los Osos Valley Groundwater Basin conditions. These sources were used to determine the potential impacts to groundwater resources associated with construction and operation of the Los Osos Wastewater Project and were used to prepare the following technical report which was used to prepare this section.

- Preliminary Hydrogeological Impacts Study, Los Osos Wastewater Project, Los Osos, California. Hopkins Groundwater Consultants, Inc. October 2008. This information is located in Appendix D-2 of the Draft EIR.
- The Land Use Element of the San Luis Obispo County General Plan - Estero Area Plan. November 2004 and last amended November 2006, County of San Luis Obispo. This document is not contained in the EIR appendices, but is instead available for review at the San Luis Obispo County Department of Planning and Building. Pursuant to CEQA Guidelines Section 15150, this document is hereby incorporated by reference.
- Local Coastal Program Policy Document, A Portion of the San Luis Obispo County Land Use Element of the General Plan - Coastal Plan Policies. March 1988. County of San Luis Obispo. This document is not contained in the EIR appendices, but is instead available for review at the San Luis Obispo County Department of Planning and Building. Pursuant to CEQA Guidelines Section 15150, this document is hereby incorporated by reference.

## 5.2.2 - Environmental Setting

### 5.2.2.1 - Los Osos Valley Groundwater Basin

The Los Osos Valley Groundwater Basin (Los Osos Basin) is an east/west trending syncline comprised of Tertiary and Quaternary age sediments that unconformably lie on top of Miocene and Jurassic age bedrock of the Pismo and Franciscan Formations, respectively. The Los Osos Basin is shown on Exhibit 5.2-1 in relation to the existing Regional Water Quality Control Board prohibition zone.

The onshore portion of the Los Osos Basin covers approximately 10 square miles, of which approximately 3.3 square miles underlie the bay and sand spit, and 6.7 square miles underlie Los Osos, Baywood Park, and the Los Osos Creek Valley. The groundwater basin is bounded to the north, east, and south by relatively impermeable bedrock formations and to the west where the aquifers outcrop on the ocean floor. Basin sediments are believed to extend close to three miles offshore, however the fresh water portion of the basin is defined by the saltwater/fresh water interface which has moved onshore.

Permeable basin sediments that comprise the shallow and deep aquifer zones consist of alluvial deposits, sand dunes, the Paso Robles Formation, and the Careaga Formation. In the deepest portions of the basin the fresh water-bearing deposits extend to depths of approximately 700 feet below sea level. Previous studies have identified six aquifer zones in the Los Osos Basin which include the unconfined alluvial aquifer in the Los Osos Creek Valley, and 5 interbedded aquifer zones designated in previous reports as Zones A through E. The letter reference system previously used to delineate the aquifer zones in the Los Osos Basin is also utilized in the Preliminary Hydrogeological Impact Study. The aquifer zones include; 1) the unconfined perched aquifer (Zone A), 2) the upper transitional aquifer (Zone B), 3) the upper main supply aquifer (Zone C), and the lower aquifers (Zones D and E). The upper and lower aquifer systems are separated by a regional aquitard that averages approximately 50 feet in thickness.

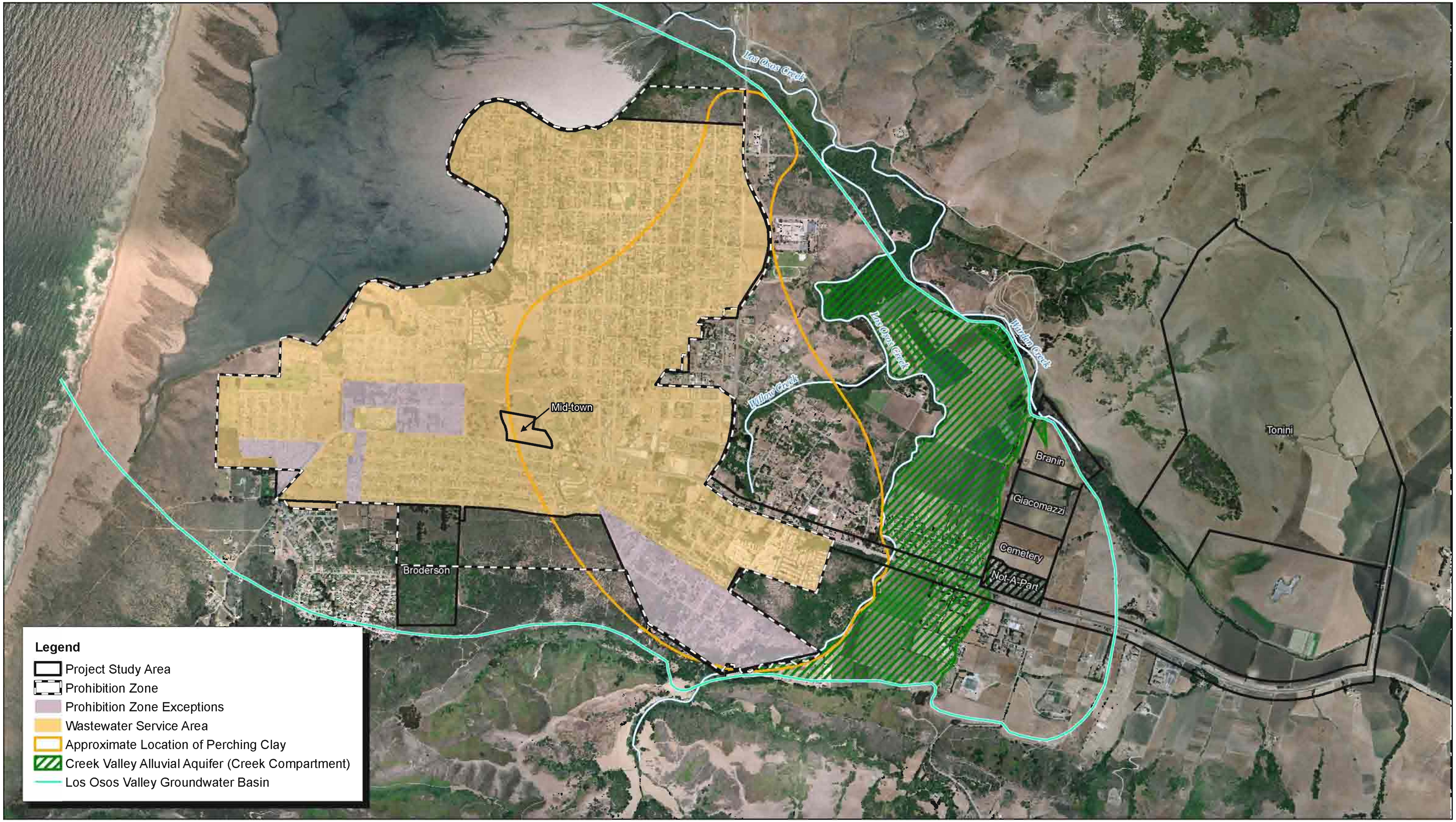
Historical interpretations of hydrogeological data lead to the inference that the Los Osos Basin was effectively partitioned by a splay of the Los Osos Fault designated as Strand B. Because of this interpretation, previous studies considered water budgets separately for basin areas east and west of the fault.

Recent studies have discovered that the aquitard is leaky enough to allow a substantial amount of groundwater to move between the upper and lower aquifer zones. Historical pumping patterns have created a head differential between the upper and lower system which has resulted in leakage from the upper aquifer becoming a substantial recharge component to the lower aquifer system. In addition, recent hydraulic testing of the aquifer system, correlation of well geophysical logs, water quality analyses, and model simulation results indicate that either the Los Osos Fault Strand B does not exist or it is not an effective barrier to groundwater flow. These findings are considered a refinement to the current understanding of the groundwater system and included in this evaluation of potential project-related impacts.

### 5.2.2.2 - Groundwater Occurrence and Movement

The majority of the recharge to the Los Osos Basin is derived from the following elements:

- Direct percolation of precipitation,
- Return flow from irrigation and septic system discharges,
- Stream seepage from Los Osos Creek,
- Subsurface inflow across basin boundaries.




Source: AirPhoto USA, Hopkins Groundwater Consultants, San Luis Obispo County GIS Data, and MBA GIS Data.

Michael Brandman Associates

NORTH

2,000 1,000 0 2,000 Feet

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Exhibit 5.2-1
Los Osos Groundwater Basin

Within the basin, individual aquifer zones may receive recharge directly from the above sources, or indirectly from aquitard leakage that allows inflow from an overlying or underlying aquifer zone. Movement of groundwater within alluvial, perched, and upper aquifer zones has been inferred from the groundwater gradients obtained from contouring historical measurements of groundwater elevations across the basin. Historical seasonal and climatic water level changes are indicated by hydrographs of water level measurements from wells constructed in individual aquifer zones across the basin.

### Alluvial Aquifer

The location of the Los Osos Creek Valley alluvial aquifer (also referenced as the creek compartment) is shown on Exhibit 5.2-1. Groundwater in the Los Osos Creek Valley alluvial aquifer moves down the alignment of the valley northward toward the Morro Bay Estuary. Alluvial aquifer recharge includes the elements listed above. Subsurface outflow from the alluvium into aquifer Zones C, D, and E occurs where these zones contact the alluvial fill beneath ground surface. Seasonal water level fluctuations within the alluvial aquifer have historically been on the order of 5 feet between the wet and dry seasons while water level declines during drought periods have exceeded 10 feet. Recharge to this aquifer is primarily provided by percolation of Los Osos Creek flows.

### Zones A, B, and C

The perched aquifer (Zone A) is comprised primarily of dune sands that are deposited on a clay layer(s) that impedes vertical flow to underlying aquifer zones. Available data indicate the clay layer pinches out to the north and west where groundwater flows into the underlying transitional aquifer (Zone B) of the upper aquifer system. The westward boundary of the perching clay has been estimated to be roughly coincident with the inferred trace of the Los Osos Fault splay referenced by previous studies as Strand B. The approximate aerial extent of the perching clay layer is shown in Exhibit 5.2-1.

The perched aquifer receives recharge from percolation of precipitation and return flows from overlying land uses. The water table contours constructed from available data roughly parallel the ground surface. Groundwater movement in Zone A is generally northwest to northeast, with relatively steep hydraulic gradients of up to 0.06 ft/ft between Bayview Heights and downtown. Groundwater in the perched aquifer rises in Willow Creek and reportedly emerges as seeps in the Oaks Preserve and along the banks in the lower reach of Los Osos Creek. A groundwater mound between downtown Los Osos and eastern Baywood Park area creates a hydraulic divide between water moving to the east toward Los Osos Creek and water moving to the west toward the Morro Bay Estuary.

Beneath the shallow dune sand deposits are interbedded clay, silt, sand, and gravel layers of the Paso Robles Formation which form the upper aquifer comprised of Zones B and C. Water level data indicate the transitional aquifer (Zone B) receives recharge through leakage from Zone A in portions of downtown Los Osos and areas to the east, and represents an intermediate hydraulic zone between the perched aquifer and the main water supply aquifer (Zone C).

Recharge to the upper aquifer (Zone C) occurs via the direct recharge sources itemized above as well as through leakage from Zones A and B. This leakage is evident in both water level and water quality data. Movement of groundwater in Zone C is variable and affected by groundwater production, but generally flows north and west toward the bay. A component of groundwater flows easterly from Baywood toward Los Osos Creek. Historical production from this aquifer has created a pumping depression which lies beneath downtown Los Osos. The hydraulic gradient in Zone C ranges from 0.004 to 0.025 (dimensionless), and averages approximately 0.009.

Groundwater levels in Zones A, B, and portions of Zone C were observed to rise during the 1970's as a result of increased recharge from irrigation and septic system return flows. Since the 1970's, water level data indicate that seasonal fluctuations and climatic cycle changes occur in the perched and upper aquifer zones, however, the system has generally stabilized and reached equilibrium between the existing sources of recharge and discharge.

### *Zones D and E*

The lower aquifer Zone D is comprised of sand and gravel layers in the Paso Robles Formation that are separated from the upper aquifer (Zone C) by a relatively continuous clay layer. The confining clay forms an aquitard that is reportedly leaky and allows downward recharge from the upper aquifer. Beneath the Zone D aquifer is another confining clay layer that delineates the top of the lower most freshwater aquifer Zone E. Aquifer Zone E is comprised of sand and gravel zones contained in the lower portion of the Paso Robles Formation and the underlying Careaga Formation which unconformably lies on older bedrock materials.

Recharge and movement of groundwater in the lower aquifer system (Zones D and E) was recently studied in detail by the Los Osos Community Services District (LOCSD) as part of a seawater intrusion investigation. The results of the lower aquifer recharge investigation indicated sources of recharge may include subsurface inflow from the Los Osos Creek Valley alluvium, subsurface inflow from bedrock, seawater intrusion, and leakage from the upper aquifer through the regional aquitard. Since 1988 groundwater studies have concluded that a principal source of recharge to the basin is septic return flows and that the majority of recharge to the lower aquifer is coming from upper aquifer leakage through the regional aquitard.

The groundwater gradient in the lower aquifers is largely influenced by pumping patterns. Presently groundwater is generally moving toward downtown Los Osos from surrounding areas of the basin. The highest water levels in the lower aquifer system are located in the Los Osos Creek Valley. The hydraulic gradient between the upper creek valley and downtown Los Osos of up to 0.03 is relatively steep and suggests significant impedance to flow which may be fault-related as noted by the U.S.G.S.

Recent studies have documented that groundwater elevations in the lower aquifer zones are below sea level over a substantial portion of the basin. This condition has persisted for many years and has resulted in the onshore flow of seawater in both lower aquifer zones. Water level declines in Zones D and E largely took place during the 1970's and early 1980's and have generally reached equilibrium between sources of discharge and recharge (which includes seawater).

## *Aquifer Recharge*

Within the Los Osos Creek Valley alluvial aquifer, there are four distinct aquifers which include the perched aquifer (Zone A), the Creek Valley aquifer (creek compartment), Upper Aquifer (Zones B and C), and Lower Aquifer (Zones D and E). Table 5.2-1 shows the current basin conditions of recharge to each aquifer as well as the outflow. As shown on Table 5.2-1, each aquifer has a balanced inflow and outflow.

### Perched Aquifer Recharge

The perched aquifer, as described above, is Zone A. The main water supply to this aquifer includes: a) precipitation, b) irrigation, and c) septic system percolation as shown in Table 5.2-1. Based on groundwater modeling, the subsurface flow within the perched aquifer flows to Zones B and C as well as to surface water features such as Morro Bay and the features shown on Exhibit 5.2-2. The exact quantity and specific location of groundwater flow to surrounding surface water features is not known.

### Creek Valley Aquifer Recharge

The main water supply to this aquifer includes: a) precipitation, b) irrigation return flows, c) septic system percolation, d) vertical leakage through the confining clay, and e) subsurface inflow from underlying bedrock as shown in Table 5.2-1.

### Upper Aquifer Recharge

As described above, the upper aquifer is comprised of Zones B and C, and the main water supply zone is Zone C. The upper aquifer is recharged primarily by sources that include; a) precipitation, b) irrigation return flows, c) septic system percolation, d) vertical leakage through the confining clay, and e) subsurface inflow from the perched aquifer (Zone A), the creek valley alluvium, and underlying bedrock. The basin model utilized for the seawater intrusion study has been subsequently revised to include changes in basin conditions that have occurred since 2005 (i.e., shifts in pumping patterns). The hydrologic budget obtained from model simulation indicates that total annual recharge to the upper aquifer under present hydrogeological conditions is estimated to be approximately 3,100-acre-feet per year (AFY) (shown as 3,092 AFY on Table 5.2-1).

As shown on Table 5.2-1, direct percolation of precipitation and irrigation is estimated at approximately 1,490 AFY. Septage return flow is estimated to contribute approximately 600 AFY and groundwater leakage through the perching clay layer and subsurface inflow from the perched aquifer, the creek compartment, and underlying bedrock is approximately 997 AFY.

**Lower Aquifer Recharge**

When groundwater is extracted from the lower aquifers, four potential sources of recharge are available for replenishment. These sources are; a) subsurface inflow from underlying bedrock, and b) the Los Osos Creek Valley, c) leakage through the regional aquitard from the upper aquifer, and d) seawater. Recent study has combined the use of water quality characterization, water level information, metered and estimated groundwater production, and basin geometry and boundary conditions to investigate the sources of lower aquifer recharge. These studies have utilized both analytical and numerical methods of analysis.

Numerical groundwater models constructed for the groundwater basin have consistently shown that the main source of recharge to the lower aquifer was leakage from the upper aquifer through the regional aquitard. This conclusion has reportedly been supported by water quality characterization and radiocarbon age-dating of the groundwater. As shown in Table 5.2-1, under current basin conditions, recharge to the lower aquifers west of the Los Osos Creek Valley is estimated to include approximately 880 AFY of upper aquifer leakage through the regional aquitard, approximately 370 AFY subsurface inflow from the Creek Valley Alluvial Aquifer (creek compartment), approximately 470 AFY of seawater intrusion, and that recharge from underlying bedrock is negligible.

**Table 5.2-1: Current Basin Balance Conditions**

| Component of Water Budget | Perched Aquifer | Creek Valley Aquifer | Upper Aquifer | Lower Aquifer |
|---|---|---|---|---|
| **Aquifer Inflow** | | | | |
| Percolation from Precipitation and Irrigation | 736 | 430 | 1,489 | 0 |
| Septic Flow | 631 | 30 | 606 | 0 |
| Seawater Intrusion | 0 | 0 | 0 | 469 |
| Los Osos Creek Inflow | 0 | 665 | 0 | 0 |
| Subsurface Inflow and Leakage/Subsurface Cross Flow In | 0 | 284 | 900 | 1,248 |
| **Total Aquifer Inflow** | **1,367** | **1,409** | **2,995** | **1,717** |
| **Aquifer Outflow** | | | | |
| Well Production | 0 | - 870 | -803 | -1,717 |
| Subsurface Outflow and Leakage/Subsurface Cross Flow Out | -815 | -456 | -2,192 | 0 |
| Los Osos Creek Outflow | 0 | - 77 | 0 | 0 |
| Warden Drain | 0 | - 6 | 0 | 0 |
| Willow Creek Outflow And Evapotranspiration | - 552 | 0 | 0 | 0 |
| **Total Aquifer Outflow** | **-1,367** | **-1,409** | **-2,995** | **-1,717** |
| aquifer inflow/Outflow Balance | 0 | 0 | 0 | 0 |
| All table quantities are in-acre-feet per year | | | | |


Source: AirPhoto USA, Hopkins Groundwater Consultants, San Luis Obispo County GIS Data, and MBA GIS Data.

Michael Brandman Associates

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Exhibit 5.2-2
Los Osos Surface Water Features

### *Groundwater Discharge*

#### Groundwater Production

Groundwater production by pumpers in the Los Osos Basin has averaged approximately 3,500 AFY since 1985 and has remained relatively constant since implementation of the 1983 building moratorium. While purveyor production can be provided by actual meter readings, private domestic and agricultural irrigation production has historically been estimated from land use information.

Recent revised groundwater production estimates include approximately 2,520 AFY produced from the upper and lower aquifers which includes 2,440 AFY produced by community purveyors (including the golf course) and 80 AFY from private domestic production within the urban area. There is also approximately 870 AFY produced for agricultural and domestic purposes within the creek valley,. The total annual groundwater production within the Los Osos Basin is approximately 3,390 AFY and is comparable to the 3,400 AFY production estimated for the year 2001 (the last year water purveyor records were made available).

#### Natural Groundwater Discharges

The Los Osos Basin groundwater system has been identified by previous studies as a source of contribution to surface water features that include springs, streams, lakes, and marshes. Natural groundwater discharges to these features has been observed but remains largely unquantified by historical monitoring programs. These features are also believed to be in part supported by groundwater recharge that is provided from rainfall runoff which is retained on-site and percolated into the groundwater system by recent developments that include the Williams Bros. Shopping Center, the commercial uses near the post office, Bayridge Estates, and Vista de Oro and Cabrillo Estates.

The surface water features that are believed to be at least partially supported by groundwater discharge from the Los Osos Basin include:

- Los Osos Creek
- Willow Creek
- Sweet Spring
- Sweet Spring Marsh
- Pecho Road Marsh
- Third Street Marsh
- Baywood Point Spring
- Baywood Marsh

The presence of these surface water features is an indication of existing shallow groundwater conditions around the Morro Bay.

### 5.2.2.3 - Sea Water Intrusion

The Los Osos Basin has been the subject of several studies that have evaluated seawater intrusion utilizing water levels and water quality as the primary criteria. The findings of the most recent assessment indicate that according to the Ghyben-Herzberg relation, a fresh water head of approximately 5.0 feet would be needed to prevent the seawater interface from moving onshore within the lowest zones of the upper aquifer. Similarly a fresh water head of approximately 9 and 17.5 feet would be required to prevent landward movement of the seawater interface in lower aquifer D Zone and E Zone, respectively. At the present time, only upper aquifer water level elevations are sufficient to prevent seawater intrusion.

The most recent study concluded that the upper aquifer fresh water/salt water interface is relatively stable and located beneath the Morro Bay sand spit, with a potential for active intrusion during extended drought periods. The study also found that seawater intrusion in the Lower Aquifer Zone D has advanced at an average rate of 60 feet per year between 1985 and 2005, and is approximately located between Pecho Road and Doris Avenue. Seawater intrusion in the Lower Aquifer Zone E was found to have advanced at an average rate of 54 feet per year between 1977 and 2005, and is approximately located between Broderson Avenue and Palisades Avenue.

### 5.2.2.4 - Groundwater Quality

The natural quality of groundwater in the Los Osos Basin has been of a sufficiently high quality to satisfy all overlying beneficial land uses. Since the beginning of land development, two primary sources have contributed to degradation of water quality; 1) seawater intrusion that has invaded the lower aquifer system as a result of over pumping, and 2) increasing nitrate concentrations that have resulted from the overlying land uses (i.e., septic system return flows, landscape fertilization, and domestic animal waste). Historical studies have documented the quality of groundwater in the Los Osos Basin that is delineated by aquifer zone. Following is a summary discussion of the existing total dissolved solids and nitrate concentrations in the Los Osos Wastewater Project (LOWWP) area.

#### *Salts*

Historical data indicate that the chemical character of water in the lower aquifers is predominantly magnesium-calcium/calcium-magnesium bicarbonate, with an average total dissolved solids (TDS) concentration of 340 milligrams per liter (mg/l). Seawater intrusion in the western coastal portion of the basin has changed the lower aquifer quality from bicarbonate to chloride anion dominance.

The Los Osos Creek Valley groundwater is characteristically magnesium-calcium bicarbonate with TDS concentrations on the order of 520 mg/l. The chemical character of groundwater in the upper aquifers is generally sodium magnesium chloride-bicarbonate water. The areas of the basin with higher TDS concentrations in shallow groundwater have been found to roughly correspond to some of the areas of higher $NO_3$-N (“Nitrate-Nitrogen”, hereinafter referred to as ‘nitrate’ throughout this document) concentrations. This may result from brine reject from domestic water softeners or other normal salt loading from domestic water use that is subsequently discharged from septic disposal systems. The range of TDS in the shallow groundwater is generally between 200 and 400 mg/l, with a low of 67 mg/l along South Bay Boulevard and a high of 1,100 mg/l beneath Sunset Terrace. Table 5.2-2 shows the TDS concentrations within the aquifers and the effluent from the existing septic system.

**Table 5.2-2: Average Groundwater and LOWWP Effluent TDS Concentrations**

| Water source | Tds (mg/l) |
|---|---|
| Perched Aquifer | 400 |
| Creek Compartment | 520 |
| Upper Aquifer System | 330 |
| Effluent | 620 |
| Source: Hopkins Groundwater Consultants, Inc. August 2008. | |

**Nitrate**

Sample results from a previous basin study prepared by Cleath and Associates show that $NO_3$-N (nitrate) concentrations measured in dedicated monitoring wells range from less than 1 mg/l to 28 mg/l with an overall average of 10 mg/l nitrate. The concentrations of nitrate contained in groundwater in the basin and the effluent from the proposed treatment plant are provided in Table 5.2-3

**Table 5.2-3: Average Groundwater and Effluent Nitrate-Nitrogen Concentrations**

| Water source | $NO_3$-N (mg/l) |
|---|---|
| Perched Aquifer | NA |
| Creek Compartment | 5 TO 10 |
| Upper Aquifer System | 10 |
| Effluent | 7 |
| Source: Hopkins Groundwater Consultants, Inc. August 2008. | |

There is an isolated area of low nitrate concentrations that is inferred to extend across the open space west of the South Bay Community Library where considerable surface runoff percolates to groundwater. The nitrate concentrations are inferred to decrease at the bay front and to the east, across South Bay Boulevard. Nitrates and other conservative constituents of basin return flows present in the upper aquifer that do not flow out into the bay or into other surface drainage courses will ultimately reach the lower aquifer. The total nitrogen in shallow groundwater samples often contained forms of nitrogen other than nitrate which included ammonia and organic nitrogen that are inferred to be contributed from septage return flows.

## 5.2.3 - Regulatory Setting

The major federal legislation governing the water quality aspects of the proposed project is the Clean Water Act, as amended by the Water Quality Act of 1987. The federal Environmental Protection Agency (EPA) is the federal agency responsible for water quality management nationwide.

The State of California's Porter-Cologne Water Quality Control Act provides the basis for water quality regulation within California. The State Water Resources Control Board (SWRCB) administers water rights, water pollution control, and water quality functions, while the Regional Water Quality Control Board (RWQCB) conducts planning, permitting, and enforcement activities. The Porter-Cologne Water Quality Control Act designates the SWRCB responsible for formulating and adopting state policy for water reclamation, while the California Department of Health Services (DHS) is responsible for establishing uniform statewide reclamation criteria to ensure that the use of recycled water would not be detrimental to public health.

### Water Quality Control Plan

The most recent update of the Water Quality Control Plan for the Central Coast Region (Basin 3) was adopted by the RWQCB in September 1994. The Basin Plan establishes beneficial uses and water quality objectives for surface and ground water sources within the basin. To be consistent with this plan, the proposed wastewater facilities project (LOWWP) must comply with the water quality objectives described in RWQCB Order No. 97-8, Waste Discharge Requirements for San Luis Obispo County Services Area 9.

### State Revolving Fund Requirements

In its Policy for Implementing the State Revolving Fund for Construction of Wastewater Treatment Facilities, the State Water Resources Control Board (SWRCB) requires compliance with all applicable federal environmental laws, including consistency with area-wide planning.

### San Luis Obispo County General Plan Land Use Element and Local Coastal Program - Estero Area Plan

In San Luis Obispo County, the individual General Plan Elements provide broad policy guidance for land use decisions throughout the unincorporated County. To provide policies and programs for specific geographic sub-areas, the County has adopted fifteen Area Plans, which serve as the General Plan Land Use Element for the given area.

The Community of Los Osos is governed by the goals and policies set forth in the Estero Area Plan. The Estero Area Plan was adopted in 1980 and updated as the Local Coastal Plan in 1988. Subsequently, the Area Plan was last updated in November 2004 and amended in July 2006. The Estero Area Plan encompasses approximately 71.5 square miles, and the plan area is consistent with the California Coastal Zone Boundary established by the California Coastal Act of 1976. In general, the plan area extends from Point Estero to the north (approximately 16.5 miles north of Los Osos) and

Point Buchon to the south (approximately 3.3 miles south of Los Osos). Following are the programs related to groundwater that are applicable to the Los Osos Wastewater Project.

A. WATER

LOS OSOS

1. Water Management. Based on community initiation, the county Public Works Department should work with communities, property owners and the Regional Water Quality Control Board to develop and implement a basin-wide water management program for Los Osos which addresses population levels in relation to water availability, groundwater quality, and the need for alternative liquid waste disposal plans.
2. Alternative Water Sources. Supplementary water such as reclaimed sewage effluent and water from existing impounments should be used to prevent overdraft of groundwater. New impoundments for recharging underground basins should be carefully considered along with other alternatives.

### County of San Luis Obispo Local Coastal Program Policy Document - Coastal Plan Policies

San Luis Obispo County has special tools available to implement the Local Coastal Program. The County adopted a Land Use Element and Land Use Ordinance system that has replaced typical general plan designations and zoning districts. The Coastal Plan Policies document states the policy commitment of San Luis Obispo County to implement the mandates of the Coastal Act. This policy document of the Local Coastal Plan is part of the Land Use Element of the County General Plan. Following is the groundwater policy under Policies for Coastal Watersheds that is applicable to the Los Osos Wastewater Project.

**Policy 1:** Preservation of Groundwater Basins

The long-term integrity of groundwater basins within the coastal zone shall be protected. The safe yield of the groundwater basin, including return and retained water shall not be exceeded except as part of a conjunctive use or resource management program which assures the biological productivity of aquatic habitats are not significantly adversely impacted.

## 5.2.4 - Thresholds of Significance

According to the CEQA Guidelines’ Appendix G Environmental Checklist, to determine whether impacts to water supply and groundwater quality are significant environmental effects, the following questions are analyzed and evaluated. Would the project:

a.) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted?

b.) Otherwise substantially degrade groundwater quality?

## Other Thresholds

Would the project conflict with local programs or policies related to groundwater quality or water supply?

## 5.2.5 - Analysis

## Groundwater Supply

| | |
|---|---|
| **Impact 5.2.A:** | **The proposed project would not substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted.** |

### *Project-Specific Impact Analysis*

#### Proposed Project 1

*Collection System*

Short-term Construction Effects

Proposed Project 1 would utilize a Septic Tank Effluent (STE) Collection System that is comprised of both septic tank effluent pumps (STEP) and septic tank effluent gravity (STEG) collection lines. This is referred to as a STEP/STEG system. With this system, old septic tanks would be taken out of use and new STEP/STEG tanks, together with effluent pumps and controls, would be installed at each connection. A total of 4,679 new STEP/STEG tanks, together with associated pumps and controls, would be installed.

Construction activities summarized above would include installation of sewer laterals with associated effluent pumps and controls at the tanks, force mains, collector lines, isolation valves conveyance lines, a stream crossing along Los Osos Valley Road. Construction activities that are located within the area of the community of Los Osos that is underlain by the perched aquifer (see Exhibit 5.2-1) may make contact with groundwater. If contact occurs, dewatering would be required during construction. Based on the depth of the proposed collection system facilities, no substantial dewatering of the existing groundwater supplies within the perched aquifer would occur; therefore, less than significant impacts to groundwater supplies would occur during construction activities.

Long-term Operational Effects

With the implementation of the STEP/STEG wastewater collection system, wastewater would no longer leach from the existing septic system into the Los Osos groundwater basin. Proposed Project 1 would eliminate the current leaching of approximately 997 AFY of which approximately 600 AFY currently leaches directly into the upper aquifer (Zone C) which is the main water supply. The treated effluent disposal associated with Proposed Project 1, in combination with the proposed water conservation program, would balance the inflow and outflow to/from the upper aquifer as further described below under "Combined Project Effects."

Since existing septic return flow into the upper aquifer system partially contributes to leakage into the lower aquifers, the implementation of Proposed Project 1 would proportionally impact groundwater supplies within the lower aquifer. The loss of flow into the lower aquifers would be offset as further described below under "Combined Project Effects".

#### *Treatment Plant Site*

##### Short-term Construction Effects

The project would result in the construction of an approximately 20-acre facultative pond treatment facility on the Giacomazzi property, an approximately 8-acre storage facility on a portion of the Cemetery property, and approximately 4-acre appurtenant facility on the Branin property. Construction activities at the treatment plant site are not expected to extend further than 10 feet below grade. Given that the existing groundwater table is at approximately 15 feet below grade, construction activities associated with the proposed treatment facilities would not contact groundwater. Therefore, construction activities associated with the proposed treatment facilities would have no impact on groundwater supplies.

##### Long-term Operational Effects

The proposed treatment ponds and storage ponds that would be implemented under Proposed Project 1 would be lined to prevent leaching of septage from the treatment plant site to the groundwater. Since the facilities would be lined, the project would have no impact on groundwater supply under the treatment plant site.

#### *Disposal Sites*

##### Short-term Construction Effects

Proposed Project 1 would include the construction of sprayfields on the Tonini property and leach-fields on the Broderson property. The spray sites at Tonini would be located on an area of approximately 175-acres. The fields would include spray heads located three vertical feet above the earth, each having a spray radius of 15 feet. The proposed facilities at Tonini would be constructed at a depth of less than 5 feet. Since groundwater ranges in elevation from 7 to approximately 40 feet above the existing surface, construction of the facilities on the Tonini property would result in no impact on the existing groundwater supply beneath the proposed treatment plant site.

The proposed leachfields at Broderson are proposed to include trenches that would extend up to 6.5 feet below grade. Since groundwater levels under Broderson are more than 100 feet below ground surface, construction activities associated with the Broderson leachfields would have no impact on groundwater supply.

Long-term Operational Effects

Operation activities under Proposed Project 1 would include two types of disposal: sprayfield irrigation and sub-surface leachfield, as well as the implementation of water conservation measures. The proposed sprayfields would discharge approximately 549 AFY of treated effluent to the Tonini disposal site. Proposed Project 1 also results in the discharge of approximately 448 AFY at the proposed Broderson site as well as the proposed water conservation measures.

Implementation of the sprayfield irrigation at the Tonini site would result in a less than significant impact on groundwater quantities within the bedrock aquifer. The implementation of the Broderson leachfields would result in a beneficial impact on the Los Osos Valley Groundwater Basin. As part of operating the Broderson leachfields, the quantity and rate of disposal would be monitored to optimize the disposal operations. The net effect of the implementation of Proposed Project 1 is described below under “Combined Project Effect”.

*Water Conservation*

As part of project construction, the project would include a component designated as water conservation. To achieve the desired 160 AFY reduction in LOWWP effluent, domestic and commercial water fixtures including toilets and shower heads will be replaced with low flow fixtures. The resulting conservation will be realized as a reduction of pumping from the overdrafted lower aquifer system. While historical production from the lower aquifer system has become a form of man-made recharge to the upper aquifer system through septic system recharge, the reduction in lower aquifer system production effectuated by conservation will result in less seawater intrusion. This impact is considered a beneficial impact to the Los Osos Basin, and would result in a less than significant impact associated with groundwater quality.

*Combined Project Effects*

Short-term Construction Effects

Based on the short-term project effects of each project component, all short-term effects on groundwater from the combined project are less than significant.

Long-term Operational Effects

During the fine screening study, effluent disposal methods were evaluated based on their ability to reduce the LOWWP impacts on seawater intrusion in the lower aquifer zones. The removal of septic recharge from the prohibition zone in the Los Osos Basin would reduce recharge to the upper aquifer zones, which in turn would reduce leakage from the upper aquifer Zone C that recharges the lower aquifer zones.

The proposed wastewater disposal methods are comprised of three components that include; a) sprayfield irrigation, b) Broderson percolation, and c) prohibition area conservation. A summary of the disposal capacity of each component is provided below in Table 5.2-4 along with the quantity of water provided that would reduce seawater intrusion in the lower aquifer zones.

**Table 5.2-4: Disposal Capacity**

| Component | Disposal or Conservation Capacity (afy) | | Seawater Intrusion Reduction (afy) | |
|---|---|---|---|---|
| | Buildout | Current | Buildout | Current |
| Sprayfields (175-acres) | 842 | 549 | 0 | 0 |
| Broderson Disposal | 448 | 448 | 99 | 99 |
| Conservation | 160 | 160 | 88 | 88 |
| **Total LOWWP Disposal** | **1,290** | **997** | **187** | **187** |

The total treated effluent disposal volume from the LOWWP is anticipated to be 1,290 AFY at buildout. Under current conditions the disposal volume is anticipated to be 997 AFY. Groundwater inflow removed from the hydrologic budget (septic system percolation) by the LOWWP collection system will affect both the upper aquifer zones, which are directly recharged by this source, and the lower aquifer zones which receive leakage from the upper aquifers. However, the disposal component of the project would ensure that there would not be a net loss in groundwater recharge to the aquifers that support overlying beneficial land uses and associated impacts would be less than significant. Furthermore, the proposed disposal of treated effluent at Broderson would reduce the current rate of seawater intrusion into the lower aquifer, thus resulting in a beneficial impact.

Modeling results indicate that the impact of this operation will be to restore groundwater levels in the upper aquifer system (Zones B and C) to elevations that are comparable to existing conditions. The study results indicate that Broderson disposal will provide beneficial impacts that restore groundwater recharge and maintain a balance in the hydrologic budget that provides outflows for local well production and freshwater features (marshes and springs) around the bay. Implementation of the proposed project would reduce septic effluent discharge into the perched aquifer (Zone A). Therefore, the project would reduce the quantity of groundwater within the perched aquifer. However, the exact quantity of reduction within the perched aquifer is unknown, and the potential impact on groundwater flow to surrounding surface water features is speculative given that the amount of perched groundwater currently flowing to surface water features is not known.

**Proposed Project 2**

Project 2 includes a gravity sewerage collection system and an Oxidation Ditch/Biolac wastewater treatment facility at the Giacomazzi site that provides secondary level treatment. The raw wastewater conveyance system carries collected wastewater from the Mid-Town pump station to the Giacomazzi wastewater treatment plant site. Treated effluent can be sent directly through the treated effluent conveyance system to the Broderson leachfield. Alternatively, some or all of the treated effluent can be sent through the eastern end of the treated effluent conveyance system to the Tonini sprayfields or the seasonal storage pond on the Tonini site.

*Collection System*

Short-term Construction Effects

The short-term effects on ground water supplies from the construction of the collection system associated with Proposed Project 2 would be the same as the short-term effects associated with Proposed Project 1.

Long-term Operational Effects

Long-term effects on ground water supplies from the proposed collection system associated with Proposed Project 2 would be the same as the long-term effects associated with Proposed Project 1.

*Treatment Plant Site*

Short-term Construction Effects

The existing groundwater table is at approximately 15 feet below grade. As with Proposed Project 1, construction activities associated with the proposed treatment facilities in Proposed Project 2 would not contact groundwater. Therefore, construction activities associated with the proposed treatment facilities in Proposed Project 2 would have the same “no impact” on groundwater supplies as Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, proposed treatment ponds and storage ponds that would be implemented under Proposed Project 2 would be lined to prevent leaching of septage from the treatment plant site to the groundwater. Since the facilities would be lined, Proposed Project 2 would have the same “no impact” on groundwater supply under the treatment plant site as Proposed Project 1.

*Disposal Sites*

Short-term Construction Effects

As with Proposed Project 1, the potential for groundwater impacts of the project disposal sites during construction of facilities for Proposed Project 2 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, the potential for groundwater impacts of the project disposal sites during operation of facilities for Proposed Project 2 would be the same less than significant impact as described above for Propose Project 1.

*Combined Project Effects*

Short-term Construction Effects

The potential for groundwater impacts of the combined project during construction of facilities for Propose Project 2 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

The potential for groundwater impacts of the combined project during operation of facilities for Proposed Project 2 would be the same as described above for Propose Project 1. Impacts to the Zone B and C aquifer is considered less than significant. The potential impact on the exact quantity of groundwater in the perched aquifer is unknown and the potential impact on groundwater flow to surrounding surface water features is speculative given that the amount of perched groundwater currently flowing to surface water features is not known. Furthermore, the proposed disposal of treated effluent at Broderson would reduce the current rate of seawater intrusion into the lower aquifer, thus resulting in a beneficial impact.

### Proposed Project 3

Project 3 includes a gravity sewage collection system and an Oxidation Ditch/Biolac wastewater treatment facility at the Giacomazzi/Branin site that provides secondary level treatment. The wastewater conveyance system carries the collected raw wastewater from the Mid-Town pump station to the combined Giacomazzi/Branin wastewater treatment plant and spray field site at Tonini. Treated effluent can be stored in the seasonal storage pond on the combined Giacomazzi/Branin site or sent directly through the treated effluent conveyance system to the Broderson leachfield and/or the Tonini spray fields.

*Collection System*

Short-term Construction Effects

The short-term effects on ground water supplies from the construction of the collection system associated with proposed project 3 would be the same as the short-term effects associated with Proposed Project 1.

Long-term Operational Effects

Long-term effects on ground water supplies from the proposed collection system associated with Proposed Project 3 would be the same as the long-term effects associated with Proposed Project 1.

*Treatment Plant Site*

Short-term Construction Effects

The existing groundwater table is at approximately 15 feet below grade. As with Proposed Project 1, construction activities associated with the proposed treatment facilities in Proposed Project 3 would not contact groundwater. Therefore, construction activities associated with the proposed treatment facilities in Proposed Project 3 would have the same “no impact” on groundwater supplies as Proposed Project 1

Long-term Construction Effects

As with Proposed Project 1, proposed treatment ponds and storage ponds that would be implemented under Proposed Project 3 would be lined to prevent leaching of septage from the treatment plant site to the groundwater. Since the facilities would be lined, Proposed Project 3 would have the same “no impact” on groundwater supply under the treatment plant site as Proposed Project 1.

*Disposal Sites*

Short-term Construction Effects

As with Proposed Project 1, the potential for groundwater impacts of the project disposal sites during construction of facilities for Proposed Project 3 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, the potential for groundwater impacts of the project disposal sites during operation of facilities for Proposed Project 3 would be the same less than significant impact as described above for Propose Project 1.

*Combined Project Effects*

Short-term Construction Effects

The potential for groundwater impacts of the combined project during construction of facilities for Propose Project 3 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

The potential for groundwater impacts of the combined project during operation of facilities for Proposed Project 3 would be the same as described above for Propose Project 1. Impacts to the Zone B and C aquifer is considered less than significant. The potential impact on the exact quantity of groundwater in the perched aquifer is unknown and the potential impact on groundwater flow to surrounding surface water features is speculative given that the amount of perched groundwater currently flowing to surface water features is not known. Furthermore, the proposed disposal of treated effluent at Broderson would reduce the current rate of seawater intrusion into the lower aquifer, thus resulting in a beneficial impact.

**Proposed Project 4**

Proposed Project 4 includes a gravity sewerage collection system and a facultative pond wastewater treatment facility at the Tonini site that provides secondary level treatment. The raw wastewater conveyance system carries the collected wastewater from the Mid-Town pump station to the combined Tonini wastewater treatment plant site. Treated effluent can be sent directly through the treated effluent conveyance system to the Broderson leachfield. Alternatively, some or all of the treated effluent can be sent to the nearby Tonini spray fields and or seasonal storage pond on the Tonini site

*Collection System*

Short-term Construction Effects

The short-term effects on ground water supplies from the construction of the collection system associated with proposed project 4 would be the same as the short-term effects associated with Proposed Project 1.

Long-term Operational Effects

Long-term effects on ground water supplies from the proposed collection system associated with Proposed Project 4 would be the same as the long-term effects associated with Proposed Project 1.

*Treatment Plant Site*

Short-term Construction Effects

The existing groundwater table is at 7 feet to approximately 40 feet below existing grade. Construction of the proposed treatment facilities will not extend to the groundwater table. As with Proposed Project 1, construction activities associated with the proposed treatment facilities in

Proposed Project 4 would not contact groundwater. Therefore, construction activities associated with the proposed treatment facilities in Proposed Project 4 would have the same “no impact” on groundwater supplies as Proposed Project 1

Long-term Construction Effects

As with Proposed Project 1, proposed treatment ponds and storage ponds that would be implemented under Proposed Project 4 would be lined to prevent leaching of septage from the treatment plant site to the groundwater. Since the facilities would be lined, Proposed Project 4 would have the same “no impact” on groundwater supply under the treatment plant site as Proposed Project 1..

*Disposal Sites*

Short-term Construction Effects

As with Proposed Project 1, the potential for groundwater impacts of the project disposal sites during construction of facilities for Proposed Project 4 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, the potential for groundwater impacts of the project disposal sites during operation of facilities for Proposed Project 4 would be the same less than significant impact as described above for Propose Project 1.

*Combined Project Effects*

Short-term Construction Effects

The potential for groundwater impacts of the combined project during construction of facilities for Propose Project 4 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

The potential for groundwater impacts of the combined project during operation of facilities for Proposed Project 4 would be the same as described above for Propose Project 1. Impacts to the Zone B and C aquifers are considered less than significant. The potential impact on the exact quantity of groundwater in the perched aquifer is unknown and the potential impact on groundwater flow to surrounding surface water features is speculative given that the amount of perched groundwater currently flowing to surface water features is not known. Furthermore, the proposed disposal of treated effluent at Broderson would reduce the current rate of seawater intrusion into the lower aquifer, thus resulting in a beneficial impact.

## *Cumulative Impact Analysis*

*Proposed projects 1 through 4*

Cumulative impacts consider the effects of past, present, and reasonably foreseeable projects with regard to groundwater supply and quality in the project vicinity. Since a moratorium on growth was imposed on the community of Los Osos in 1983, no additional structures have been constructed that would contribute to an effect on groundwater supply or would contribute to degradation of groundwater quality in the area. Groundwater supply and quality conditions have remained largely unchanged since the moratorium was imposed. Related projects within the greater cumulative project area are detailed in Section 4.2 and Exhibit 4.2-1 in the Draft EIR. Three of the nine related projects (Los Osos CSD Waterline Replacement, Los Osos Valley Road Palisades Storm Drain, and AT&T Cable) physically overlap with the study area for the proposed project but are either completed or expected to be completed by the time that construction of the proposed project is anticipated to begin (2010). Six of the nine related projects (State Park Marina Renovation, Morro Bay Wastewater Treatment Plant, Dredging of Morro Bay, CMC Wastewater Treatment Plant, Phase II Steam Generator Replacement at Diablo, and Spent Fuel Storage Facility at Diablo) have no physical overlap with the proposed project. The two related Diablo projects are nearly 7 miles south of Los Osos. Therefore, since there are no related projects that would contribute to cumulative groundwater supply impacts, implementation of Proposed Projects 1 through 4 would not contribute to cumulative impacts related to groundwater supply.

## *Mitigation Measures*

### Project-Specific

*Proposed Project 1*

No mitigation measures are required.

*Proposed Project 2*

No mitigation measures are required.

*Proposed Project 3*

No mitigation measures are required.

*Proposed Project 4*

No mitigation measures are required.

### Cumulative

*Proposed Project 1 through Project 4*

No mitigation measures are required.

## *Level of Significance After Mitigation*

### Project-Specific

*Proposed Project 1*

Less than significant.

*Proposed Project 2*

Less than significant.

*Proposed Project 3*

Less than significant.

*Proposed Project 4*

Less than significant.

**Cumulative**

*Proposed Project 1 through Project 4*

No impact.

## Groundwater Quality

| **Impact 5.2.B:** | **The proposed project would not degrade groundwater quality.** |
|---|---|

### *Project-Specific Impact Analysis*

#### *Proposed Project 1*

*Collection System*

Short-term Construction Effects

Proposed Project 1 would utilize a Septic Tank Effluent (STE) Collection System that is comprised of both septic tank effluent pumps (STEP) and septic tank effluent gravity (STEG) collection lines. This is referred to as a STEP/STEG system. With this system, old septic tanks would be taken out of use and new STEP/STEG tanks, together with effluent pumps and controls, would be installed.

Construction activities would include approximately 40,600 linear feet of 6-, 8-, and 10-inch PVC force mains, 203,000 linear feet of pressure sewer collector, 630 isolation valves and air release valves, 240 flushing ports, 1,000 linear feet of creek crossings, and 4,679 new STEP/STEG tanks with accompanying effluent pumps and controls. Construction activities that are located within the area of the community of Los Osos that is underlain by the perched aquifer (see Exhibit 5.2-1) may make contact with groundwater. If contact occurs, dewatering would be required. Based on the depth of the proposed collection system facilities, no substantial dewatering of the existing groundwater supplies within the perched aquifer would occur. Since no substantial dewatering would be required, the quality of the groundwater would encounter less than significant impacts during construction activities.

Long-term Operational Effects

The project's collection system will result in the removal of wastewater conveyance to private septic systems and would install a conveyance system to direct wastewater flows to the proposed treatment plant. The construction of the collection system would remove septic recharge from private septic tank systems, resulting in the removal of a source of groundwater contamination. Accordingly, the construction and operation of the proposed collection system would result in a beneficial impact to groundwater quality.

*Treatment Plant Site*

Short-term Construction Effects

The project would result in the construction of an approximately 20-acre facultative pond treatment facility on the Giacomazzi property, an approximately 8-acre storage facility on a portion of the Cemetery property, and approximately 4-acre appurtenant facility on the Branin property. Construction activities at the treatment plant site are not expected to extend further than 10 feet below grade. Given that the existing groundwater table is at approximately 15 feet below grade, construction activities associated with the proposed treatment facilities would not contact groundwater. Therefore, construction activities associated with the proposed treatment facilities would have no impact on groundwater quality

Long-term Operational Effects

The construction of the treatment plant would comply with all applicable regulations related to runoff, which would ensure that the project would not impact groundwater quality. The design and operation of the treatment plant site would provide measures that would ensure that untreated wastewater does not enter the groundwater supply, including the installation of impermeable linings for treatment ponds. As such, all wastewater treated at the treatment plant site would be conveyed to the disposal sites, ensuring that groundwater quality impacts at the proposed treatment plant would be less than significant.

*Disposal Sites*

Short-term Construction Effects

Proposed Project 1 would include the construction of sprayfields on the Tonini property and leach-fields on the Broderson property. The spray sites at Tonini would be located on an area of approximately 175-acres. The fields would include spray heads located three vertical feet above the earth, each having a spray radius of 15 feet. The proposed facilities at Tonini would be constructed at a depth of less than 5 feet. Since groundwater is anticipated to range from 7 feet to 40 feet in depth, construction of the facilities on the Tonini property would result in no impact on the existing groundwater quality beneath the proposed disposal site.

The proposed leachfields at Broderson are proposed to include trenches that would extend up to 6.5 feet below grade. Since groundwater levels under Broderson are more than 100 feet below ground surface, construction activities associated with the Broderson leachfields would have no impact on groundwater quality.

Long-term Operational Effects

During operation of the proposed sprayfields, potential impacts to groundwater from sprayfield irrigation will include a potential increase in TDS concentration, and nitrate loading of surface soils which can eventually percolate to groundwater. Geological conditions at the site indicate that percolation of applied irrigation water (approximately 210 AFY) in the sprayfields would contribute to groundwater recharge. Groundwater that rises in the Warden Lake drainage would flow downstream to Los Osos Creek and into Morro Bay. Groundwater emergence at lower elevations around the drainage channel would provide a beneficial impact to existing natural wetlands located adjacent Warden Creek.

Salt loading of the upper soils occurs when applied water is removed by evapotranspiration leaving the minerals not consumed by crops in the soil. These concentrated salts are subsequently leached to groundwater by excess irrigation and/or precipitation. Precipitation is essentially distilled water and acts as a diluting agent for the deposited salts. The net impact of water percolating to groundwater would likely have a higher or lower TDS concentration than the initial irrigation water depending on the rainfall to evapotranspiration ratio. The spray irrigation effluent is anticipated to have a TDS concentration on the order of 620 mg/l.

The use of sprayfield disposal at the Tonini site has the potential for groundwater quality impacts beneath the site by raising the total dissolved solids (TDS) concentration. While the nitrogen in the effluent will be largely (if not completely) consumed by plant uptake and natural denitrification processes, the dissolved salts in the effluent will be concentrated in the soil as a function of the evapotranspiration process. Salt precipitation in the root zone of irrigated crops is typical of all farming operations and often requires overwatering to leach the salt downward and remove the deleterious effects on the plants being raised. Annual rainfall in the Los Osos area may be sufficient for leaching purposes and preclude the need for typical overwatering operations to achieve salt removal from shallow soils.

The quality of groundwater underlying the Tonini site is a function of the source water quality, mineralogy of the underlying bedrock, and the residence time during which the groundwater remains in the formation prior to discharge at downgradient locations. The underlying groundwater at the Tonini site is primarily contained in fractured bedrock that comprises an aquifer system whereby flow is likely controlled by the orientation of fractures that create secondary porosity. The aquifer is an open system and outflow is observed downgradient as seeps and springs on the land surface, as well as, inferred to contribute underflow into the channel alluvium along the Warden Lake drainage and into the Los Osos Creek Valley aquifer. Because it is not a closed basin (without outflow) the increase in salt concentrations in the groundwater from irrigation practices will reach equilibrium and not continue to increase over time.

The TDS concentration of treated effluent that would be used for sprayfield disposal at the Tonini Ranch is estimated at approximately 620 mg/l and is comparable to the groundwater that underlies the Tonini site which was measured and averaged 606 mg/l. Because of the similar TDS concentrations, the effects on groundwater from using the LOWWP effluent as an irrigation source versus pumping groundwater for crop irrigation are the same. Based on these conditions the salt loading impacts to groundwater from irrigating crops with effluent at the proposed Tonini sprayfield site are considered less than significant.

Laboratory test results for groundwater samples collected from three wells on the Tonini property indicate the groundwater has an average TDS concentration of 606 mg/l and a nitrate concentration of 7.2 mg/l. Although the estimated TDS concentration of percolating water from sprayfield operations may be higher than local groundwater, the infiltration will mix with native groundwater flowing beneath the site and proportionally reduce the salts concentration. It is anticipated that a substantial portion of the nitrate in the applied water will be removed by crop uptake and decrease the concentration from 7 mg/l to a concentration lower than the background concentration of 7.2 mg/l and not contribute to degradation of existing conditions. Therefore, impacts associated with salt concentrations would be less than significant.

The potential impacts of effluent disposal at Broderson on the underlying groundwater quality was assessed by the LOCSD who performed the water quality modeling study in 2003. Table 5.2-5 lists the anticipated limits of the effluent that will be discharged at the subsurface leachfield. The study simulated groundwater quality changes that would result from discharge of treated effluent with an average $NO_3$-N concentration of 7 mg/l. The study concluded that while change would be gradual over time, the removal of septic system recharge in the prohibition area and the return of treated effluent with a reduced nitrate concentration to the Broderson site would result in a beneficial impact that would improve water quality.

**Table 5.2-5: Effluent Water Limitations from Previous Discharge Requirements (Order No. R3-2003-0007)**

| Effluent Limitations | | | |
|---|---|---|---|
| **Constituent** | **Units** | **Monthly Average** | **Daily Maximum** |
| Settleable Solids | MG/L | 0.1 | 0.5 |
| BOD*, 5-DAY | MG/L | 60 | 100 |
| Suspended Solids | MG/L | 60 | 100 |
| **Total Nitrogen (AS N)** | **MG/L** | **7** | **10** |
| *Biological Oxygen Demand | | | |

*Combined Project Effects*

Short-term Construction Effects

Based on the short-term project effects of each project component, all short-term effects on groundwater quality from construction of the collection system and the facilities at the treatment plant site and disposal sites are less than significant

Long-term Operational Effects

A summary of the water quality mass balance calculation results is provided in Appendix D-2 of this Draft EIR. Combining the average effluent concentration of 7 mg/l with all the other nitrogen sources in the Los Osos Basin, the average nitrate concentrations in the upper aquifer after LOWWP completion would be approximately 8.3 mg/l, and is below the drinking water standard. The nitrate concentration calculation results are included in Table 5.2-6.

The resulting average TDS concentration calculated for the upper aquifer zones with the operation of the Broderson leachfieldand the removal of septic return flows is provided in Table 5.2-6. Both of these results indicate the combined project would provide a beneficial water quality impact on the Los Osos Basin. Accordingly, water quality impacts associated with the combined project disposal program would be less than significant or beneficial.

**Table 5.2-6: Summary of Upper Aquifer Nitrate Loading and Average Concentrations**

| Basin Condition | Total Surface Recharge to Los Osos Basin (AFY) | Total Nitrogen Load (Tons) | Estimated Average Concentration (MG/L) |
|---|---|---|---|
| Current | 3,525 | 52.1 | 10.9 |
| Post development | 3,337 | 37.9 | 8.3 |

**Table 5.2-7: Summary of Upper Aquifer Average Total Dissolved Solids Concentration**

| Basin Condition | Total Salts Load (Tons) | Estimated Average Concentration (MG/L) |
|---|---|---|
| Current | 1,378 | 352 |
| Broderson 448 Afy | 1,097 | 299 |

**Proposed Project 2**

Project 2 includes a gravity sewerage collection system and an Oxidation Ditch/Biolac wastewater treatment facility at the Giacomazzi site that provides secondary level treatment. The raw wastewater conveyance system carries collected wastewater from the Mid-Town pump station to the Giacomazzi wastewater treatment plant site. Treated effluent can be sent directly through the treated effluent conveyance system to the Broderson leachfield. Alternatively, some or all of the treated effluent can be sent through the eastern end of the treated effluent conveyance system to the Tonini sprayfields or the seasonal storage pond on the Tonini site.

*Collection System*

Short-term Construction Effects

The short-term effects on groundwater quality from the construction of the collection system associated with Proposed Project 2 would be the same as the short-term effects associated with Proposed Project 1.

Long-term Operational Effects

Long-term effects on groundwater quality from the proposed collection system associated with Proposed Project 2 would be the same as the long-term effects associated with Proposed Project 1

*Treatment Plant Site*

Short-term Construction Effects

The existing groundwater table is at approximately 15 feet below grade. As with Proposed Project 1 construction activities associated with the proposed treatment facilities in Proposed Project 2 would not contact groundwater. Therefore, construction activities associated with the proposed treatment facilities in Proposed Project 2 would have the same “no impact” on groundwater quality as Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, proposed treatment ponds and storage ponds that would be implemented under Proposed Project 2 would be lined to prevent leaching of septage from the treatment plant site to the groundwater. Since the facilities would be lined, Proposed Project 2 would have the same "no impact" on groundwater quality under the treatment plant site.

*Disposal Sites*

Short-term Construction Effects

As with Proposed Project 1, the potential for groundwater quality impacts of the project disposal sites during construction of facilities for Proposed Project 2 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, the potential for groundwater quality impacts of the project disposal sites during operation of facilities for Proposed Project 2 would be the same less than significant impact as described above for Proposed Project 1.

*Combined Project Effects*

Short-term Construction Effects

The potential for groundwater quality impacts of the combined project during construction of facilities for Propose Project 2 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

The potential for groundwater quality impacts of the combined project during operation of facilities for Proposed Project 2 would be the same less than significant impact as described above for Propose Project 1.

**Proposed Project 3**

Project 3 includes a gravity sewerage collection system and an Oxidation Ditch/Biolac wastewater treatment facility at the Giacomazzi/Branin site that provides secondary level treatment. The wastewater conveyance system carries the collected raw wastewater from the Mid-Town pump station to the combined Giacomazzi/Branin wastewater treatment plant and spray field site at Tonini. Treated effluent can be stored in the seasonal storage pond on the combined Giacomazzi/Branin site or sent directly through the treated effluent conveyance system to the Broderson leachfield and/or the Tonini spray fields.

*Collection System*

Short-term Construction Effects

The short-term effects on groundwater quality from the construction of the collection system associated with Proposed Project 3 would be the same as the short-term effects associated with Proposed Project 1.

Long-term Operational Effects

Long-term effects on groundwater quality from the proposed collection system associated with Proposed Project 3 would be the same as the long-term effects associated with Proposed Project 1.

*Treatment Plant Site*

Short-term Construction Effects

The existing groundwater table is at approximately 15 feet below grade. As with Proposed Project 1 construction activities associated with the proposed treatment facilities in Proposed Project 3 would not contact groundwater. Therefore, construction activities associated with the proposed treatment facilities in Proposed Project 3 would have the same “no impact” on groundwater quality as Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, proposed treatment ponds and storage ponds that would be implemented under Proposed Project 3 would be lined to prevent leaching of septage from the treatment plant site to the groundwater. Since the facilities would be lined, Proposed Project 3 would have the same “no impact” on groundwater quality under the treatment plant site.

*Disposal Sites*

Short-term Construction Effects

As with Proposed Project 1, the potential for groundwater quality impacts of the project disposal sites during construction of facilities for Proposed Project 3 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, the potential for groundwater quality impacts of the project disposal sites during operation of facilities for Proposed Project 3 would be the same less than significant impact as described above for Proposed Project 1.

*Combined Project Effects*

Short-term Construction Effects

The potential for groundwater quality impacts of the combined project during construction of facilities for Propose Project 3 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

The potential for groundwater impacts of the combined project during operation of facilities for Proposed Project 3 would be the same as described above for Propose Project 1. Less than significant impact or beneficial.

**Proposed Project 4**

Proposed Project 4 includes a gravity sewerage collection system and a facultative pond wastewater treatment facility at the Tonini site that provides secondary level treatment. The raw wastewater conveyance system carries the collected wastewater from the Mid-Town pump station to the combined Tonini wastewater treatment plant site. Treated effluent can be sent directly through the treated effluent conveyance system to the Broderson leachfield. Alternatively, some or all of the treated effluent can be sent to the nearby Tonini spray fields and or seasonal storage pond on the Tonini site

*Collection System*

Short-term Construction Effects

The short-term effects on groundwater quality from the construction of the collection system associated with Proposed Project 4 would be the same as the short-term effects associated with Proposed Project 1.

Long-term Operational Effects

Long-term effects on groundwater quality from the proposed collection system associated with Proposed Project 4 would be the same as the long-term effects associated with Proposed Project 1

*Treatment Plant Site*

Short-term Construction Effects

The existing groundwater table is 7 feet to approximately 40 feet below existing grade. Construction of the proposed treatment facilities will not extend to the groundwater table. As with Proposed Project 1, construction activities associated with the proposed treatment facilities in Proposed Project 4 would not contact groundwater. Therefore, construction activities associated with the proposed treatment facilities in Proposed Project 4 would have the same "no impact" on groundwater quality as Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, proposed treatment ponds and storage ponds that would be implemented under Proposed Project 4 would be lined to prevent leaching of septage from the treatment plant site to the groundwater. Since the facilities would be lined, Proposed Project 4 would have the same "no impact" on groundwater quality under the treatment plant site.

*Disposal Sites*

Short-term Construction Effects

As with Proposed Project 1, the potential for groundwater quality impacts of the project disposal sites during construction of facilities for Proposed Project 4 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

As with Proposed Project 1, the potential for groundwater quality impacts of the project disposal sites during operation of facilities for Proposed Project 4 would be the same less than significant impact as described above for Proposed Project 1.

*Combined Project Effects*

Short-term Construction Effects

The potential for groundwater quality impacts of the combined project during construction of facilities for Propose Project 4 would be the same less than significant impact as described above for Proposed Project 1.

Long-term Operational Effects

The potential for groundwater quality impacts of the combined project during operation of facilities for Proposed Project 4 would be the same less than significant impact as described above for Propose Project 1.

### *Cumulative Impact Analysis*

*Proposed Projects 1 through 4*

Cumulative impacts consider the effects of past, present, and reasonably foreseeable projects with regard to groundwater supply and quality in the project vicinity. Since a moratorium on growth was imposed on the community of Los Osos in 1983, no additional structures have been constructed that would contribute to an effect on groundwater supply or would contribute to degradation of groundwater quality in the area. Groundwater supply and quality conditions have remained largely unchanged since the moratorium was imposed. Related projects within the greater cumulative project area are detailed in Section 4.2 and Exhibit 4.2-1 in the Draft EIR. Three of the nine related projects (Los Osos CSD Waterline Replacement, Los Osos Valley Road Palisades Storm Drain, and AT&T Cable) physically overlap with the study area for the proposed project but are either completed or expected to be completed by the time that construction of the proposed project is anticipated to begin (2010). Six of the nine related projects (State Park Marina Renovation, Morro Bay Wastewater Treatment Plant, Dredging of Morro Bay, CMC Wastewater Treatment Plant, Phase II Steam Generator Replacement at Diablo, and Spent Fuel Storage Facility at Diablo) have no physical overlap with the proposed project. The two related Diablo projects are nearly 7 miles south of Los Osos. Therefore, since there are no related projects that would contribute to cumulative groundwater quality impacts, implementation of Proposed Projects 1 through 4 would not contribute to cumulative impacts related to groundwater quality.

### *Mitigation Measures*

#### Project-Specific

*Proposed Project 1*

No mitigation measures are required.

*Proposed Project 2*

No mitigation measures are required.

*Proposed Project 3*

No mitigation measures are required.

*Proposed Project 4*

No mitigation measures are required.

#### Cumulative

*Proposed Project 1 through Project 4*

No mitigation measures are required.

### *Level of Significance After Mitigation*

#### Project-Specific

*Proposed Project 1*

Less than significant.

*Proposed Project 2*

Less than significant.

*Proposed Project 3*

Less than significant.

*Proposed Project 4*

Less than significant.

#### Cumulative

*Proposed Project 1 through Project 4*

No impact.

## Local Programs and Policies Related to Groundwater Supply or Quality

**Impact 5.2.C:** **The proposed project would not conflict with local programs or policies related to groundwater quality or water supply?**

### *Project-Specific Impact Analysis*

#### Proposed Projects 1 through 4

Projects 1 through 4 are in compliance with the County's applicable General Plan programs and policy related to groundwater quality or supply as described in Table 5.2-8 below.

**Table 5.2-8: Consistency of the Proposed Projects with General Plan Programs and Policy**

| Groundwater Resources Programs and Policy | Proposed Project Consistency | | | |
|---|---|---|---|---|
| | Proposed Project 1 | Proposed Project 2 | Proposed Project 3 | Proposed Project 4 |
| **Estero Area Plan Program A.1**: Water Management. Based on community initiation, the County Public Works Department should work with communities, property owners and the Regional Water Quality Control Board to develop and implement a basin-wide water management program for Los Osos which addresses population levels in relation to water availability, groundwater quality, and the need for alternative liquid waste disposal plans. | The proposed projects are a plan for alternative liquid waste disposal; therefore, the projects would be consistent with this program. | | | |

**Table 5.2-8 (Cont.): Consistency of the Proposed Projects with General Plan Programs and Policy**

| Groundwater Resources Programs and Policy | Proposed Project Consistency | | | |
|---|---|---|---|---|
| | Proposed Project 1 | Proposed Project 2 | Proposed Project 3 | Proposed Project 4 |
| **Program A.2:** Alternative Water Sources. Supplementary water such as reclaimed sewage effluent and water from existing improvements should be used to prevent overdraft of groundwater, New impoundments for recharging underground basins should be carefully considered along with other alternatives. | The proposed projects include the discharge of treated effluent into the Los Osos Groundwater Basin. The proposed discharge would result in a balance of the groundwater supplies within the Zone C aquifer which is the main water source. Therefore, the proposed projects would be consistent with this program. | | | |
| **Local Coastal Program Policy Document** **Policy 1**: Preservation of Groundwater Basins. The long-term integrity of groundwater basins within the coastal zone shall be protected. The safe yield of the groundwater basin, including return and retained water shall not be exceeded except as part of a conjunctive use or resource management program which assures the biological productivity of aquatic habitats are not significantly adversely impacted | The proposed projects include a balance of groundwater levels in the main water source aquifer and therefore, the projects would be consistent with this policy. | | | |

## *Cumulative Impact Analysis*

*Proposed Projects 1 through 4*

Cumulative impacts consider the effects of past, present, and reasonably foreseeable projects with regard to groundwater supply and quality in the project vicinity. Since a moratorium on growth was imposed on the community of Los Osos in 1983, no additional structures have been constructed that would contribute to an effect on groundwater supply or would contribute to degradation of groundwater quality in the area. Groundwater supply and quality conditions have remained largely unchanged since the moratorium was imposed. Related projects within the greater cumulative project area are detailed in Section 4.2 and Exhibit 4.2-1 in the Draft EIR. Three of the nine related projects (Los Osos CSD Waterline Replacement, Los Osos Valley Road Palisades Storm Drain, and AT&T Cable) physically overlap with the study area for the proposed project but are either completed or expected to be completed by the time that construction of the proposed project is anticipated to begin (2010). Six of the nine related projects (State Park Marina Renovation, Morro Bay Wastewater

Treatment Plant, Dredging of Morro Bay, CMC Wastewater Treatment Plant, Phase II Steam Generator Replacement at Diablo, and Spent Fuel Storage Facility at Diablo) have no physical overlap with the proposed project. The two related Diablo projects are nearly 7 miles south of Los Osos. Therefore, since there are no related projects that would contribute to cumulative impacts to County groundwater supply and groundwater quality programs and policies, implementation of Proposed Projects 1 through 4 would not contribute to cumulative impacts on the County's groundwater supply and groundwater quality programs and policies.

### *Mitigation Measures*

#### Project-Specific

*Proposed Projects 1 through 4*

No mitigation measures are required.

#### Cumulative

*Proposed Projects 1 through 4*

No mitigation measures are required.

### *Level of Significance After Mitigation*

#### Project-Specific

*Proposed Projects 1 through 4*

Less than significant.

#### Cumulative

*Proposed Projects 1 through 4*

No impact.

# D-2: Hydrogeological Impacts Study

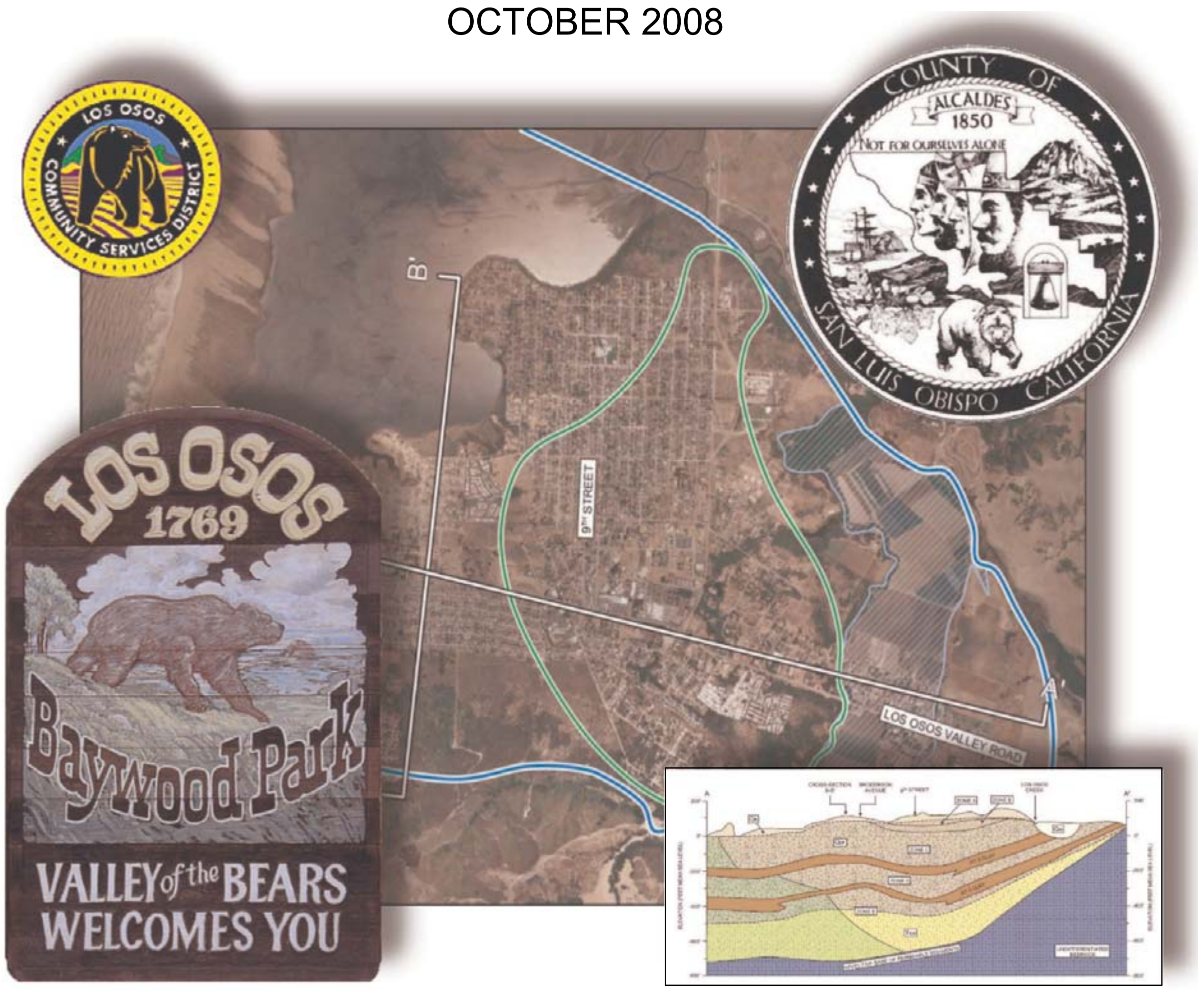
HOPKINS GROUNDWATER CONSULTANTS, INC.

# PRELIMINARY HYDROGEOLOGICAL IMPACTS STUDY

# LOS OSOS WASTEWATER PROJECT
# LOS OSOS, CALIFORNIA

Prepared for:
COUNTY OF SAN LUIS OBISPO

OCTOBER 2008



**HOPKINS**
**GROUNDWATER**
**CONSULTANTS, INC.**
**THE WATER RESOURCE SPECIALISTS**

October 31, 2008
Project No. 07-016-01

Michael Brandman Associates
220 Commerce, Suite 200
Irvine, California 92602

Attention: Mr. Michael E. Houlihan
Manager of Environmental Services

Subject: Final Report of Preliminary Hydrogeological Impacts Study, Los Osos Wastewater Project, Los Osos, California, Prepared for: County of San Luis Obispo, October, 2008.

Dear Houlihan:

Hopkins Groundwater Consultants, Inc. (Hopkins) is pleased to provide this final report summarizing the findings, conclusions, and recommendations of the subject preliminary hydrogeological study which analyzed the potential impacts of the proposed Los Osos Wastewater Project.

We trust the information contained in this report sufficiently describes present groundwater basin conditions and the anticipated changes that will result from the project. If you have any questions or need any additional information, please give us a call.

REGISTERED GEOLOGIST
CURTIS J. HOPKINS
EG NO. 1800
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

Sincerely,

HOPKINS GROUNDWATER CONSULTANTS, INC.

Curtis J. Hopkins
Principal Hydrogeologist
Certified Engineering Geologist EG 1800
Certified Hydrogeologist HG 114

Brian M. Cosner
Staff Hydrogeologist

c:

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## PLATES



## APPENDICES

## INTRODUCTION

The purpose of this preliminary hydrogeological study is to compile available hydrogeological data and information that summarize the present level of understanding of the Los Osos Valley Groundwater Basin conditions for the purpose of assessing the potential impacts of the proposed Los Osos Wastewater Project (LOWWP). The groundwater conditions and potential impacts summarized herein will be subsequently utilized in the project Environmental Impact Report of the proposed LOWWP alternatives being considered by the County of San Luis Obispo (County). The study area is indicated on Plate 1 – Study Area Location Map.

### Historical Studies

The Los Osos community has historically derived its entire water supply from groundwater sources. In the early 1970's groundwater was recognized as being impacted by seawater intrusion and elevated nitrate concentrations from overlying land uses (DWR, 1973). Over the last 30 years substantial hydrogeological studies have been conducted on the natural water resources that occur in the vicinity of Los Osos. The following list of studies indicates the primary sources of hydrogeological conditions that are summarized in this report.

- Freshwater Influences on Morro Bay, 1990
- Hydrogeological Investigation of the Broderson Site, 2000
- Simulated Effects of a Proposed Sewer Project on Nitrate Concentrations in the Los Osos Valley Groundwater Basin, 2003
- Geotechnical Report Los Osos Wastewater Project, 2004
- Los Osos Nitrate Monitoring Program, 2005
- Sea Water Intrusion Assessment and Lower Aquifer Source Investigation of the Los Osos Valley Groundwater Basin, 2005

These published sources derive substantial information from other historical studies and combine those findings with additional data to formulate our current understanding of the Los Osos Valley Groundwater Basin conditions. The hydrogeological understanding of the basin at the time of this study was utilized to assess potential project related impacts.

## LOS OSOS VALLEY GROUNDWATER BASIN

The Los Osos Valley Groundwater Basin (Los Osos Basin) is an east/west trending syncline comprised of Tertiary and Quaternary age sediments that unconformably lie on top of Miocene and Jurassic age bedrock of the Pismo and Franciscan Formations, respectively. The approximate basin boundary is indicated on Plate 1.

### Hydrogeology

The onshore portion of the Los Osos Basin covers approximately 10 square miles, of which approximately 3.3 square miles underlie the bay and sand spit, and 6.7 square miles underlie Los Osos, Baywood Park, and the Los Osos Creek Valley (C&A, 2005c). The groundwater basin is bounded to the north, east, and south by relatively impermeable bedrock formations and to the west where the aquifers outcrop on the ocean floor. Basin sediments are believed to extend close to three miles offshore, however the fresh water portion of the basin is defined by the saltwater/fresh water interface which has moved onshore.

Permeable basin sediments that comprise the shallow and deep aquifer zones consist of alluvial deposits, sand dunes, the Paso Robles Formation, and the Careaga Formation. The location of hydrogeological cross-sections that show the relationship of these formations is indicated on Plate 2 – Hydrogeological Cross-Section Location Map. An east-west and north-south subsurface profile of the Los Osos Basin is included as Plates 3 and 4 – Hydrogeological Cross-Section A to A’ and B to B’, respectively.

As shown on Plates 3 and 4, in the deepest portions of the basin the fresh water-bearing deposits extend to depths of approximately 700 feet below sea level. Previous studies have identified six aquifer zones in the Los Osos Basin which include the unconfined alluvial aquifer in the Los Osos Creek Valley, and 5 interbedded aquifer zones designated in previous reports as Zones A through E (C&A, 2005c). The letter reference system previously used to delineate the aquifer zones in the Los Osos Basin is also utilized by this study. The aquifer zones include; 1) the unconfined perched aquifer (Zone A), 2) the upper transitional aquifer (Zone B), 3) the upper main supply aquifer (Zone C), and the lower aquifers (Zones D and E). The upper and lower aquifer systems are separated by a regional aquitard that averages approximately 50 feet in thickness. Historical interpretations of hydrogeological data lead to the inference that the Los Osos Basin was effectively partitioned by a splay of the Los Osos Fault designated as Strand B. Because of this interpretation, previous studies considered water budgets separately for basin areas east and west of the fault.

Recent studies have discovered that the aquitard is leaky enough to allow a substantial amount of groundwater to move between the upper and lower aquifer zones.

Historical pumping patterns have created a head differential between the upper and lower system which has resulted in leakage from the upper aquifer becoming a substantial recharge component to the lower aquifer system. In addition, recent hydraulic testing of the aquifer system, correlation of well geophysical logs, water quality analyses, and model simulation results indicate that either the Los Osos Fault Strand B does not exist or it is not an effective barrier to groundwater flow. These findings are considered a refinement to our understanding of the groundwater system and are included in this study of potential project related impacts.

### Groundwater Occurrence and Movement

The majority of the recharge to the Los Osos Basin is derived from the following elements:

- Direct percolation of precipitation,
- Return flow from irrigation and septic system discharges,
- Stream seepage from Los Osos Creek,
- Subsurface inflow across basin boundaries.

Within the basin, individual aquifer zones may receive recharge directly from the above sources, or indirectly from aquitard leakage that allows inflow from an overlying or underlying aquifer zone. Movement of groundwater within alluvial, perched, and upper aquifer zones can be inferred from the groundwater gradients indicated by historical groundwater elevation contour maps (see Appendix B in reference report C&A, 2005c). Historical seasonal and climatic water level changes are indicated by hydrographs for wells constructed in individual aquifer zones across the basin (see Appendix D in reference report C&A, 2005c).

#### Alluvial Aquifer

The location of the Los Osos Creek Valley alluvial aquifer (also referenced as the creek compartment) is shown on Plate 2. Groundwater in the Los Osos Creek Valley alluvial aquifer moves down the alignment of the valley northward toward the Morro Bay Estuary. Alluvial aquifer recharge includes the elements listed above. Subsurface outflow from the alluvium into aquifer Zones C, D, and E occurs where these zones contact the alluvial fill beneath ground surface. Seasonal water level fluctuations within the alluvial aquifer have historically been on the order of 5 feet between the wet and dry seasons while water level declines during drought periods have exceeded 10 feet. Recharge to this aquifer is primarily provided by percolation of Los Osos Creek flows.

### Zones A, B, and C

The perched aquifer (Zone A) is comprised primarily of dune sands that are deposited on a clay layer(s) that impedes vertical flow to underlying aquifer zones. Available data indicate the clay layer pinches out to the north and west where groundwater flows into the underlying transitional aquifer (Zone B) of the upper aquifer system (C&A, 2005c). The westward boundary of the perching clay has been estimated to be roughly coincident with the inferred trace of the Los Osos Fault splay referenced by previous studies as Strand B (TMG, 1989). The approximate areal extent of the perching clay layer is shown in Plate 2.

The perched aquifer receives recharge from percolation of precipitation and return flows from overlying land uses. The water table contours constructed from available data roughly parallel the ground surface. Groundwater movement in Zone A is generally northwest to northeast, with relatively steep hydraulic gradients of up to 0.06 ft/ft between Bayview Heights and downtown. Groundwater in the perched aquifer rises in Willow Creek and emerges as seeps in the Oaks Preserve and along the banks in the lower reach of Los Osos Creek. A groundwater mound between downtown Los Osos and eastern Baywood Park area creates a hydraulic divide between water moving to the east toward Los Osos Creek and water moving to the west toward the Morro Bay Estuary (C&A, 2005c).

Beneath the shallow dune sand deposits are interbedded clay, silt, sand, and gravel layers of the Paso Robles Formation which form the upper aquifer comprised of Zones B and C. Water level data indicate the transitional aquifer (Zone B) receives recharge through leakage from Zone A in portions of downtown Los Osos and areas to the east, and represents an intermediate hydraulic zone between the perched aquifer and the main water supply aquifer (Zone C).

Recharge to the upper aquifer (Zone C), occurs via the direct recharge sources itemized above, as well as through leakage from Zones A and B. This leakage is evident in both water level and water quality data. Movement of groundwater in Zone C is variable and affected by groundwater production, but generally flows north and west toward the bay. A component of groundwater flows easterly from Baywood toward Los Osos Creek. Historical production from this aquifer has created a pumping depression which lies beneath downtown Los Osos. The hydraulic gradient in Zone C ranges from 0.004 to 0.025 (dimensionless), and averages approximately 0.009 (C&A, 2005c).

Groundwater levels in Zones A, B, and portions of Zone C were observed to rise during the 1970's as a result of increased recharge from irrigation and septic system return flows. Since the 1970's, water level data indicate that seasonal fluctuations and climatic cycle changes occur in the perched and upper aquifer zones, however, the system has generally stabilized and reached equilibrium between the existing sources of recharge and discharge.

### Zones D and E

The lower aquifer Zone D is comprised of sand and gravel layers in the Paso Robles Formation that are separated from the upper aquifer (Zone C) by a relatively continuous clay layer. The confining clay forms an aquitard that is reportedly leaky and allows downward recharge from the upper aquifer (Y&W, 2003, C&A, 2005c). Beneath the Zone D aquifer is another confining clay layer that delineates the lowermost freshwater aquifer Zone E. Aquifer Zone E is comprised of sand and gravel zones contained in the lower portion of the Paso Robles Formation and the underlying Careaga Formation which unconformably lies on older bedrock materials.

Recharge and movement of groundwater in the lower aquifer system (Zones D and E) was recently studied in detail by the Los Osos Community Services District (LOCSD) as part of a seawater intrusion investigation (C&A, 2005c). The results of the lower aquifer recharge investigation indicated sources of recharge may include subsurface inflow from the Los Osos Creek Valley alluvium, subsurface inflow from bedrock, seawater intrusion, and leakage from the upper aquifer through the regional aquitard. Since 1988 groundwater studies have concluded that a principal source of recharge to the basin is septic return flows and that the majority of recharge to the lower aquifer is coming from upper aquifer leakage through the regional aquitard (Y&W, 2003, C&A, 2005c).

The groundwater gradient in the lower aquifers is largely influenced by pumping patterns. Presently groundwater is generally moving toward downtown Los Osos from surrounding areas of the basin. The highest water levels in the lower aquifer system are located in the Los Osos Creek Valley. The hydraulic gradient between the upper creek valley and downtown Los Osos of up to 0.03 is relatively steep and suggests significant impedance to flow which may be fault-related as noted by the U.S. Geological Survey (U.S.G.S.) (Yates and Wiese, 1988).

Recent studies have documented that groundwater elevations in the lower aquifer zones are below sea level over a substantial portion of the basin. This condition has persisted for many years and has resulted in the onshore flow of seawater in both lower aquifer zones. Water level declines in Zones D and E largely took place during the 1970's and early 1980's and have generally reached equilibrium between sources of recharge (which includes seawater) and discharge.

## PERENNIAL YIELD

### Aquifer Recharge

#### Upper Aquifer Recharge

Historical groundwater study has identified that the main water supply aquifer zone (C Zone) is recharged primarily by sources that include; a) precipitation, b) irrigation return flows, c) septic system percolation, d) vertical leakage through the confining clay, and e) subsurface inflow from the A and B Zones, the creek valley alluvium, and underlying bedrock. The basin model utilized for the seawater intrusion study has been subsequently revised to include changes in basin conditions that have occurred since 2005 (i.e., shifts in pumping patterns). Model results were utilized for the development of the rough and fine screening studies and subsequently documented (C&A, 2008b) and utilized in this hydrogeological impacts study. The hydrologic budget obtained from model simulation indicates that total annual recharge to the upper main water supply aquifer under present hydrogeological conditions is estimated to be on the order of 3,100 acre-feet per year (AFY) (C&A, 2008b).

Direct percolation of precipitation and irrigation return flows is estimated at approximately 1,489 AFY. Septage return flow is estimated to contribute approximately 606 AFY and groundwater leakage through the perching clay layer is approximately 374 AFY. Subsurface inflow from the shallower A and B Zones aquifer, the creek compartment, and underlying bedrock is about 526 AFY (C&A, 2008b).

#### Lower Aquifer Recharge

When groundwater is extracted from the lower aquifers, four potential sources of recharge are available for replenishment. These sources are; a) subsurface inflow from underlying bedrock, b) the Los Osos Creek Valley, c) leakage through the regional aquitard from the upper aquifer, and d) seawater. Recent study has combined the use of water quality characterization, water level information, metered and estimated groundwater production, and basin geometry and boundary conditions to investigate the sources of lower aquifer recharge. These studies have utilized both analytical and numerical methods of analysis.

Numerical groundwater models constructed for the groundwater basin have consistently shown that the main source of recharge to the lower aquifer was leakage from the upper aquifer through the regional aquitard (C&A, 2005c). This conclusion has reportedly been supported by water quality characterization and radiocarbon age-dating of the groundwater. Under current basin conditions recharge to the lower aquifers west of the Los Osos Creek Valley is estimated to include 880 AFY of upper aquifer leakage through the regional aquitard, 370 AFY subsurface inflow from the Creek Valley Alluvial Aquifer (creek compartment), and 470 AFY of seawater intrusion (C&A, 2008b). Past studies also indicate that recharge from bedrock is negligible.

## Groundwater Discharge

### Groundwater Production

Groundwater production by pumpers in the Los Osos Basin has averaged approximately 3,500 AFY since 1985 and has remained relatively constant since implementation of the 1983 building moratorium. Production from individual aquifer zones delineated by user group is summarized below in Table 1 - Los Osos Basin Groundwater Production Data. While purveyor production is based on actual meter readings, private domestic and agricultural irrigation production has historically been estimated from land use information.

**Table 1 – Los Osos Basin Groundwater Production Data**

| AQUIFER ZONE | PURVEYORS | | | PRIVATE DOMESTIC | AGRICULTURAL IRRIGATION | 1985-2001 AVERAGE | 2001 PRODUCTION |
|---|---|---|---|---|---|---|---|
| | GOLDEN STATE WATER CO. | LOCSD | S&T | | | | |
| A & B | 0 | 0 | 0 | 40 | 0 | 40 | 40 |
| C & ALLUVIUM | 250 | 230 | 50 | 120 | 330 | 980 | 810 |
| D | 820 | 630 | 60 | 40 | 400 | 1,950 | 2,170 |
| E | 0 | 280 | 0 | 0 | 220 | 500 | 380 |
| TOTAL | 1,070 | 1,140 | 110 | 200 | 950 | 3,470 | 3,400 |

TABLE QUANTITIES IN ACRE-FEET PER YEAR (DATA FROM C&A, 2005C)

A comparison of the 1985-2001 average with the 2001 data indicate that the C Zone production has decreased by approximately 17 percent and is inferred to be a result of water quality degradation, while the E Zone production has decreased approximately 24 percent as a result of salt water encroachment. The reduction of groundwater from these aquifer zones has been accommodated by greater production in the D Zone and water conservation. Approximately two-thirds (67%) of the total groundwater production in the basin is conducted by the 3 main purveyors with the remainder produced by agricultural irrigation and domestic uses equal to approximately 27 percent and 6 percent, respectively.

Recent revised groundwater production estimates include 2,440 AFY produced by community purveyors (including the golf course), 870 AFY agricultural and domestic within the creek valley, and 80 AFY private domestic production within the urban area. The total annual groundwater production within the Los Osos Basin is estimated at 3,390 AFY (C&A, 2008b) and is comparable to the production estimated in the year 2001.

**Natural Groundwater Discharges**

The Los Osos Basin groundwater system has been identified by previous studies as a source of contribution to surface water features that include springs, streams, lakes, and marshes. Natural groundwater discharges to these features has been observed and largely unquantified by historical monitoring programs. These features are also believed to be supported by groundwater recharge that is provided from rainfall runoff which is retained onsite and percolated into the groundwater system by recent developments that include the Williams Bros. shopping center, the commercial uses near the post office, Bayridge Estates, and Vista de Oro and Cabrillo Estates. A listing of the local features of concern is provided in Table 2 – Summary of Local Surface Water Features. The approximate location of these features within the Los Osos Basin is identified in Appendix A – Los Osos Basin Surface Water Features (see Plate A1).

<u>Los Osos Creek</u>

Stream flow on Los Osos Creek at Los Osos Valley Road has been gauged by the County since 1976. The records from this gage are considered reasonably representative of inflow from the creek into Morro Bay approximately 1.5 miles downstream. Previous environmental studies documented observations of declining creek flows within various reaches of Los Osos Creek during the spring of 1985 and occasional observations in 1986 (TMG & TES, 1990). These observations indicated that the creek alluvium continued to drain downstream of the gauging station and resulted in minor surface flows into the estuary for approximately 4 to 6 weeks following cessation of flow in the creek at the gage (see Plate B1).

As outflow from the upper segments of the creek emerging from Clark Valley declined, surface flows in Los Osos Creek were observed to cease in the area near the equestrian ranch about 1/2 mile above Los Osos Valley Road. The limit of surface flow was speculated to migrate even further upstream to near the lower end of Clark Valley during very dry years (TMG & TES, 1990).

<u>Willow Creek</u>

Willow Creek (also known as Eto Creek) surfaces near Los Osos Valley Road, and flows northeasterly to Eto Lake which is located adjacent to Los Osos Creek. The present Willow Creek conditions are shown in Appendix A (see Plate A2). The creek flows a small amount during most of the year that primarily supports dense riparian vegetation. Flows in Willow Creek are fed by rising groundwater but they do not reach the bay except when Los Osos Creek is flowing to the bay.

An unnamed drainage channel in the vicinity of the mobile home park, south of Los Osos Valley Road, reportedly flows seasonally through the oak preserve into Los Osos Creek in the vicinity of Los Osos Valley Road (TMG & TES, 1990).

**Table 2 – Summary of Local Surface Water Features**

| SURFACE WATER FEATURE | SEASONALITY | SIZE OR RATE OF FLOW | SOURCE |
|---|---|---|---|
| LOS OSOS CREEK (AT LOS OSOS ROAD BRIDGE) | EPHEMERAL | 1,630 TO 4,110 AFY | MORRO GROUP, 1990 |
| WILLOW CREEK (ETO CREEK) | EPHEMERAL | 438 AFY (DISCHARGE FROM PERCHED AQUIFER) | YATES & WILLIAMS, 2003 |
| ETO LAKE | PERENNIAL | NA | NA |
| SWEET SPRING | PERENNIAL | 292 AFY | MORRO GROUP, 1990 |
| SWEET SPRING MARSH | EPHEMERAL | NA | MORRO GROUP, 1990 |
| PECHO ROAD MARSH | EPHEMERAL | NA | MORRO GROUP, 1990 |
| THIRD STREET MARSH | NA | APPROX. 2-5 GPM OBSERVED | MORRO GROUP, 1990 |
| BAYWOOD POINT SPRING | NA | APPROX. 5 GPM | MORRO GROUP, 1990 |
| BAYWOOD MARSH | NA | NA | MORRO GROUP, 1990 |
| LOS OSOS CREEK ESTUARY | NA | SEVERAL SMALL OUTFLOW CHANNELS AT APPROX. 0.5 GPM | MORRO GROUP, 1990 |

Sweet Spring

Sweet Spring is identified as the largest freshwater spring at the fringe of the bay during historical mapping of freshwater seepages and vegetation. The spring is located at the easterly end of two manmade ponds that contain the freshwater until it flows out the westerly end of the westerly pond. The spring flow is augmented by the flow from an old artesian well that is located at the south edge of the larger pond. The location of the artesian well, ponds, and Sweet Spring are shown in Appendix A (see Plate A3). Reportedly the flow from this well appears substantially less than the flow into the west end of the pond from the spring, however, the flow rate is undocumented.

The estimated flow from Sweet Spring was documented as approximately 0.4 cfs (180 gpm) or 290 AFY (TMG & TES, 1990). The water quality in the ponds is reportedly dominated by the fresh water from the spring until salt water from the bay flows into the ponds during high tides. We recognize that the tidal influence in the ponds likely makes it difficult to accurately estimate the flow emanating from the well and the spring.

Sweet Spring Marsh

The salt marsh that receives flow from Sweet Spring also appears to receive flow from freshwater springs located in the marsh (TMG & TES, 1990) (see Plate B3). These apparent springs were identified from aerial photographs and distinguished from salt pans in the marsh based on a rounded shape feature with "dark spots" near the center. These features reportedly have defined outflow channels through the salt marsh to the open water of the bay. Groundwater outflow rates from these apparent features are undocumented. Sweet Spring has been recognized as the area having the most pronounced development of major freshwater springs at the bay fringe and is considered the most sensitive of any area along the southerly fringe of the bay because it includes Sweet Spring and is believed the most likely to be significantly affected by the South Bay sewer project (TMG & TES, 1990).

Sweet Spring reportedly appears to flow at a relatively uniform rate, while the springs in the salt marsh appear to be ephemeral. This observation may suggest a hydrologic separation between the springs. Explanations for this occurrence include the potential that Sweet Spring may be fed by groundwater from the eastern side of the Los Osos Fault Strand B, while the springs in the marsh are fed by groundwater on the western side. This previous hydrogeological interpretation was based on shallow water levels which are higher on the eastern side of the inferred Strand B Fault location by about 10 feet near the bay fringe. Groundwater levels are moderately higher near the inferred Strand B Fault, but they decline significantly to the west. An alternative explanation is that Sweet Spring is fed by rising groundwater from the shallow B Zone which is being fed by A Zone recharge that is flowing off of the clay layer. The further from the clay layer, the less effect the recharge source will have on the shallow groundwater levels. Current hydrologic interpretation indicates that Sweet Spring was developed (a man-made excavation) and lies at the base of a larger watershed than any of the other springs around the bay (C&A, 2005c).

Pecho Road Marsh

A similar ephemeral freshwater spring may exist at the westerly end of the local salt marsh in the area of Pecho Road. This possible spring reportedly has similar characteristics to those in the Sweet Spring area, but is much smaller. The freshwater outflow from this possible spring is believed relatively small in comparison to the postulated freshwater springs at Sweet Spring. An aerial photograph with the approximate marsh boundary is shown in Appendix A (see Plate A4).

Third Street Marsh

The area to the east of Sweet Spring and generally west of 3rd Street supports a freshwater marsh composed of bulrushes boardered by willows. During low tide a small amount of seepage estimated at approximately 2-5 gallons per minute (gpm) was observed emanating from the banks to the bay. The measured conductivity of the water was in the range of 3,800-4,600 µmhos/cm indicating that it is comprised of a freshwater component. The marsh reportedly extends southeast along Pismo Avenue and west of 4th Street. The location of the Third Street Marsh is shown in Appendix A (see Plate A5).

Baywood Point Spring

The Baywood Point Spring is reportedly an ephemeral freshwater spring that was flowing a small amount of water during the Morro Group study in 1989. The conductivity in the spring pool was measured at approximately 42,000 µmhos/cm (a little lower than seawater). Reportedly the spring is inundated by seawater much of the time (see Plate A1).

Baywood Marsh

Baywood Marsh as documented begins near the north end of 4th Street and extends easterly and northeasterly for a distance of approximately 3,500 feet. The bay shore is vegetated by bulrush stands which reportedly extend down to levels of +1 to +2 feet mean low level water, and are inundated daily by saltwater during medium and high tides. The bulrushes appear to be supported by an underlying source of rising fresh water in this zone. Conductivity measurements of surface waters at the inner fringe of the marsh are as low as 550 µmhos/cm (fresh). In the central portion of the marsh the conductivity of the water was measured at about 4,000± µmhos/cm, and increased to a range of 32,000-44,000 μmhos/cm at the outer fringe of the bulrushes. Included in the Baywood Marsh area is a freshwater spring known locally as Hidden Spring. The conductivity of this spring was measured at 420 μmhos/cm. The spring was estimated to be flowing at approximately 5 gpm during observations in November 1989, (TMG, 1990). The marsh zone terminates at a point approximately 1,800 feet west of the South Bay Boulevard Bridge where the width of the bulrushes narrows and the more typical sequence of freshwater vegetation begins and continues into the estuary of Los Osos Creek. The approximate boundaries of the Baywood Marsh are shown in Appendix A (see Plate A6).

**Annual Basin Yield Estimates**

The annual yield of a groundwater basin is the average annual amount of groundwater that can be produced without creating detrimental water levels or water quality effects. The Los Osos Basin has been studied since the early 1970's to estimate the annual basin yield.

The 1988 Estero Area Plan reported safe yield estimates of between 1,300 to 1,800 AFY derived from computer model simulations from a 1974 groundwater basin study. The updated 2004 Estero Area Plan continues to utilize this estimate as the most recent estimate of safe yield of this basin. The resulting safe yield estimate of 1,800 AFY was reportedly a net water consumption value and the actual groundwater production value was estimated to be closer to 3,750 AFY (C&A, 2005c) when considering the (gross) production value of actual pumping by purveyors and growers.

Basin yield was subsequently evaluated by the Department of Water Resources (DWR) in 1989. The DWR study relied heavily on a groundwater model developed by the U.S.G.S. (Yates and Wiese, 1988). The DWR estimated the safe basin yield under current (septic tank) conditions at 2,190 AFY. This yield estimate is presented by their study as a production yield, not a net consumptive yield, and therefore the study estimated a substantially lower annual basin yield. As indicated by subsequent study the DWR study likely underestimated the actual basin yield (C&A, 2005c).

The U.S.G.S. model was subsequently revised by URS and Team Engineering as part of an effort to provide basin yield estimates for wastewater project conditions which were under evaluation in 2000. URS modeled several proposed management scenarios which reportedly showed that seawater intrusion would not likely occur in any model layer, based on simulated water levels that remained above sea level. Assuming seawater intrusion is an indicator of overdraft, then the basin was reportedly not in overdraft for these scenarios. The final management scenario report for that study included a table of recommended production for the basin purveyors that totals 3,150

AFY, with a total basin yield of 3,900 AFY given the wastewater project conditions being considered.

The 2000 study estimates were updated for the LOCSD Water Master Plan (WMP) (Wallace & Cleath, 2002). The 2002 safe yield analysis contained in the LOCSD WMP included both analytical and numerical approaches. The analytical approach compartmentalized the basin and utilized the Hill method of approximation and average annual recharge methods to estimate the sustainable yield. The numerical approach utilized a revised version of the URS basin model. Both approaches in the LOCSD WMP maintained the assumption that water levels must be maintained above sea level to avoid salt water intrusion. The WMP estimated the safe yield of the basin at 3,560 AFY under current conditions with septic tank return flows and 3,940 AFY under wastewater project disposal recharge conditions.

In 2003 a modeling effort was conducted by the community water purveyors to simulate the effects of the proposed sewer project on nitrate concentrations in groundwater. In the model groundwater recharge was estimated using a recharge preprocessor which simulates deep percolation of infiltrated rainfall, applied irrigation water, and percolation of septic system leachate. The preprocessor simulates the soil moisture budget on a daily basis using a time series of daily rainfall and reference evapotranspiration. The results of the simulation indicated an average recharge of 9.1 in/yr occurs over a basin area of approximately 4,658 acres. The estimated annual recharge was 3,525 AFY; however, there was no attempt to utilize the model to estimate an annual basin yield.

In 2007 the County completed a Rough Screening Report of wastewater project alternatives that was conducted to evaluate the feasibility of alternatives to remove septage from the Regional Water Quality Control Board (RWQCB) designated prohibition area. As part of the rough screening study the County utilized the present understanding of the groundwater system to determine the feasibility of treated effluent disposal. It was recognized that groundwater production at buildout should be a sustainable condition with respect to water resources that does not exceed the basin safe yield. The rough screening study considered multiple alternatives that optimized distribution of wastewater disposal, reuse, and well production to satisfactorily approach safe yield development.

For the rough screening study the County estimated that with current groundwater production in the basin at 3,350 AFY and a basin safe yield (under current conditions) of approximately 3,250 AFY that the basin is currently in overdraft. The study also recognized that although the estimated difference between the developed yield and the safe yield is 100 acre-feet overall, there is 500 to 600 AFY of seawater intrusion occurring since the overdraft is entirely in the lower aquifer, which is evidenced by the presence of salt water.

Safe basin yield with a wastewater project (combined with significant changes in pumping practices) is projected to reach an estimated 3,630 AFY (C&A, 2005b). This indicates that even with the basin yield fully developed, there is a 370 AFY deficit in meeting the buildout demand of approximately 4,000 AFY (Estero Area Plan, 2006).

The subsequent fine screening study focused on basin safe yield by comparing the assets developed by each alternative wastewater disposal/reuse project as a means of seawater mitigation. As previously discussed, there is more than one optimized distribution of wastewater disposal, reuse, and well production that satisfactorily approaches safe yield development. In the fine screening study the assets of each project disposal/reuse alternative was broken down by cost and compared with the benefits gained with respect to restoring the basin water balance (seawater intrusion mitigation) and to water quality impacts (salt loading and nitrate loading). The pros and cons of developing basin safe yield under the various wastewater disposal/reuse projects was reviewed and compared to provide a basis for selecting the viable projects that have the best cost-benefit ratio and that provide a suitable foundation toward operating the basin at safe yield.

Plans originally developed during the late 1980's for treated effluent disposal at higher elevations on the west side of the basin provide a reasonable alternative for incidental recharge to the lower aquifer zones (through aquitard leakage) which will serve to abate seawater intrusion and bolster the perennial yield of the basin.

## SEAWATER INTRUSION

The Los Osos Basin has been the subject of several studies that have evaluated seawater intrusion utilizing water levels and water quality as the primary criteria. The findings of the most recent assessment indicate that according to the Ghyben-Herzberg relation, a fresh water head of approximately 5 feet would be needed to prevent the seawater interface from moving onshore within the lowest zones of the upper aquifer (C&A, 2005c). Similarly a fresh water head of approximately 9 and 17.5 feet would be required to prevent landward movement of the seawater interface in lower aquifer D Zone and E Zone, respectively. At the present time, only upper aquifer water level elevations are sufficient to prevent seawater intrusion.

The most recent study concluded that the upper aquifer fresh water/salt water interface is relatively stable and located beneath the Morro Bay sand spit, with a potential for active intrusion during extended drought periods. The study also found that seawater intrusion in lower aquifer D Zone has advanced at an average rate of 60 feet per year between 1985 and 2005, and is approximately located between Pecho Road and Doris Avenue (C&A, 2005c). Seawater intrusion in lower aquifer E Zone was found to have advanced at an average rate of 54 feet per year between 1977 and 2005, and is approximately located between Broderson Avenue and Palisades Avenue.

## GROUNDWATER QUALITY

The natural quality of groundwater in the Los Osos Basin has been of a sufficiently high quality to satisfy all overlying beneficial land uses. Since the beginning of land development, two primary sources have contributed to degradation of water quality; 1) seawater intrusion that has invaded the lower aquifer system as a result of over pumping, and 2) increasing nitrate concentrations that have resulted from the overlying land uses (i.e., septic system return flows, landscape fertilization, and domestic animal waste). Historical studies have documented the quality of groundwater in the Los Osos Basin that is delineated by aquifer zone. The following sections provide a summary of the existing total dissolved solids and nitrate concentrations in the LOWWP area.

### Salts

Historical data indicate that the chemical character of water in the lower aquifers is predominantly magnesium-calcium bicarbonate and calcium-magnesium bicarbonate, with an average total dissolved solids (TDS) of 340 milligrams per liter (mg/l). Seawater intrusion in the western coastal portion of the basin has changed the lower aquifer quality from bicarbonate to chloride anion dominance.

The Los Osos Creek Valley groundwater is characteristically magnesium-calcium bicarbonate with TDS concentrations on the order of 520 mg/l. Historical groundwater quality from bedrock sources is generally magnesium-calcium bicarbonate with a median TDS concentration of 470 mg/l (C&A, 2005c).

The chemical character of groundwater in the upper aquifers is generally sodium magnesium chloride-bicarbonate water. The areas of the basin with higher TDS concentrations in shallow groundwater have been found to roughly correspond to some of the areas of higher $NO_3$-N concentrations. This may result from brine reject from domestic water softeners or other normal salt loading from domestic water use that is subsequently discharged from septic disposal systems. The range of TDS in the shallow groundwater is generally between 200 and 400 mg/l, with a low of 67 mg/l along South Bay Boulevard and a high of 1,100 mg/l beneath Sunset Terrace (C&A, 2005a). Table 3 – Average Groundwater and LOWWP Effluent TDS Concentrations lists the current TDS in the Los Osos Basin.

**Table 3 – Average Groundwater and LOWWP Effluent TDS Concentrations**

| WATER SOURCE | TDS (MG/L) |
|---|---|
| PERCHED AQUIFER | 400[1] |
| CREEK COMPARTMENT | 520[2] |
| UPPER AQUIFER SYSTEM | 330[3] |
| EFFLUENT | 620[4] |

[1] - MASS BALANCE CALCULATION BASED ON PRECIPITATION, IRRIGATION AND SEPTIC RETURN FLOWS
[2] - C&A, 2005c, PART 2, PAGE 55, PAR. 2
[3] - C&A, 2005a, TABLE 5 - AVERAGE CONCENTRATION FOR MONTH OF APRIL, 2005
[4] - FINE SCREENING REPORT, SECTION 2.3.1.1

### Nitrate

Sample results from previous basin study show that $NO_3$-N concentrations measured in dedicated monitoring wells range from less than 1 mg/l to 28 mg/l with an overall average of 10 mg/l ($NO_3$-N) (C&A, 2005a). The concentrations of $NO_3$-N contained in groundwater in the basin and the proposed effluent to be used for disposal within the basin are listed in Table 4 – Average Groundwater and LOWWP Effluent Nitrate Concentrations.

**Table 4 – Average Groundwater and LOWWP Effluent Nitrate Concentrations**

| WATER SOURCE | $NO_3$-N (MG/L) |
|---|---|
| PERCHED AQUIFER | NA |
| CREEK COMPARTMENT | 5 TO 10[1] |
| UPPER AQUIFER SYSTEM | 10[2] |
| EFFLUENT | 7[3] |

[1] – YEATS AND WILLIAMS, 2003
[2] - C&A 2005a, TABLE 5,
[3] - FINE SCREENING REPORT, SECTION 2.3.1.1

There is an isolated area of low $NO_3$-N concentrations that is inferred to extend across the open space west of the South Bay Community Library where considerable surface runoff percolates to groundwater. The $NO_3$-N concentrations are inferred to decrease at the bay front and to the east, across South Bay Boulevard (C&A, 2005a). Nitrates and other conservative constituents of basin return flows present in the upper aquifer that do not flow out into the bay or into other surface drainage courses will ultimately reach the lower aquifer (C&A, 2005c). The total nitrogen in shallow groundwater samples often contained forms of nitrogen other than nitrate which included ammonia and organic nitrogen that are inferred to be contributed from septage return flows (C&A, 2005a).

## PROJECT DISPOSAL ALTERNATIVES

During the rough screening study, effluent disposal/reuse alternatives with fatal flaws along with alternatives that were clearly inferior to other alternatives were eliminated. However, because multiple disposal alternatives can be used simultaneously, and because a single alternative may not have sufficient capacity to accommodate all of the effluent flow and/or mitigate potential project impacts, redundant alternatives were not necessarily eliminated. A description of the disposal alternatives that were utilized by the Fine Screening Analysis and presented in the final project design memorandum is provided in the following section.

### Disposal Methods

A wastewater collection system will be constructed to collect wastewater from properties less than one acre in size within the RWQCB Prohibition Zone. Wastewater will be conveyed to the newly constructed Wastewater Treatment Plant (WWTP) located east of the Los Osos Creek. The treatment plant will be designed to process an average dry weather flow of 1.2 million gallons per day (mgd) and a peak wet weather flow of 1.5 mgd. Implementation of conservation measures is anticipated to reduce consumption and subsequent disposal volume by 160 AFY. The total treated effluent disposal volume from the LOWWP is anticipated to be 1,290 AFY at buildout. Disposal strategies under consideration include;

- Spray fields
- Sub-surface leach field or percolation ponds
- Agricultural reuse
- Urban/landscaping reuse

### Spray Fields

Spray field disposal will consist of distributing treated effluent on sufficient area for disposal through evapotranspiration and if possible percolation. Maximum disposal volume utilizing spray fields is anticipated to be 842 AFY placed primarily during dry weather months over an area of 175 acres (see Table 2). The spray field disposal site is located outside of the Los Osos Basin on the Tonini Ranch property. A County memorandum that summarizes pertinent hydrogeological data from the ranch are included in Appendix B – Tonini Ranch Data.

### Subsurface Leach Field

A sub-surface leach field located east of Broderson Avenue will be utilized throughout most of the year for effluent disposal. The Broderson disposal facilities will be the primary source of disposal during the wet weather months. During the rainy season, treated wastewater passing through the treatment process could reach as high as 1.5 mgd for short periods (60 days or less) and require storage and disposal. When surface irrigation is unnecessary during the rainy season, a portion of the treated wastewater will be disposed of through the sub-surface leach field. The remainder will be contained onsite in a holding pond(s) for future disposal. Over time, the reintroduction of treated wastewater, together with the elimination of individual septic leach fields within the collection area will the lower nitrate concentration in the shallow aquifer zones. In addition, the Broderson disposal alternative will provide the benefit of replacing a component of the groundwater recharge to the upper aquifer system that is exported for treatment. The maximum disposal rate at the Broderson site is anticipated to be as high as 800,000 gallons per day (gpd) but not to exceed an annual rate of 448 acre-feet.

The most recent available study of hydrogeologic conditions in the vicinity of the Broderson property was conducted by Cleath and Associates (C&A, 2000a and b). Based on test hole data from the site, the regional aquitard designated the AT2 Clay, has been determined to underlie the site at depths of between 190 - 235 feet below ground surface (bgs). Groundwater measured at the north end of the site was found at a depth of 150 feet bgs, and approximately 210 feet below surface in the center of the site.

### Agricultural Reuse

Agricultural reuse would entail providing secondary or tertiary treated wastewater to local farmers for crop irrigation. The required level of treatment will depend on the crop type being raised. Agricultural reuse would have the dual positive impact of effluent disposal and reduction of groundwater usage. Potential sites for agricultural reuse are located throughout the Los Osos Creek Valley. Potential effluent disposal from agricultural reuse could be as high as 690 AFY over an area of 230 acres (Carollo, 2008); however this intensive application of water would require growing forage crops rather than food crops.

**Urban/landscaping Reuse**

Urban/landscaping reuse disposal could be as high as 70 AFY as included in Level 2a and 2c alternatives. During dry weather, treated wastewater will be recycled by irrigating the Cemetery and the landscaping at the WWTP. Urban/landscaping reuse would require tertiary treatment of effluent before distribution.

**Feasible Project Disposal Alternatives**

During the fine screening study, effluent disposal methods were further evaluated based on their ability to mitigate the LOWWP impacts on seawater intrusion in the lower aquifer zones. The removal of septic recharge from the prohibition zone in the Los Osos Basin will reduce recharge to the upper aquifer zones which in turn will reduce leakage from the upper aquifer C Zone that recharges the lower aquifer zones. Project disposal/reuse methods were combined to form feasible project disposal alternatives and evaluated based on their ability to mitigate the additional seawater intrusion.

The Fine Screening Report states that one of the goals of the wastewater project was that it must mitigate seawater intrusion at least to current levels. Because of this goal, combined project alternatives rated with a Level 0 were identified as alternatives that provided no mitigation of seawater intrusion and were eliminated from further evaluation. Project benefit levels 1 through 4 were rated as having progressively increasing benefit for mitigating seawater intrusion. However Levels 3 and 4 require the participation of agencies (water purveyors) outside the control of the County and are considered infeasible as part of the wastewater project. This study evaluates the combined project alternatives that are; a) based on the conclusions presented in the Fine Screening Report, b) designed to handle plant effluent capacities at buildout, c) estimated to provide the greatest seawater intrusion mitigation measures (i.e., Level 2 projects), and d) don’t require other agency involvement for implementation (Carollo, 2008).

The final LOWWP will consist of a collection system, treatment plant, storage facility, and disposal system that can be evaluated independently with regard to potential impacts. Regardless of the type of collection system, the type of treatment utilized at a central treatment plant, or the location and size of the storage facilities, the potential environmental impacts of each combined disposal/reuse alternative can be evaluated independently. The following sections describe the three final project alternatives proposed by the County that combine disposal/reuse components that together achieve the total treated effluent disposal volume from the LOWWP at buildout. The remaining proposed combined disposal projects are designated as Viable Project Alternatives (VPA) 2a, 2b, and 2c (Carollo, 2008).

### Viable Project Alternative 2a

As developed by the fine screening study VPA 2a is comprised of disposal and reuse methods that include; a) spray field irrigation, b) Broderson subsurface percolation, c) agricultural irrigation maintaining current cropping patterns, d) cemetery irrigation, e) prohibition area conservation, and f) plant site irrigation. A summary of the disposal capacity of these alternative components is provided in Table 5 – Viable Project Alternative 2a along with the mitigation factor and the estimated quantity of water provided that would mitigate seawater intrusion in the lower aquifer zones.

**Table 5 – Viable Project Alternative 2a**

| ALTERNATIVE COMPONENT | DISPOSAL OR CONSERVATION CAPACITY (AFY) | | MITIGATION FACTOR | SEAWATER INTRUSION MITIGATION (AFY) | |
|---|---|---|---|---|---|
| | BUILDOUT | CURRENT | | BUILDOUT | CURRENT |
| SPRAY FIELDS (65 ACRES) | 312 | 69 | 0 | 0 | 0 |
| BRODERSON DISPOSAL | 448 | 448 | 0.22 | 99 | 99 |
| AGRICULTURAL REUSE | 460 | 480 | 0.1 | 46 | 46(1) |
| CONSERVATION | 160 | 160 | 0.55 | 88 | 88 |
| CEMETERY REUSE | 50 | 0 | 0.1 | 5 | 0 |
| PLANT SITE IRRIGATION | 20 | 0 | 0 | 0 | 0 |
| **TOTAL LOWWP DISPOSAL OR MITIGATION** | **1,290** | **997** | **0** | **238** | **233** |
| (1) THE SEAWATER MITIGATION IS BASED ON PRESENT USE IN CREEK COMPARTMENT THAT IS OFFSET BY THE PROJECT WHICH IS THE SAME UNDER CURRENT CONDITIONS AND AT BUILDOUT | | | | | |

### Viable Project Alternative 2b

VPA 2b is the most basic feasible alternative which is comprised of three components that include; a) spray field irrigation, b) Broderson percolation, and c) prohibition area conservation. A summary of the disposal capacity of each alternative component is provided in Table 6 – Viable Project Alternative 2b along with the mitigation factor and the quantity of water provided that would mitigate seawater intrusion in the lower aquifer zones. This potential alternative level will achieve the required LOWWP disposal and mitigation measures without agricultural reuse. This alternative does not require the cooperation and participation of existing land owners nor does it require the County obtain land and maintain farming operations on the land necessary for agricultural reuse.

**Table 6 – Viable Project Alternative 2b**

| ALTERNATIVE COMPONENT | DISPOSAL OR CONSERVATION CAPACITY (AFY) | | MITIGATION FACTOR | SEAWATER INTRUSION MITIGATION (AFY) | |
|---|---|---|---|---|---|
| | BUILDOUT | CURRENT | | BUILDOUT | CURRENT |
| SPRAY FIELDS (175 ACRES) | 842 | 549 | 0 | 0 | 0 |
| BRODERSON DISPOSAL | 448 | 448 | 0.22 | 99 | 99 |
| CONSERVATION | 160 | 160 | 0.55 | 88 | 88 |
| **TOTAL LOWWP DISPOSAL OR MITIGATION** | **1,290** | **997** | **0** | **187** | **187** |

### Viable Project Alternative 2c

VPA 2c is comprised of the same disposal and reuse alternatives that are included in VPA 2a however, the agricultural irrigation would be managed to maximize disposal. This type of irrigation management would require a change in cropping intensity and/or crop type to a variety of plant(s) that could tolerate the additional water. A summary of the disposal capacity of the alternative components is provided in Table 7 – Viable Project Alternative 2c along with the mitigation factor and the quantity of water provided that would mitigate seawater intrusion in the lower aquifer zones.

## Table 7 – Viable Project Alternative 2c

| ALTERNATIVE COMPONENT | DISPOSAL OR CONSERVATION CAPACITY (AFY) | | MITIGATION FACTOR | SEAWATER INTRUSION MITIGATION (AFY) | |
|---|---|---|---|---|---|
| | BUILDOUT | CURRENT | | BUILDOUT | CURRENT |
| SPRAY FIELDS (17 ACRES) | 82 | 0 | 0 | 0 | 0 |
| BRODERSON DISPOSAL | 448 | 448 | 0.22 | 99 | 99 |
| AGRICULTURAL REUSE | 690 | 549 | 0.1 | 46(1) | 46(1) |
| CONSERVATION | 160 | 160 | 0.55 | 88 | 88 |
| CEMETERY REUSE | 50 | 0 | 0.1 | 5 | 0 |
| PLANT SITE IRRIGATION | 20 | 0 | 0 | 0 | 0 |
| **TOTAL LOWWP DISPOSAL OR MITIGATION** | **1,290** | **997** | **0** | **238** | **233** |
| (1) THE SEAWATER MITIGATION IS BASED ON PRESENT USE IN CREEK COMPARTMENT THAT IS OFFSET BY THE PROJECT WHICH IS THE SAME AS LEVEL 2A | | | | | |

## DISPOSAL ALTERNATIVES IMPACTS

### Description of Project Disposal/Reuse Alternatives

A gravity or STEP/STEG wastewater collection system will be constructed to collect wastewater from properties less than one acre in size within the RWQCB Prohibition Zone (see Plate 1). Wastewater will be conveyed to the newly constructed WWTP located east of the Los Osos Creek at the Branin, Giacomazzi, or Tonini sites (depending on final project alternative selection). Effluent will be treated by means of oxidation ditch, BIOLAC© wastewater treatment system, or facultative ponds. The treatment plant will be designed to process an average dry weather flow of 1.2 mgd and a peak wet weather flow of 1.5 mgd. Implementation of conservation measures throughout the prohibition area is anticipated to reduce consumption and subsequently disposal volume by 160 AFY. The total treated effluent disposal volume from the LOWWP is anticipated to be 1,290 AFY at buildout. Under current conditions the disposal volume is anticipated to be 997 AFY.

All the viable LOWWP alternatives being assessed by the County will have the same types of potential impacts to local groundwater and surface water. Each alternative includes construction of pipelines, pump stations, a treatment facility, storage facility, and spray disposal facility. To mitigate the potential for seawater intrusion that could be caused by the LOWWP, the Broderson leach field disposal facilities is also included as a project component with all treatment plant and conveyance facility alternatives. Because all the treatment facilities alternatives being considered for the project have common potential groundwater and surface water impacts the following impacts analysis is believed representative regardless of treatment plant location.

The potential impacts of the disposal/reuse alternatives considered for the final LOWWP are analyzed using available data. Because factors that will influence impacts of the LOWWP at buildout include additional groundwater pumping and we can not assess or control where the pumping will occur, this study is assessing the project related impacts based on current Los Osos Basin conditions. The steady-state groundwater model utilized for the seawater intrusion study (C&A, 2005c) was refined and utilized during the development of the rough screening and fine screening studies to develop the viable project alternatives that are identified for the LOWWP. Subsequent modifications were made to the model, which include an estimate of the inland shift in lower aquifer pumping, to provide the simulations that are used by this study to identify the potential impacts of the LOWWP on the Los Osos Basin (C&A, 2008b). A copy of the project memorandum that summarizes the results of the equivalent freshwater head steady-state basin model hydrologic budgets and the accompanying groundwater elevation contours is included as Appendix C – Groundwater Model Hydrologic Budget Results.

The hydrologic budget calculated by the model to reflect existing conditions is summarized below in Table 8 – Current Basin Balance Conditions. Subsequent model simulations for the VPA 2a and 2b are included as Tables 9 and 10 – Viable Project Alternative 2a and 2b Basin Balance Conditions, respectively. Because VPA 2c is comprised of the same disposal/reuse components as VPA 2a and there is no further reduction to groundwater pumping, the hydrologic budget remains the same and is represented by the summary provided in Table 9.

The model simulated estimations of the changes to the inflow and outflow components of the groundwater system are subsequently used to identify the potential impacts of the LOWWP, which are described in the following sections of this report. As shown in Table 7, seawater inflow recharging the over pumped lower aquifer zones is estimated at approximately 470 AFY under present basin conditions. The LOWWP viable project alternatives have been designed with a primary goal of mitigating the impacts of the project to a level that maintains or reduces the quantity of seawater inflow and provides system infrastructure that may be utilized by the community to further abate seawater intrusion in the future.

## Table 8 – Current Basin Balance Conditions

| COMPONENT OF WATER BUDGET | PERCHED AQUIFER | CREEK VALLEY AQUIFER | UPPER AQUIFER | LOWER AQUIFER |
|---|---|---|---|---|
| PERCOLATION FROM PRECIPITATION AND IRRIGATION | 736 | 430 | 1,489 | 0 |
| SEPTIC RETURN FLOW | 631 | 30 | 606 | 0 |
| SUBSURFACE OUTFLOW | 0 | 0 | - 1,310 | 0 |
| SUBSURFACE INFLOW | 0 | 167 | 112 | 0 |
| LEAKAGE OR SUBSURFACE CROSS FLOW IN | 0 | 117 | 788 | 1,248 |
| LEAKAGE OR SUBSURFACE CROSS FLOW OUT | - 815 | - 456 | - 882 | 0 |
| SEAWATER INTRUSION | 0 | 0 | 0 | 469 |
| LOS OSOS CREEK INFLOW | 0 | 665 | 0 | 0 |
| LOS OSOS CREEK OUTFLOW | 0 | - 77 | 0 | 0 |
| WELL PRODUCTION | 0 | - 870 | -803 | -1,717 |
| WARDEN DRAIN | 0 | - 6 | 0 | 0 |
| WILLOW CREEK OUTFLOW AND EVAPOTRANSPIRATION | - 552 | 0 | 0 | 0 |
| **AQUIFER INFLOW** | **1,367** | **1,409** | **2,995** | **1,717** |
| **AQUIFER OUTFLOW** | **- 1,367** | **- 1,409** | **- 2,995** | **- 1,717** |

ALL TABLE QUANTITIES ARE IN ACRE-FEET PER YEAR

A comparison of the septic return flow volumes in Tables 8 and 9 shows the reduction in this component in the hydrologic budget that is effectuated by the LOWWP. Roughly half of the recharge from septic system percolation is located over the perching clay layer while the remainder is located over the upper aquifer in areas not confined by the clay layer. As indicated by the reduction in this recharge component (see Table 9) the LOWWP effectively captures over 90 percent of the septage return flows within the Los Osos Basin.

## Table 9 – Viable Project Alternative 2a Basin Balance Conditions

| COMPONENT OF WATER BUDGET | PERCHED AQUIFER | CREEK VALLEY AQUIFER | UPPER AQUIFER | LOWER AQUIFER |
|---|---|---|---|---|
| PERCOLATION FROM PRECIPITATION AND IRRIGATION | 736 | 430 | 1,489 | 0 |
| SEPTIC RETURN FLOW | 36 | 30 | 44 | 0 |
| SUBSURFACE OUTFLOW | 0 | 0 | - 1,209 | 0 |
| SUBSURFACE INFLOW | 0 | 137 | 100 | 0 |
| LEAKAGE OR SUBSURFACE CROSS FLOW IN | | 103 | 685 | 1,249 |
| LEAKAGE OR SUBSURFACE CROSS FLOW OUT | - 737 | - 546 | - 754 | 0 |
| SEAWATER INTRUSION | 0 | 0 | 0 | 308 |
| LOS OSOS CREEK INFLOW | 0 | 492 | 0 | 0 |
| LOS OSOS CREEK OUTFLOW | 0 | - 168 | 0 | 0 |
| WELL PRODUCTION (INCLUDES CONSERVATION) | 0 | - 390 | - 803 | - 1,557 |
| WARDEN DRAIN | 0 | - 88 | 0 | |
| WILLOW CREEK OUTFLOW AND EVAPOTRANSPIRATION | - 35 | 0 | 0 | 0 |
| BRODERSON INFLOW | 0 | 0 | 448 | |
| **AQUIFER INFLOW** | **772** | **1,192** | **2,766** | **1,460** |
| **AQUIFER OUTFLOW** | **- 772** | **- 1,192** | **- 2,766** | **- 1,460** |

ALL TABLE QUANTITIES ARE IN ACRE-FEET PER YEAR

As shown in both Tables 9 and 10 the LOWWP effectively reduces the seawater intrusion component of the lower aquifer system recharge by greater than 100 AFY. This is achieved in combination by the offsetting recharge provided by disposal at the Broderson subsurface percolation facilities and water supply conservation. As indicated both VPA 2a and 2b achieve the seawater intrusion mitigation goal. However, the main change in the hydrologic budget under these alternatives is the decrease in outflow from the perched aquifer to evapotranspiration and surface flow in the Willow Creek Drainage area.

## Table 10 – Viable Project Alternative 2b Basin Balance Conditions

| COMPONENT OF WATER BUDGET | PERCHED AQUIFER | CREEK VALLEY AQUIFER | UPPER AQUIFER | LOWER AQUIFER |
|---|---|---|---|---|
| PERCOLATION FROM PRECIPITATION AND IRRIGATION | 736 | 430 | 1,489 | 0 |
| SEPTIC RETURN FLOW | 36 | 30 | 44 | 0 |
| SUBSURFACE OUTFLOW | 0 | 0 | - 1,169 | 0 |
| SUBSURFACE INFLOW | 0 | 166 | 107 | 0 |
| LEAKAGE OR SUBSURFACE CROSS FLOW IN | 0 | 103 | 719 | 1,205 |
| LEAKAGE OR SUBSURFACE CROSS FLOW OUT | - 737 | - 455 | - 835 | 0 |
| SEAWATER INTRUSION | 0 | 0 | 0 | 352 |
| LOS OSOS CREEK INFLOW | 0 | 665 | 0 | 0 |
| LOS OSOS CREEK OUTFLOW | 0 | - 60 | 0 | 0 |
| WELL PRODUCTION (INCLUDES CONSERVATION) | 0 | - 870 | - 803 | - 1,557 |
| WARDEN DRAIN | 0 | - 9 | 0 | 0 |
| WILLOW CREEK OUTFLOW AND EVAPOTRANSPIRATION | - 35 | 0 | 0 | 0 |
| BRODERSON INFLOW | 0 | 0 | 448 | 0 |
| **AQUIFER INFLOW** | **772** | **1,394** | **2,807** | **1,557** |
| **AQUIFER OUTFLOW** | **- 772** | **- 1,394** | **- 2,807** | **- 1,557** |

ALL TABLE QUANTITIES ARE IN ACRE-FEET PER YEAR

## Analysis of Water Supply Impacts

### LOWWP Facilities Construction Impacts

The sewage collection system for each alternative is effectively the same with the exception of sewage pipeline route to the final location of the LOWWP. Each collection system alternative removes septic system effluent discharges from within the prohibition zone. After treatment to a secondary level, the effluent will be conveyed to spray fields proposed for location at the Tonini site and a leach field proposed for location at the Broderson property. During construction of pipelines, pump station, and treatment facilities shallow groundwater may be encountered that requires disposal.

Disposal alternatives include discharge to surface water drainages, discharge to storm water sedimentation and percolation basins, or reuse during project construction for dust control or soil moisture conditioning of the backfill materials prior to compaction.

Inflows to groundwater (septic system percolation) that will be removed from the hydrologic budget by the LOWWP collection system will no longer recharge the upper aquifer zones, which are directly recharged by this source, and the lower aquifer zones which receive leakage from the upper aquifers. Removal of this recharge source without returning a significant portion of the treated effluent from the LOWWP will create a hydrologic imbalance in the groundwater system. Effluent disposal at Broderson is designed to rebalance the hydrologic budget in the aquifer zones that provide a supply to the overlying beneficial uses.

Construction of facilities that require soil excavation creates a potential for soil erosion to occur during rainfall events. This potential impact can be mitigated through preparation and implementation of an erosion control plan. Erosion control through best management practices (BMPs) (i.e., sand bagging, straw wadding, plastic sheet covering, etc.) will be required during all phases of construction to prevent soil erosion and sediment loading of rainfall runoff.

### Water Conservation Impacts

As part of project construction all viable project alternatives include a component designated as water conservation. To achieve the desired 160 AFY reduction in LOWWP effluent, domestic and commercial water fixtures including toilets and shower heads will be replaced with low flow fixtures. The resulting conservation will be realized as a reduction of pumping from the overdrafted lower aquifer system. While historical production from the lower aquifer system has become a form of man-made recharge to the upper aquifer system through septage recharge, the reduction in lower aquifer system production effectuated by conservation will result in less seawater intrusion. This impact is considered a beneficial impact to the Los Osos Basin.

## Analysis of Disposal/Reuse Methods Impacts

### Spray Fields

Spray field disposal will be conducted at the Tonini site and will consist of distributing treated effluent on sufficient area for disposal through evapotranspiration (Et) and percolation. Current viable project alternatives under consideration include the disposal of 69 AFY on spray fields covering an area of 17 acres (see Table 5), 549 AFY on 175 acres (see Table 6), and no spray field disposal if heavy agricultural reuse is implemented (see Table 7) (C&A, 2008a). These numbers represent current conditions. The wide margin of difference is attributable to the amount, if any, of agricultural use of recycled water. Spray field disposal capacity for the balance of buildout flows is available and is anticipated to be up to 312, 842, and 72 AFY, for VPA's 2a, 2b, and 2c, respectively.

### Short-term Construction Impacts

Spray field disposal would likely require secondary treatment with disinfection. Spray field operations would be conducted during the daytime to maximize Et and require night time and seasonal storage facilities. The Tonini property has been identified as the primary site for spray field disposal. Water from the treatment facility would be pumped to the Tonini property through a pressurized pipeline. The irrigation lines to spray heads would be buried less than two feet below grade. A catch basin(s) would be constructed at the bottom of the spray fields to collect any irrigation runoff and allow redistribution into the spray system. Because the effluent disposed at the spray fields would likely not meet Title 22 tertiary treatment standards, the spray field area would be fenced off to prevent public contact with the water. Spray field sites will be located on property with underlying groundwater at a depth that was measured to range between approximately 7 and 42 feet bgs (C&A, 2008a). These recent observations indicated that several bedrock springs were present on the property but are located well outside of the spray field areas. Based on recent observations, spray field construction is not anticipated to impact groundwater. As with other construction related components of the project, erosion control will be required to stabilize soils during seasonal runoff.

### Long-term Operation Impacts

This analysis indicates potential impacts to groundwater from spray field irrigation will include a potential increase in TDS concentration, and nitrate loading of surface soils which can eventually percolate to groundwater. Geological conditions at the site indicate that percolation of applied irrigation water (approximately 210 AFY, VPA 2b) in the spray fields will contribute to groundwater inflow (C&A, 2008b and C&A, 2007). Groundwater that rises in the Warden Lake drainage will flow downstream to the Morro Bay. Groundwater emergence at lower elevations around the drainage channel would provide a beneficial impact to existing natural wetlands located adjacent Warden Creek.

### Salt Loading

Salt loading of the upper soils occurs when applied water is removed by evapotranspiration leaving the minerals not consumed by crops in the soil. These concentrated salts are subsequently leached to groundwater by excess irrigation and/or precipitation. Precipitation is essentially distilled water and acts as a diluting agent for the deposited salts. The net impact of water percolating to groundwater would likely have a higher or lower TDS concentration than the initial irrigation water depending on the rainfall to evapotranspiration ratio. The spray irrigation effluent is anticipated to have a TDS concentration on the order of 620 mg/l.

The use of sprayfield disposal at the Tonini site has the potential for groundwater quality impacts beneath the site by raising the TDS concentration. While the nitrogen in the effluent will be largely (if not completely) consumed by plant uptake and natural denitrification processes, the dissolved salts in the effluent will be concentrated in the soil as a function of the evapotranspiration process. Salt precipitation in the root zone of irrigated crops is typical of all farming operations and often requires overwatering to leach the salt downward and remove the deleterious effects on the plants being raised. Annual rainfall in the Los Osos area may be sufficient for leaching purposes and preclude the need for typical overwatering operations to achieve salt removal from shallow soils.

The quality of groundwater underlying the Tonini site is a function of the source water quality, mineralogy of the underlying bedrock, and the residence time during which the groundwater remains in the formation prior to discharge at downgradient locations. The underlying groundwater at the Tonini site is primarily contained in fractured bedrock that comprises an aquifer system whereby flow is likely controlled by the orientation of fractures that create secondary porosity. The aquifer is an open system and outflow is observed downgradient as seeps and springs on the land surface, as well as, inferred to contribute underflow into the channel alluvium along the Warden Lake drainage and into the Los Osos Creek Valley aquifer. Because it is not a closed basin (without outflow) the increase in salt concentrations in the groundwater from irrigation practices will reach equilibrium and not continue to increase over time.

Laboratory test results for groundwater samples collected from three wells on the Tonini property indicate the groundwater has an average TDS concentration of 606 mg/l and a nitrate concentration of 7.2 mg/l. Although the estimated TDS concentration of percolating water from sprayfield operations may be higher than local groundwater, the infiltration will mix with native groundwater flowing beneath the site and proportionally reduce the salts concentration. The TDS concentration of treated effluent that would be used for sprayfield disposal at the Tonini Ranch is estimated at approximately 620 mg/l and is comparable to the groundwater that underlies the Tonini site. Because of the similar TDS concentrations, the effects on groundwater from using the LOWWP effluent as an irrigation source versus pumping groundwater for crop irrigation are the same. Based on these conditions the salt loading impacts to groundwater from irrigating crops with effluent at the proposed Tonini sprayfield site are considered less than significant.

It is anticipated that a substantial portion of the nitrate in the applied water will be removed by crop uptake and decrease the concentration from 7 mg/l to a concentration lower than the background concentration of 7.2 mg/l and not contribute to degradation of existing conditions. Therefore, impacts associated with salt concentrations would be less than significant.

**Broderson Subsurface Percolation**

The LOWWP will initially remove approximately 997 AFY of septage recharge from the Los Osos Basin and ultimately remove approximately 1,290 AFY at buildout. This number includes anticipated conservation plans that will reduce water usage in the area by 160 AFY and wet weather infiltration into the collection system. The viable disposal methods developed to offset the net deficit in groundwater recharge to the basin include the Broderson leach field, agricultural reuse in the Los Osos Creek Valley, and urban irrigation with recycled water within the Los Osos Basin.

As preliminarily designed, a subsurface leach field located on property west of Broderson Avenue will be utilized throughout the year for effluent disposal with the heaviest usage occurring during the wet weather months. During the rainy season, treated wastewater passing through the treatment process could reach as high as 1.5 mgd for short periods (60 days or less) and require disposal. During wet weather when surface irrigation is unnecessary, a portion of the treated wastewater will be disposed of through the sub-surface leach field. The remainder will be contained onsite in a holding pond(s) for future disposal at the spray field or for reuse by agriculture. Over time, the reintroduction of treated wastewater, together with the elimination of individual septic leach fields within the collection area, is expected to contribute to the flushing and dilution of the shallow aquifer and lower the nitrate concentrations.

Maximum disposal rates at the Broderson site are initially anticipated to be as high as 800,000 gpd but not to exceed 448 AFY unless groundwater monitoring indicates higher percolation rates can be achieved without developing adverse conditions. Periodic rehabilitation of leach fields will be required to maintain the minimum design disposal rates.

Substantial study has been conducted at the Broderson disposal site by the County and the LOCSD to determine subsurface conditions and estimate the ability of the site to be used for various rates of disposal and identify potential impacts of this disposal method. These studies include;

- Metcalf & Eddy (1997), Evaluation of Effluent Disposal at the Proposed Broderson Recharge site, Los Osos, California, Draft Report, Prepared for County of San Luis Obispo, Dated November 21.

- Cleath & Associates (2000a), Hydrogeologic Investigation of the Broderson Site, Prepared for the Los Osos Community Services District, Dated July.

- Cleath & Associates (2000b), *Hydrogeologic Investigation of the Broderson Site, Phase 2 – Impacts Assessment,* Prepared for the Los Osos Community Services District, Dated November.

- Yates, Gus and Williams, Derrik (2003), *Simulated Effects of a Proposed Sewer Project on Nitrate Concentrations in the Los Osos Valley Groundwater Basin*, Prepared for Los Osos Community Services District and Cleath & Associates, Dated November 6.

- Fugro West, Inc (2004), *Geotechnical Report Los Osos Wastewater Project, Los Osos Community Services District, San Luis Obispo County, California,* Prepared for Montgomery Watson Harza, Dated March 9.

In 1997 Metcalf & Eddy performed pilot infiltration testing for the County at the Broderson site using 2 dry wells for disposal testing and downgradient monitoring points (neutron probe access tubes) to observe moisture movement. The study procedures and findings were summarized in a report dated November 21, 1997. Subsequent review of the dry well pilot test data indicated that the hydraulic testing alone may be insufficient to characterize the adequacy of the site for disposal. In 2000 the LOCSD conducted a second investigation of the site which included drilling an additional 5 test holes and conducting downhole geophysical surveys to better define subsurface conditions beneath the site (C&A, 2000a). Based the test hole data, the study determined that the regional aquitard (designated the AT2 Clay) which separates the upper and lower aquifer zones, underlies the site at depths of between 190 - 235 feet bgs. Groundwater measured at the north end of the site was found at a depth of 150 feet bgs, and approximately 210 feet bgs in the center of the site.

The Phase II portion of the LOCSD investigation included the modification of the existing Los Osos Basin groundwater flow model (USGS, URS) to reflect conditions that would likely occur during the operation of facilities at the Broderson disposal site for the purpose of identifying potential disposal project impacts. The results of the LOCSD investigation indicate that disposal at a rate of 896 AFY could be conducted without excessive mounding beneath the site. This indicates that there is a low potential for groundwater ‘daylighting’ out the slope face downgradient of the site due to leach field operation at the proposed rate.

Based on model results, a more conservative disposal rate of 448 AFY was identified as an initial start-up rate for disposal to prevent rising groundwater at lower elevations along the bay (C&A, 2000b). The lower rate would allow disposal that would restore shallow groundwater conditions but not require harvest wells to be used to drawdown the water table along the bay. A series of groundwater monitoring wells on the site and downgradient of the site will be installed to measure groundwater levels for the purpose of reducing the rate of disposal if necessary. However, the study speculated that at any discharge rate, there may be increased potential for liquefaction beneath residences immediately downgradient of the disposal area (C&A, 2000b).

To assess the potential for liquefaction impacts to occur, the LOCSD conducted another subsurface investigation in 2004. The study conducted cone penetrometer testing to obtain site specific subsurface data around the area of proposed effluent spreading and downgradient into the adjacent community. The results of the study indicated that the potentially liquefiable soils in the vicinity of the site consisted of unconsolidated loose dune sand deposits contained within the upper 5 to 10 feet bgs. The underlying Paso Robles Formation is weakly indurated and forms a dense soil that has a low potential for liquefaction or seismic settlement to occur as a result of the effluent disposal system and the estimated groundwater mounding beneath Broderson (Fugro, 2004). The LOCSD 2004 study also conducted confirmatory field percolation testing and a prototype percolation line pilot test to provide infiltration data for correlation with the previous 1997 County study, and conducted additional laboratory soil tests to provide data for a preliminary disposal system design.

To assess the potential impacts of effluent disposal at Broderson on the underlying groundwater quality, the LOCSD performed a water quality modeling study in 2003 (Y&W, 2003). The study simulated groundwater quality changes that would result from discharge of treated effluent with an average NO3-N concentration of 7 mg/l. The study concluded that while change would be gradual over time, the removal of septic system recharge in the prohibition area and the return of treated effluent with a reduced nitrate concentration to the Broderson site would result in a beneficial impact that will improve water quality.

#### Short-term Construction Impacts

The entire Broderson site consists of approximately 75 acres. The leach field area as designed would occupy a rectangular area covering approximately 8 acres and the remainder would be preserved as open-space. The leach field design includes excavation of leach line trenches to an average depth of 6.5 feet during construction and subsequently re-graded. The leach fields would consist of a 4-foot depth of gravel for drainage, covered by a geotextile fabric, and then there would be at least 2.5 feet of native soil backfill. The percolation piping would consist of 4-inch perforated PVC pipe laid with the perforations facing upwards, one foot below the geotextile fabric layer. If the pores beneath the leach field become clogged over time, the leach field will need to be excavated and the ground beneath it ripped, disked, or otherwise treated to restore percolation rates. The estimated frequency of leach field rehabilitation is once every 5 to 10 years (Carollo, 2008b). As previously mentioned, groundwater is currently over 150 feet bgs at the site. Construction and subsequent rehabilitation of the leach fields will have no impact on groundwater. As with other construction activities, erosion control measures will be required during site excavation to prevent sediment transport offsite by surface runoff.

#### Long-term Operation Impacts

Potential impacts of the Broderson disposal site include impacts associated with water quality degradation and local high groundwater levels. The design studies conducted for this alternative indicate that a disposal rate of 448 AFY can be achieved without inducing adverse water level conditions beneath the site or downgradient in the community. With the initial proposed disposal capacity it is anticipated that at least 100 AFY will percolate through the regional aquitard into the lower aquifer system. The remaining 348 AFY will be a component of annual recharge to the upper aquifer system.

Modeling results indicate that the impact of this operation will be to restore groundwater levels in the upper aquifer system (B and C Zones) to elevations that are comparable to existing conditions (C&A, 2008b). The study results indicate that Broderson will provide beneficial impacts that restore groundwater recharge and maintain a balance in the hydrologic budget that provides outflows for local well production and freshwater features (marshes and springs) around the bay. The restoration of water level elevations beneath the bay and along the shoreline will mitigate the potential for seawater intrusion into the upper aquifer zones. Broderson recharge is not anticipated to impact water levels in the A Zone aquifer that lies above the perching clay layer.

#### Groundwater Quality Impacts

The RWQCB issued "Waste Discharge/Recycled Water Requirements Order No. R3-20030007" when LOCSD was moving forward with the previously abandoned wastewater project. The EIR for that project was completed in 2001 and the LOCSD proceeded with obtaining all the requisite permits including the Coastal Development Permit and the RWQCB order referenced above. The effluent and recycled water limitations from that order have been included here in Table 11 - Effluent Water Limitations from Previous Discharge Requirements (KJC, 2008).

**Table 11 - Effluent Water Limitations from Previous Discharge Requirements (Order No. R3-2003-0007)**

| EFFLUENT LIMITATIONS | | | |
|---|---|---|---|
| CONSTITUENT | UNITS | MONTHLY AVERAGE | DAILY MAXIMUM |
| SETTLEABLE SOLIDS | MG/L | 0.1 | 0.5 |
| BOD*, 5-DAY | MG/L | 60 | 100 |
| SUSPENDED SOLIDS | MG/L | 60 | 100 |
| TOTAL NITROGEN (AS N) | MG/L | 7 | 10 |

*Biological Oxygen Demand

The treatment facilities are being designed to produce an effluent that will have an average $NO_3$-N concentration of 7 mg/l and an estimated TDS concentration of 620 mg/l (Carollo, 2007b). The average nitrate concentration presently in the Los Osos Basin in the proximity of the prohibition zone groundwater is on the order of 10 mg/l ($NO_3$-N) (Y&W, 2003) and the average TDS concentration is approximately 330 mg/l (C&A, 2005c).

Effluent disposed at Broderson would have a positive affect on slowing the current conditions of seawater intrusion in the lower aquifer zones and flushing nitrate laden water from upper aquifer zones. The slow turnover rate of groundwater has been identified as the single most important basin characteristic affecting water-quality trends in the Los Osos Basin (Y&W, 2003). This occurs because the volume of groundwater in storage is relatively large compared to annual inflows and outflows. The result is that any action to decrease nitrogen loading (i.e., the LOWWP) will take a relatively long time to have an effect. As a result, nitrate concentrations in some deep wells may continue to increase for many years before the effect of septage removal reaches the lower aquifer system. Recent study has concluded that the shallow aquifer system may take on the order of three decades to equilibrate to a change in nitrate loading (Y&W, 2003). Regardless of the time frame required to realize a reduction in nitrate concentrations across the Los Osos Basin this impact is considered a beneficial impact to the basin.

To assess the impacts of TDS and NO3-N concentrations in the Los Osos Basin caused by effluent disposal at Broderson, a mass balance calculation was performed using septic return flows, precipitation, irrigation, subsurface cross flows and effluent disposed at Broderson at a rate of 448 AFY. The hydrologic budget summarized in Appendix C of this study was utilized for the purpose of comparing current conditions and conditions estimated for the viable project alternatives (C&A, 2008b). A summary of the mass balance calculation results is provided in Appendix D – Water Quality Mass Balance Summary. Combining the average effluent concentration of 7 mg/l with all the other nitrogen sources in the Los Osos Basin the average NO3-N concentrations in the upper aquifer after LOWWP completion will be approximately 8.3 mg/l, and is below the drinking water standard. The nitrate concentration calculation results are included in Table 12 – Summary of Upper Aquifer Nitrate Loading and Average Concentrations.

The resulting average TDS concentration calculated for the upper aquifer zones with the operation of Broderson is provided in Table 13 – Summary of Upper Aquifer Average Total Dissolved Solids Concentration. Both of these results indicate Broderson will provide a beneficial water quality impact on the Los Osos Basin.

**Table 12 – Summary of Upper Aquifer Nitrate Loading and Average Concentrations**

| BASIN CONDITION | TOTAL SURFACE RECHARGE TO LOS OSOS BASIN (AFY) | TOTAL NITROGEN LOAD (TONS) | ESTIMATED AVERAGE CONCENTRATION (MG/L) |
|---|---|---|---|
| CURRENT | 3,525 | 52.1 | 10.9 |
| BRODERSON 448 AFY | 3,337 | 37.9 | 8.3 |
| BRODERSON 896 AFY | 3,785 | 42.1 | 8.2 |

CONCENTRATION ESTIMATE WITH NO SUBSURFACE DENITRIFICATION FOLLOWING WASTEWATER DISPOSAL

**Table 13 – Summary of Upper Aquifer Average Total Dissolved Solids Concentration**

| BASIN CONDITION | BRODERSON DISCHARGE (AFY) | TOTAL SALTS LOAD (TONS) | ESTIMATED AVERAGE CONCENTRATION (MG/L) |
|---|---|---|---|
| CURRENT | 0 | 1,378 | 352 |
| VPA 2a | 448 | 1,073 | 296 |
| VPA 2b | 448 | 1,097 | 299 |
| VPA 2a | 896 | 1,450 | 343 |
| VPA 2b | 896 | 1,475 | 345 |

### Agricultural Reuse

Agricultural reuse would entail providing secondary or tertiary treated wastewater (depending on the crop) to local farmers for crop irrigation. Agricultural reuse would have the dual benefit of allowing effluent disposal and a reduction of local groundwater usage. Potential sites for agricultural reuse are located throughout the Los Osos Creek Valley. Potential effluent disposal from agricultural reuse could be as high as 690 AFY over a surface area of 230 acres.

#### Short-term Construction Impacts

Agricultural reuse would require the installation of conveyance piping to farms participating in the use of recycled water for irrigation. Depth to groundwater along the anticipated pipeline routes are currently below a depth of approximately 10 feet bgs. Trenching required to install water supply piping to the agricultural reuse sites would likely not exceed a depth 5 feet bgs and would not impact groundwater.

#### Long-term Operation Impacts

The revised groundwater model indicates a reduction in groundwater production from the creek valley aquifer on the order of 480 AFY would likely increase recharge to the lower aquifer zones from the creek compartment. The model indicated the increase could be in the range of approximately 5 to 145 AFY.

The water quality analysis of the creek compartment (alluvial aquifer) was calculated separately using the average existing groundwater TDS concentration of 520 mg/l (see Appendix D). A summary of the mass balance calculation for TDS concentrations in the creek compartment under the current conditions and alternative VPA 2a is provided as Tables D3 and D4, respectively. As indicated by the mass balance calculations (see Appendix D), the application of treated effluent would result in a salt balance that is comparable to current conditions and would not impact groundwater.

### Urban Landscaping Reuse

Urban landscaping reuse disposal was estimated by previous study to have the potential for disposal as high as 133 AFY. During dry weather conditions treated wastewater would be recycled by irrigating play fields and landscaping within the community. Among the sites that were considered are the four public schools; Bayview Elementary, Monarch Grove Elementary, Sunnyside Elementary and Los Osos Middle Schools. Additional sites included; landscape at the WWTP, the Los Osos Valley Memorial Park, the South Bay Community Center, and a portion of the Sea Pines Golf Course. Urban/landscaping reuse would require tertiary treatment before distribution and a separate conveyance system to each area of application. The impact of this project reuse alternative would result from a reduction of groundwater supply required by local purveyors and be beneficial toward reducing groundwater overdraft by the amount of offset demand (up to 113 AFY). The viable project alternatives VPA 2a and VPA 2c identified by the fine screening study contain landscape irrigation of approximately 20 AFY irrigation at the WWTP and 50 AFY at the Cemetery.

## MITIGATION MEASURES FOR VIABLE PROJECT DISPOSAL ALTERNATIVES

As discussed in the previous sections of this report, the viable project alternatives for effluent disposal and reuse were developed through the County screening process and considered various combinations of disposal/reuse methods that could accommodate the estimated rates of effluent discharge and minimize impacts and/or provide feasible mitigations. Because no single disposal method could provide both disposal capacity and complete mitigation of the related impacts, the impacts identified in the previous section of this report are combined to evaluate the potential mitigation measures for the viable project alternatives. As previously defined in the fine screening study, all viable project alternatives that are still being considered for disposal and reuse will sufficiently mitigate seawater intrusion impacts through use of the Broderson facilities. Mitigation measures for additional potential groundwater supply and water quality impacts are discussed in the following report sections.

### Viable Project Alternative 2a

The potential impacts identified for VPA 2a include;

a) **Facilities construction** – disposal of shallow groundwater and erosion of exposed soil,

b) **Spray field disposal** – groundwater quality, surface runoff from disposal area, and removal of groundwater recharge from the Los Osos Basin,

c) **Urban irrigation reuse** – groundwater quality,

d) **Agricultural irrigation reuse** – groundwater quality,

e) **Broderson subsurface percolation** – groundwater quality, liquefaction, rising groundwater, and groundwater seeps emerging down slope of the project site.

Impacts that occur during the LOWWP construction will be relatively short in duration and mitigable primarily through BMP's. As previously indicated the potential impacts of the shallow groundwater discharge that is anticipated to be removed during installation of pipelines and pump stations can be mitigated by compliance with discharge requirements for surface water release, storm water detention basin release, or beneficial reuse for dust control or soil moisture conditioning of backfill prior to compaction. If additional disposal capacity is required and water quality conditions including high nitrate or settleable solids concentrations (or turbidity) preclude compliance with permitted discharge standards, spray irrigation of pasture grasses at the Tonini spray fields may conducted with a water truck as a fallback mitigation during project construction. Surface water runoff impacts can be mitigated with standard BMP's for erosion control to minimize the sediment load in offsite runoff.

**Water Quality**

The potential water quality impacts of VPA 2a include the potential increased concentration of salts or nutrients in groundwater beneath the Tonini spray field disposal site, the agricultural reuse area, and the Broderson disposal area. As summarized in the previous report sections, analyses indicates that disposal at Broderson will reduce nitrate loading and result in a beneficial impact on nutrient concentrations in the basin (Y&W, 2003). The salinity of the upper aquifer recharge from the VPA 2a discharge at Broderson is the same as the current conditions of recharge from domestic septic recharge. The return of a component of this source of recharge to the basin will have an insignificant impact to existing salt balance conditions in the basin and will require no mitigation.

Urban irrigation reuse within the basin is small (at buildout only) and will have virtually the same insignificant water quality impacts as Broderson because it would use water with a reduced nitrate concentration (7 mg/l) and the same TDS that is presently returned through septage infiltration. The impacts of agricultural irrigation reuse that is included in VPA 2a are insignificant and require no mitigation. This determination is based on the agronomic uptake of nitrogen that will be introduced during irrigation at lower concentrations than the standard agricultural practices. The results of a mass balance calculation of the resulting TDS concentration in groundwater within the Creek Valley alluvial aquifer (creek compartment) indicate that average cumulative TDS concentration of inflow sources to the creek compartment under current conditions is 458 mg/l which is comparable to the VPA 2a conditions that are estimated to result in an inflow concentration of 455 mg/l.

Laboratory test results for groundwater samples collected from three wells on the Tonini property indicate the groundwater has an average TDS concentration of 606 mg/l and a nitrate concentration of 7.2 mg/l. Although the estimated TDS concentration of percolating water from sprayfield operations may be higher than local groundwater, the infiltration will mix with native groundwater flowing beneath the site and proportionally reduce the salts concentration. The TDS concentration of treated effluent that would be used for sprayfield disposal at the Tonini Ranch is estimated at approximately 620 mg/l and is comparable to the groundwater that underlies the Tonini site. Because of the similar TDS concentrations, the effects on groundwater from using the LOWWP effluent as an irrigation source versus pumping groundwater for crop irrigation are the same. Based on these conditions the salt loading impacts to groundwater from irrigating crops with effluent at the proposed Tonini sprayfield site are considered less than significant.

It is anticipated that a substantial portion of the nitrate in the applied water will be removed by crop uptake and decrease the concentration from 7 mg/l to a concentration lower than the background concentration of 7.2 mg/l and not contribute to degradation of existing conditions. Therefore, impacts associated with nitrate concentrations would be less than significant.

During urban and agricultural irrigation, best management practices can be utilized to prevent and mitigate offsite runoff of recycled water. Runoff of irrigation water from spray field disposal is potentially significant but can be mitigated through the use of catch basins that impound the water and allow it to percolate and be reintroduced into the irrigation system. As indicated by this analysis the VPA 2a discharge scenario will not have any significant water quality impacts that require mitigation.

**Water Supply**

Collection of septage will remove a source of groundwater recharge in the Los Osos Basin. Disposal of the LOWWP effluent outside the Los Osos Basin will result in removal of groundwater recharge (inflow) and proportionally affect some component of groundwater outflow from the upper aquifer zones. As previously indicated in this report, the County considered the reduced outflow impact to the over drafted lower aquifer system and determined measures to mitigate this impact were crucial. The VPA 2a alternative contains water supply conservation, agricultural reuse, and Broderson disposal which are all anticipated to provide mitigation to the seawater intruded the lower aquifer system. As shown in Table 5, conservation (160 AFY) is perceived as a mitigation that can be directly applied as a reduction in groundwater production from lower aquifer zone. Based on the mitigation factor developed for this project component (Carollo, 2007), the resulting mitigation is equal to 88 AFY (see Table 5). As previously indicated, groundwater recharge caused by disposal at the Broderson site is estimated to result in recharge to the lower aquifer zones that will further contribute approximately 99 AFY (see Table 5). The mitigation to lower aquifer recharge provided by the agricultural reuse component is estimated at 46 AFY (see Table 5). The total seawater intrusion mitigation to the lower aquifer system from the VPA 2a is 233 AFY (Carollo, 2008).

As indicated by the hydrologic budget shown in Table 9, the VPA 2a change in basin water supply conditions primarily impacts evapotranspiration and Willow Creek flows that emanate from the upper aquifer system A zone. The model simulated groundwater elevations (see Appendix C) were enlarged on plates that are included in Appendix E – Water Level Contour Maps, to show the area of primary impact to the upper aquifer B and C zones. The resulting impacts of individual VPA components are tabulated in Table 14 – Los Osos Basin Water Level Impacts. The values listed in Table 14 consist of existing conditions and a comparison of simulated conditions upon project startup.

**Table 14 - Los Osos Basin Water Level Impacts**

| PROJECT COMPONENT | UPPER AQUIFER WATER LEVEL ELEVATIONS (FEET) | | LOWER AQUIFER WATER LEVEL ELEVATIONS (FEET) | | UPPER AQUIFER WATER LEVEL CHANGE (FEET) | | LOWER AQUIFER WATER LEVEL CHANGE (FEET) | |
|---|---|---|---|---|---|---|---|---|
| | ALONG THE BAY SHORE | MID BASIN | ALONG THE BAY SHORE | MID BASIN | ALONG THE BAY SHORE | MID BASIN | ALONG THE BAY SHORE | MID BASIN |
| EXISTING CONDITION | 5 | 15 TO 20 | -2 | -5 | NA | NA | NA | NA |
| SPRAY FIELDS ONLY | 0 TO 5 | 5 TO 10 | -5 | -5 | -2 | -8 | -2 | -3 |
| CONSERVATION ONLY | 5 | 10 TO 15 | 0 TO -5 | -5 | -2 | -6 | -1 | -1 |
| BRODERSON ONLY | 5 | 15 TO 20 | 0 TO -5 | -5 | 0 TO -5 | 0 | 0 TO -1 | 0 |
| AG REUSE ONLY | 5 | 10 TO 15 | 0 TO -5 | -3 | -2 | -5 | -1 | -1 |
| VPA 2A | 5 | 15 TO 20 | 0 | 0 | 1 TO -1 | 0 | 2 | 4 |
| VPA 2B | 5 | 15 TO 20 | 0 | 0 | 1 TO -1 | 0 | 0 TO 2 | 2 |

These results indicate that because Broderson discharge effectively replenishes the B and C zones beneath the perching clay, the upper aquifer water levels are virtually restored to the current condition (C&A, 2008b) (see Appendix E, Plates E1 and E2) from the 448 AFY discharge scenario. Without the Broderson disposal alternative the removal of the upper aquifer system recharge from septic system percolation (i.e., complete disposal of effluent to the Tonini spray fields) would imbalance the hydraulic equation and allow water levels to decline to near or below sea level along the bay shoreline (see Appendix E, Plate E3). The potential impact to fresh water features around the bay (i.e., springs, marshes, etc.) would be significant. In addition, the low water levels in the upper aquifer would create a vulnerability to seawater intrusion and would be a significant impact. As indicated, the potential VPA 2a water supply impacts are less than significant because of the hydrologic budget balance created by the combined project that includes the Broderson disposal site.

The Broderson disposal recharge can not mitigate potential impacts of reduced groundwater outflow that drains out of the upper aquifer A zone toward the Willow Creek drainage or directly into the bay. The annual drainage in the Willow Creek area will be reduced by the LOWWP to natural or above natural conditions prior to the Los Osos community development. Drainage will still occur, however the flow rates may be reduced to the present ephemeral surface flows. The potential impacts of the reduced groundwater discharge in this area of the Los Osos Basin could be realized along the riparian corridors of the drainage features. However, seasonal runoff and shallow groundwater are anticipated to provide sufficient water for use by the riparian vegetation established well before the Los Osos community was developed.

**Hydrogeologic Hazards**

Potential hydrogeological hazards identified by this study are focused around the Broderson disposal site. Potential hazards include increased rising groundwater in the community at lower elevations around the bay, groundwater seepage from slope faces below the leach field, or liquefaction of soils between the site and the points of onshore and offshore discharge. Specific studies have been conducted to assess the potential for each of these impacts to occur.

As previously mentioned, water level elevation changes in the vicinity of the site and across the Los Osos Basin in the upper aquifer zones were modeled as part of the project design study. The design capacity of 448 AFY was selected based on the ability of the aquifer system to receive this annual quantity of water without developing adverse conditions. The reduced design capacity alleviates hazards that could be caused by discharge at a higher rate. This rate reduces mounding beneath the site to eliminate the potential for groundwater to flow laterally and exacerbate saturated soil hazards near the bay. The design rate minimizes the potential for additional rising groundwater around the bay at lower elevations. While this condition presently exists in many low lying areas around the bay, the proposed disposal capacity at startup is designed to maintain existing conditions and not exacerbate this potential hazard. Liquefaction is a hazard that was specifically studied by the LOCSD to understand the potential for its occurrence (Fugro, 2004). The result of the field tests indicated that the potential was low because of the nature of the underlying geologic formation which was comprised of dense soils beneath the dune sands.

While project studies indicate that potential risk for these hazards is low, the occurrence of these potential impacts would be controlled during operation by the installation of a monitoring network at the Broderson site and downgradient within the residential community prior to initiating discharge. The groundwater monitoring network would allow direct observation of the changes in groundwater conditions and appropriate adjustments to the disposal operations can be made. In addition, if monitoring indicates additional groundwater disposal can occur without creating adverse conditions, the future benefit to aquifer supply and sea water intrusion mitigation provided by this disposal option can be increased.

**Viable Project Alternative 2b**

VPA 2b contains three of the same project discharge/reuse components as VPA 2a but does not include agricultural reuse, cemetery reuse, or plant irrigation (see Table 6). Of the remaining project discharge components the impacts of Broderson and water supply conservation are the same for VPA 2b as those identified in VPA 2a. The primary difference is the elimination of effluent reuse components and reliance on disposal at the Tonini spray fields for the entire amount of effluent not disposed at Broderson.

The VPA 2b alternative contains water supply conservation and Broderson disposal which are both anticipated to provide mitigation to the seawater intruded lower aquifer system. The seawater intrusion mitigation is 51 AFY less in VPA 2b than provided by VPA 2a and provides a total mitigation of 187 AFY, (Carollo, 2008). This amount is sufficient to offset groundwater supply reduction created by removal of the septic system discharges.

The potential water quality, water quantity, and groundwater induced geologic hazard impacts are comparable to the VPA 2b for the Broderson and Tonini disposal sites as those described in VPA 2a and are controlled by the combined project design.

**Viable Project Alternative 2c**

VPA 2c disposal/reuse components are identical to the components in VPA 2a with a change in the disposal quantity at the Tonini spray fields (from 69 to 0 AFY) and a change in the agricultural reuse quantity (from 480 to 549 AFY) (see Table 7). The resulting impact from this relatively minor increase in use is insignificant to the water quality of irrigation return flows that percolate to groundwater and will require no mitigation.

## CONCLUSIONS

Groundwater inflow removed from the hydrologic budget (septic system percolation) by the LOWWP collection system will affect both the upper aquifer zones, which are directly recharged by this source, and the lower aquifer zones which receive leakage from the upper aquifers. However, the disposal component of the project is designed to ensure that there would not be a net loss in groundwater recharge to the aquifers that support overlying beneficial land uses and associated impacts would be less than significant. Furthermore, the proposed disposal of treated effluent at Broderson would reduce the current rate of seawater intrusion into the lower aquifer, thus resulting in a beneficial impact.

Modeling results indicate that the impact of this operation will be to restore groundwater levels in the upper aquifer system (Zones B and C) to elevations that are comparable to existing conditions. The study results indicate that Broderson disposal will provide beneficial impacts that restore groundwater recharge and maintain a balance in the hydrologic budget that provides outflows for local well production and freshwater features (marshes and springs) around the bay. Implementation of the proposed project would reduce septic effluent discharge into the perched aquifer (Zone A). Therefore, the project would reduce the quantity of groundwater within the perched aquifer. However, the exact quantity of reduction within the perched aquifer (while estimated) is unknown, and the potential impact on groundwater flow to surrounding surface water features is speculative given that the amount of perched groundwater currently flowing to surface water features is not known.

The findings of this study conclude the following:

- The impacts of shallow groundwater disposal during project construction would be less than significant if beneficially reused during construction (i.e., dust control and soil moisture conditioning of backfill soils) and/or disposed to storm drains or storm water percolation basins in accordance with RWQCB permit conditions, and/or spray disposed at Tonini site utilizing a water truck.

- Surface water runoff impacts during project construction can be mitigated with standard BMP’s for erosion control to minimize the sediment load in offsite runoff.

- Runoff of irrigation water from spray field disposal would be less than significant if captured by the use of catch basins that impound the water and allow it to percolate and be reintroduced into the irrigation system.

Onsite runoff can be minimized by diverting runoff from surrounding areas outside the spray field parcels around the disposal site.

- The designed operation of the Broderson disposal alternative at the approximate capacity of 448 AFY (or greater) would reduce the potential impact of groundwater recharge losses that will result from the LOWWP elimination of septic system recharge to the main aquifers that provide water for overlying beneficial uses in the Los Osos Basin to less than significant.

- Potential geologic hazards arising from groundwater conditions created by operation of the Broderson leach field disposal will be controlled through the proper design and use of a monitoring network to track the occurrence and movement of water beneath the site and downgradient of the site. This monitoring component of the Broderson disposal alternative would allow verification that these potential impacts remain less than significant.

- The potential impact on the exact quantity of groundwater in the perched aquifer is unknown and the potential impact on groundwater flow to surrounding surface water features is speculative given that the amount of perched groundwater currently flowing to surface water features is not known.

- The proposed disposal of treated effluent at Broderson would reduce the current rate of seawater intrusion into the lower aquifer, thus resulting in a beneficial impact.

- Analyses indicates that disposal at Broderson will reduce nitrate loading and result in a beneficial impact on nutrient concentrations in the basin.

- The salinity of the upper aquifer recharge from septic system effluent is the same as the treated effluent discharge proposed at Broderson and the groundwater replenishment resulting from this discharge will have a less than insignificant impact to existing salt balance conditions in the basin.

- The TDS concentration of treated effluent that would be used for sprayfield disposal at the Tonini Ranch is estimated at approximately 620 mg/l and is comparable to the groundwater that underlies the Tonini site. Because of the similar TDS concentrations, the effects on groundwater from using the LOWWP effluent as an irrigation source versus pumping groundwater for crop irrigation are the same. Based on these conditions the salt loading impacts to groundwater from irrigating crops with effluent at the proposed Tonini sprayfield site are considered less than significant.

- It is anticipated that a substantial portion of the nitrate in the applied water will be removed by crop uptake and decrease the concentration from 7 mg/l to a concentration lower than the background concentration of 7.2 mg/l and not contribute to degradation of existing conditions. Therefore, impacts associated with nitrate concentrations would be less than significant.
- The combined components of VPA2a, VPA2b, and VPA2c provide a sufficient design to reduce potential hydrogeological impacts to less than significant.

## CLOSURE

This report has been prepared for the exclusive use of San Luis Obispo County and its agents for specific application to the understanding of the potential environmental impacts that would result from the construction and operation of the Los Osos Wastewater Project, located in the City of Los Osos, California. The findings, conclusions, and recommendations presented herein were prepared in accordance with generally accepted hydrogeological engineering planning practices. No other warranty, express or implied, is made

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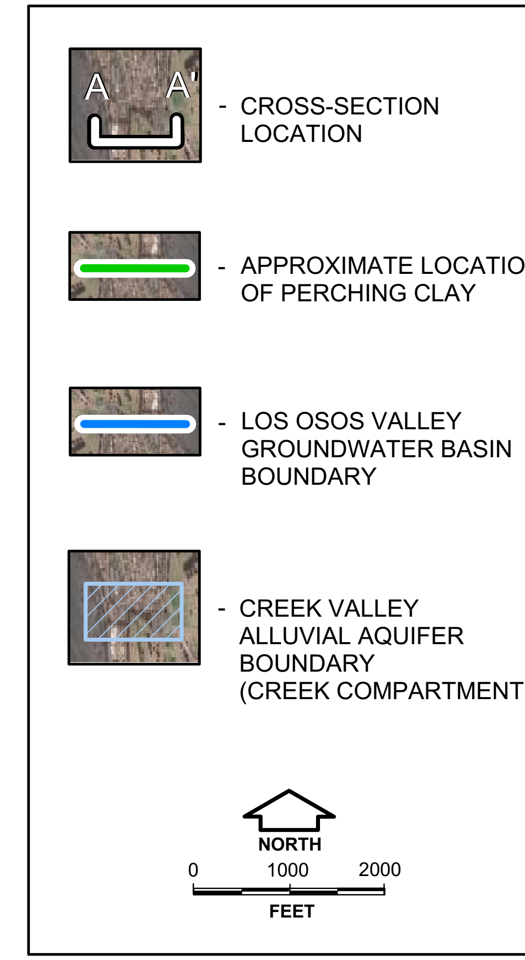
# PLATES

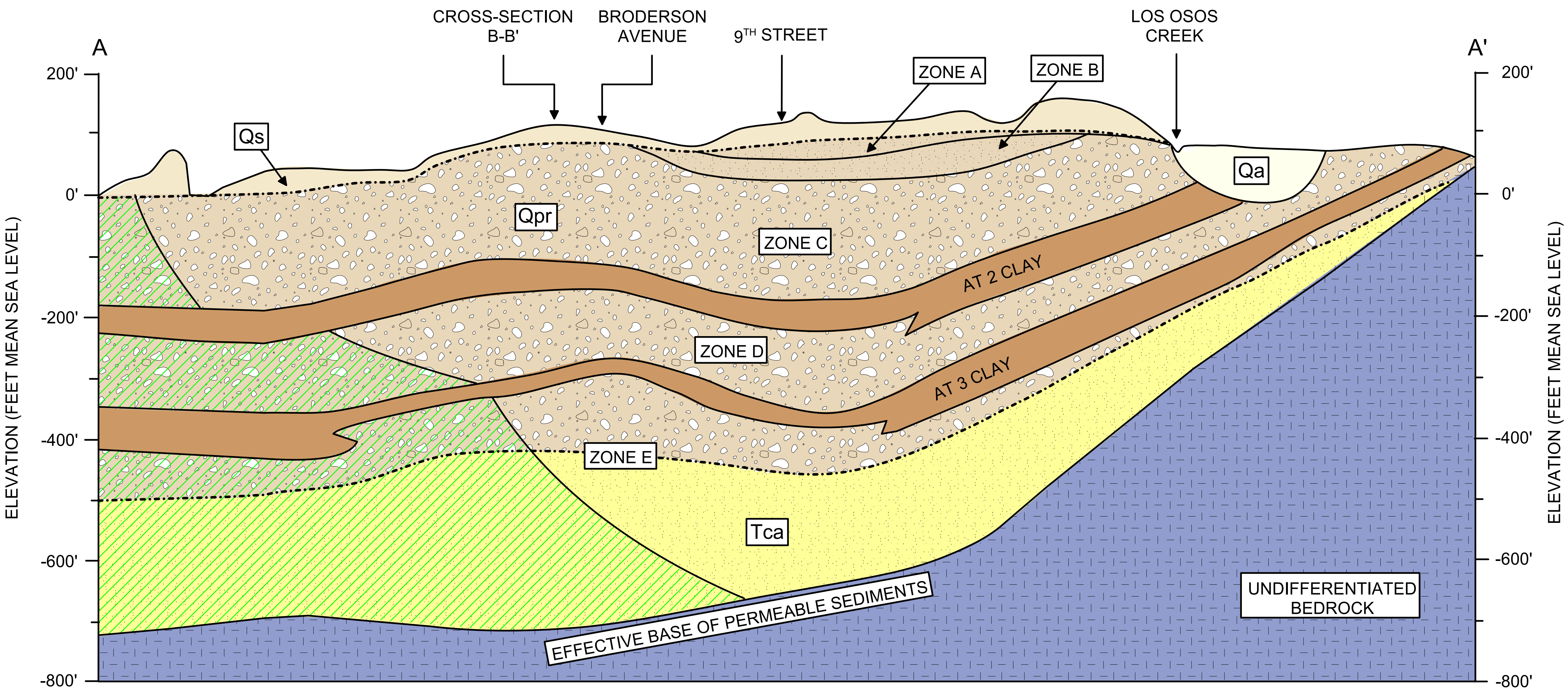

**STUDY AREA LOCATION MAP**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

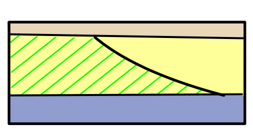
PLATE 1


**HYDROGEOLOGICAL CROSS-SECTION LOCATION MAP**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

PLATE 2



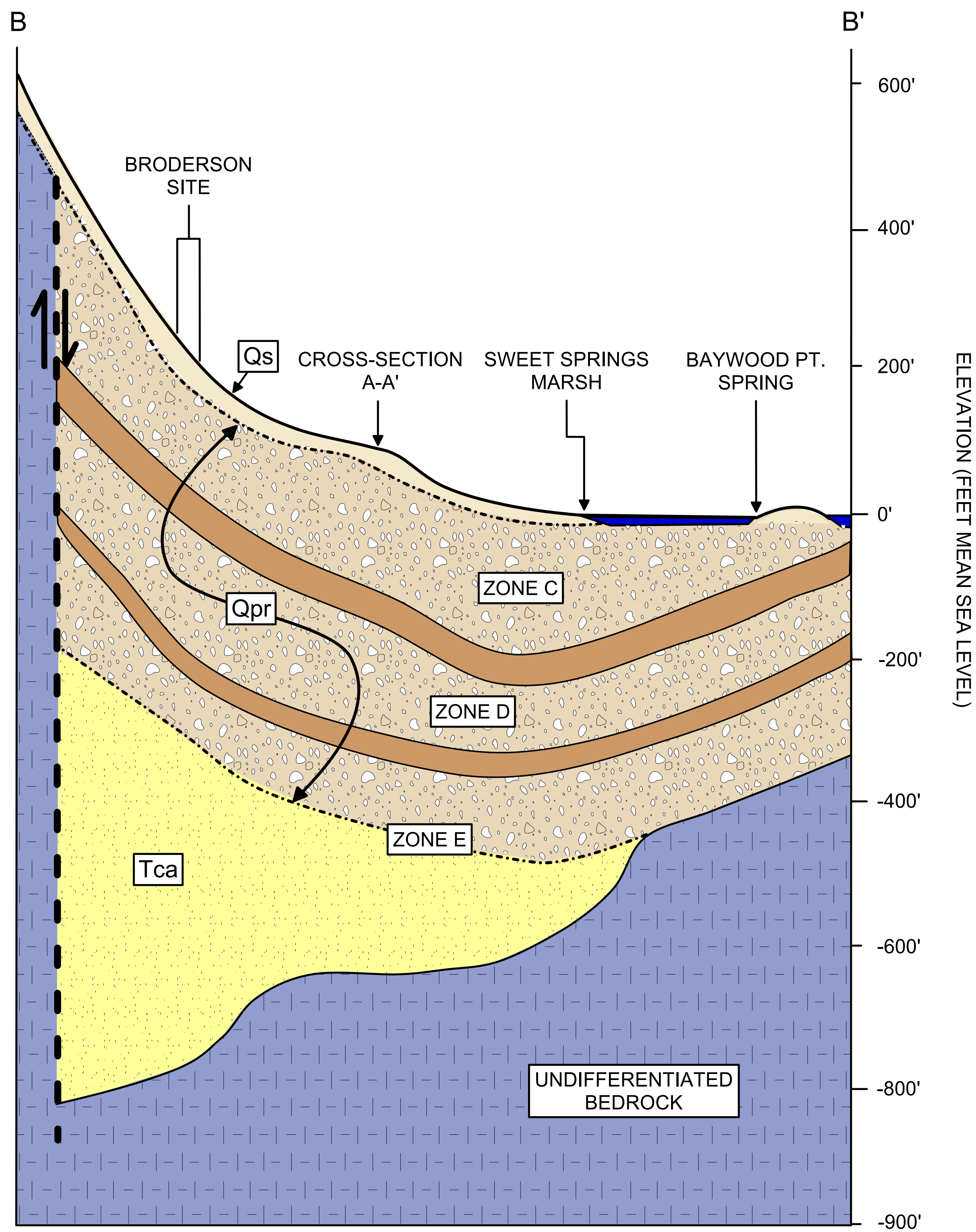



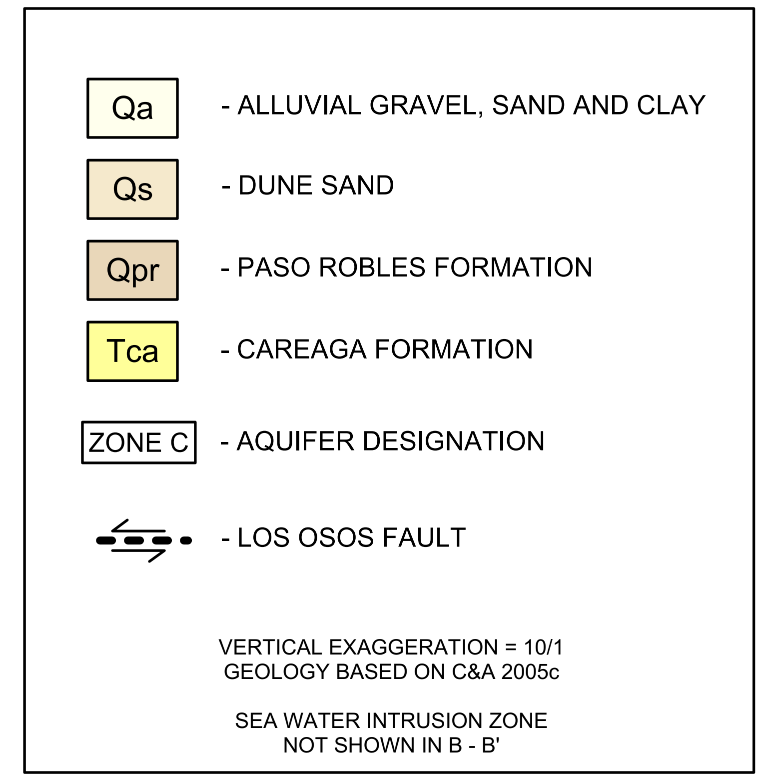
- APPROXIMATE AREA OF AQUIFER INTRUDED BY SEA WATER (CLEATH, 2005c)

VERTICAL EXAGGERATION = 10/1
GEOLOGY BASED ON C&A 2005c

**HYDROGEOLOGICAL**
**CROSS-SECTION A-A'**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

PLATE 3




**HYDROGEOLOGICAL CROSS-SECTION B-B'**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

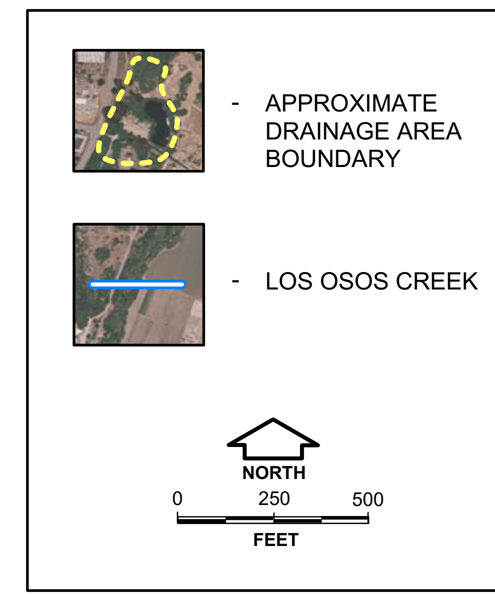
# APPENDIX A
# LOS OSOS BASIN
# SURFACE WATER FEATURES

**HOPKINS GROUNDWATER CONSULTANTS**


**SURFACE WATER FEATURES LOCATION MAP**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

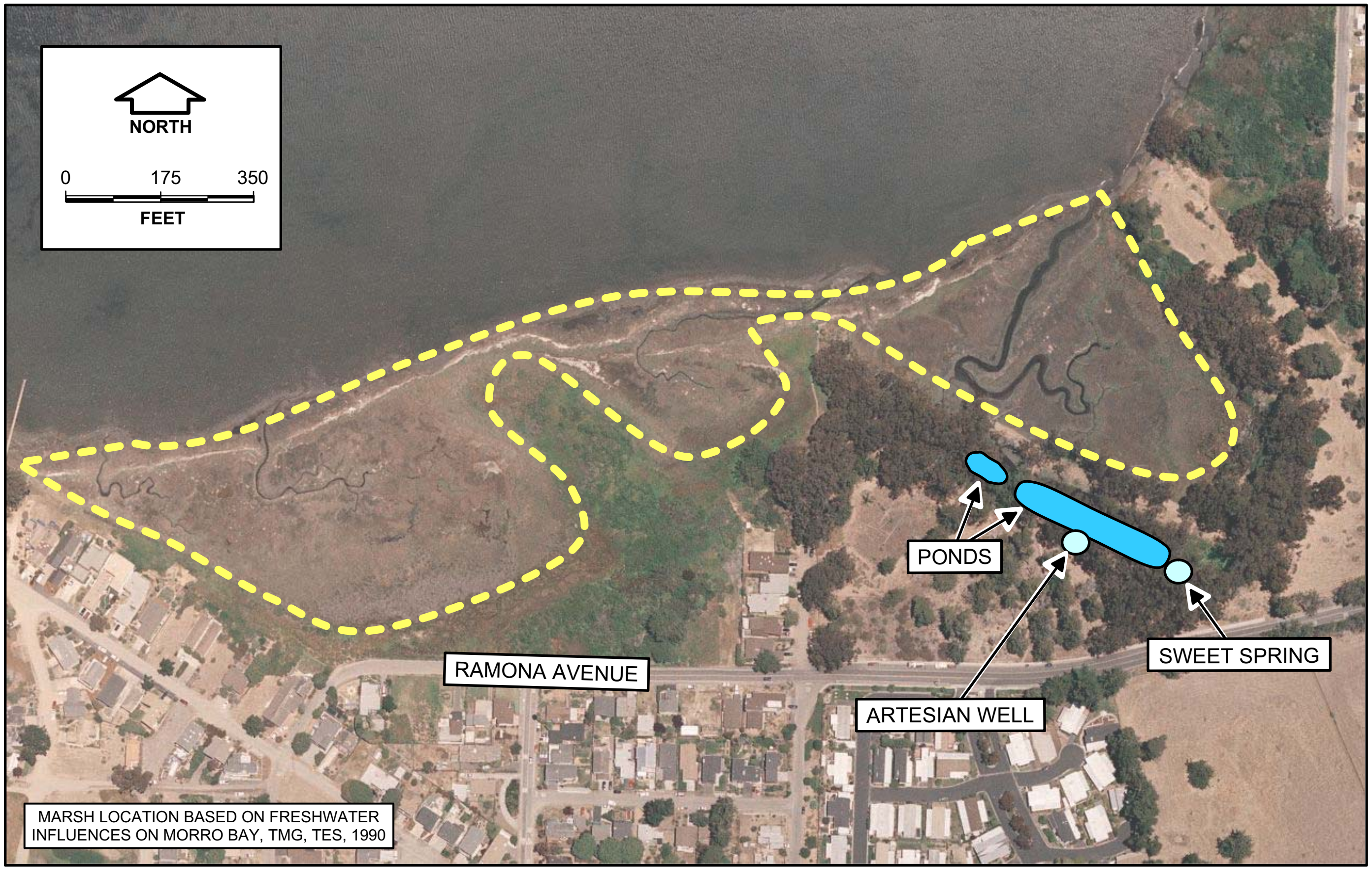
PLATE A1

HOPKINS
GROUNDWATER
CONSULTANTS


**WILLOW CREEK DRAINAGE**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

PLATE A2




**SWEET SPRINGS MARSH**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

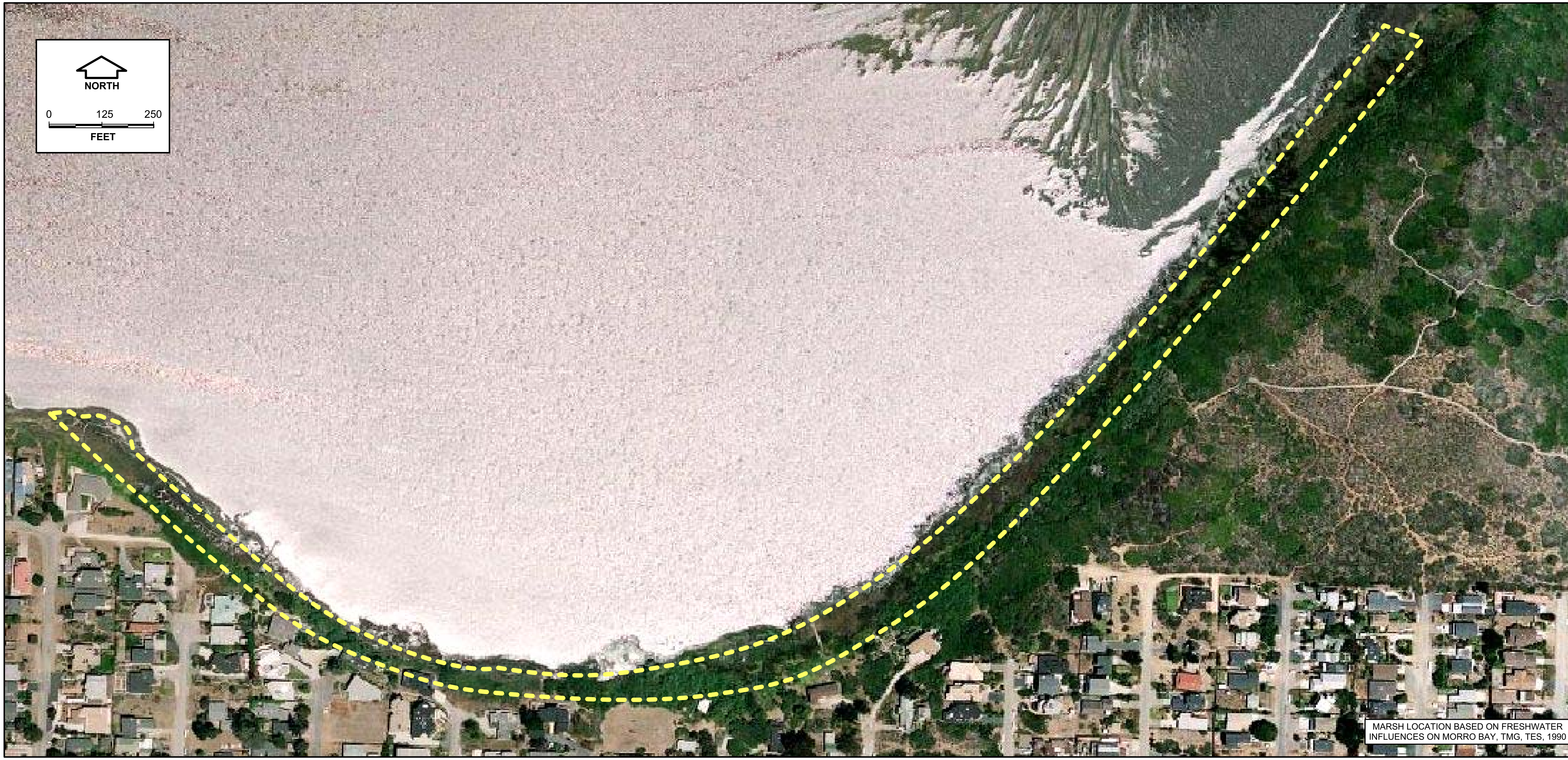
PLATE A3


**PECHO MARSH**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

PLATE A4


**THIRD STREET MARSH**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

PLATE A5




**BAYWOOD MARSH**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

# APPENDIX B
# TONINI RANCH DATA

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# Memorandum

**Date:** March 15, 2007
**From:** Spencer Harris, Cleath & Associates
**To:** LOWWP Team

**Subject:** **Support documentation for LOWWP Disposal Memo dated March 13, 2007**

This memorandum documents the reservoir storage calculations, slow-rate percolation documentation, and ET disposal capacity estimates used for the March 13th disposal costing memo.

## Irrigation Water Demand

The basic equation for calculating irrigation water demand for a crop is:
D (AFY) = Crop area * (ET-Pe)/((1-LR)*IE)

D = demand
ET = crop evapotranspiration potential
Pe = effective precipitation
LR = leaching ratio
IE - Irrigation efficiency

and where
ET = Kc * ETo

Kc = crop coefficient
ETo = reference ET

and
LR = ECi / ((5*ECe)-ECi

ECi = irrigation water EC (dS/m)
ECe = soil extract EC (dS/m)

This methodology has been used to estimate annual crop water demand for different water planning areas in the county (August 1998 Water Master Plan Update) and monthly demand by Ripley Pacific (Appendix TM 5-A). For fine screening, the Water Master Plan estimates for annual water demand are used, based on the average historical cropping pattern for ag land use in the Los Osos Creek valley. This annual use is distributed into monthly demand based on Ripley's calculations.

ETo values used by Ripley look a little high, based on a review of DWR values for the coastal zones. The creek valley does get some fog, so ETo Zone 2 (light fog; 39 inches ET per year) is probably a conservative match, although the actual DWR state ETo map puts the creek valley at the edge of Zone

6 (coastal uplands - no fog; 49.7 inches ET per year), which is closer to what Ripley used. Crop demand includes adjustments for effective rainfall, irrigation efficiency, leaching requirement, and individual crop coefficients. Again, Ripley's crop demand appears a little high (intensive), so only the monthly distribution from Appendix TM 5-A is applied. The monthly ETo and ag irrigation demand distribution from Appendix TM-5A is provided for reference below:

Ripley Pacific ETo Distribution

| | Inches | Percent |
|---|---|---|
| Jan | 2.01 | 4.18 |
| Feb | 2.42 | 5.04 |
| Mar | 3.63 | 7.56 |
| Apr | 4.32 | 8.99 |
| May | 5.73 | 11.93 |
| Jun | 5.97 | 12.43 |
| Jul | 6 | 12.49 |
| Aug | 5.41 | 11.26 |
| Sep | 4.6 | 9.58 |
| Oct | 3.52 | 7.33 |
| Nov | 2.44 | 5.08 |
| Dec | 1.98 | 4.12 |
| | 48.03 | 100 |

Ripley Pacific Crop Demand

| | Inches | Percent |
|---|---|---|
| Jan | 0 | 0 |
| Feb | 0 | 0 |
| Mar | 1.67 | 4.08 |
| Apr | 3.7 | 9.05 |
| May | 5.82 | 14.23 |
| Jun | 6.94 | 16.97 |
| Jul | 7 | 17.11 |
| Aug | 6.3 | 15.4 |
| Sep | 5.35 | 13.08 |
| Oct | 2.94 | 7.19 |
| Nov | 1.18 | 2.89 |
| Dec | 0 | 0 |
| TOTAL | 40.9 | 100 |

As mentioned in the March 13 disposal memo text, the actual historical crop water demand in the Los Osos Creek valley is estimated at 2 feet per year, rather than the 3.4 feet per year of potential demand estimated by Ripley Pacific for intensive agriculture. Both the ET monthly distribution and the annual demand estimates can be refined when assessing the viable projects.

## Spray Field Evapotranspiration

The ET distribution used for spray fields is based on the unadjusted reference ETo, for two reasons. ETo is the ET for a reference crop, which is either turfgrass (ETo) or alfalfa (ETr). Spray fields are basically intensive irrigated pasture, which can approach or even exceed the ETo. The other reason is that spray fields can still be used in the winter months (at a lower application rate) when no irrigation would normally be needed to support pasture. Spray fields maximize both the evaporation component and the transpiration component of ET.

The nominal value of 3 feet per year ET for spray fields used for fine screening is less than the 3.4 feet per year (ET-Pe) listed by Ripley, but keep in mind that Ripley's ETo may be a little high for the area, so 3 feet for fine screening purposes is more conservative.

## Spray Field Slow-Rate Percolation

Slow-rate percolation capacity was estimated by taking the published permeability rates for the soils at Tonini Ranch (from USDA Soil Conservation Service report) and multiplying by 4 percent, as suggested by the EPA process design manual on Land Treatment of Municipal Wastewater (1981). Specifically, in section 4.5.1, the water balance equation given for monthly loading is:

Lw = ET - Pr + Pw

Lw = wastewater hydraulic loading rate
ET = evapotranspiration rate
Pr = Pe (effective precipitation)
Pw = percolation rate

The ET-Pe value is 3 feet per year, as discussed above, and the monthly distribution is proportioned to the reference ETo to reflect year-round hydraulic loading at the spray field. Pw, which is the slow-rate percolation component, is not to exceed 4% to 10% of the minimum soil permeability. Table 1 below lists the various soils and acreage (by planimeter) for Tonini Ranch on slopes less than 30%. The soils map is attached (Figure 1).

**Table 1**
**Soil permeability at Spray Field site**
**(with acreage for slopes below 30 percent)**

| Soil Number - Type (area) | Listed Permeability (SCS -1984) |
|---|---|
| 128 - Cropley clay (155 acres) | 0.06-0.2 in/hr |
| 131 - Diablo and Cibo clays (70 acres) | 0.06-0.2 in/hr |
| 191 - Pismo-Tierra complex (70 acres) | 6.0 - 20 in/hr |
| 121 - Conception loam (50 acres) | Variable (use 0.06-0.2 in/hr) |
| 216 - Tierra sandy loam (40 acres) | Variable (use 0.06-0.2 in/hr) |
| 169 - Marimel sandy clay loam, occ. flooded (15 acres) | 0.2-0.6 in/hr |

The lowest permeability listed in most cases is 0.06 in/hr. Using the most conservative slow-rate factor of 4 percent, the resulting percolation rate would be 0.0024 inches per hour, equivalent to 1.8 feet per year (assuming year-round operations). Spray fields ET (3 ft./yr) and slow-rate capacity (1.8 ft/yr) total 4.8 feet per year. Note that the total area of slopes less than 30 percent is 400 acres. Only 270 acres have been proposed for spray fields, with 190 acres of generally flat topography, and 80 acres with slopes up to 20 percent. If spray field operations are manageable on slopes between 20 and 30 percent, then more area would be available at the site.

Reservoir Storage Calculations

The required reservoir storage to accommodate spray fields at 1,120 AFY disposal was estimated at 170 AFY. The calculations (in AFY) are as follows:

Calculation 1 - Spray Field at 1,120 AFY

| | Capacity | Flows | Storage |
|---|---|---|---|
| Oct | 87.86 | 86 | 0 |
| Nov | 69.65 | 108 | 38.35 |
| Dec | 61.89 | 108 | 84.46 |
| Jan | 62.4 | 108 | 130.06 |
| Feb | 69.31 | 108 | 168.75 |
| Mar | 89.72 | 86 | 165.03 |
| Apr | 101.35 | 86 | 149.68 |
| May | 125.13 | 86 | 110.55 |
| Jun | 129.18 | 86 | 67.37 |
| Jul | 129.69 | 86 | 23.68 |
| Aug | 119.74 | 86 | 0 |
| Sep | 106.08 | 86 | 0 |
| TOTAL | 1152 | 1120 | |

Capacity for the Spray fields are determined by taking the nominal annual capacity of 1,152 AFY ((4.8 ft/yr * 190 acres) + (3 ft/yr * 80 acres)) and proportioning it according to the reference ETo distribution. The ET component of spray field capacity is 3 ft/yr * 270 acres = 810 AFY, and the slow-rate percolation component is 1.8 ft/yr * 190 acres = 342 AFY.

For example, in April the reference ETo listed by Ripley Pacific (Appendix TM 5-A) is 4.32 inches, which is 9% of the 48.03 inch annual total. The spray field capacity in April would be 9% of the annual ET capacity (810 AFY * 0.09 = 72.9 acre-feet) plus an equal monthly share of the slow-rate percolation capacity (342 AFY/12 months = 28.5 acre-feet), for a total capacity of 101.4 acre feet. As can be seen above, the maximum required storage is close to 170 acre-feet in February.

Ag reuse storage requirements are based on the crop demand. Flows to the ag areas are assumed to be constant year round (up to 460 AFY). The resulting storage calculations in AFY are:

Calculation 2 - Ag Resue at 460 AFY

| | Flows | Demand | Storage |
|---|---|---|---|
| Oct | 38.33 | 33 | 5.33 |
| Nov | 38.33 | 13 | 30.66 |
| Dec | 38.33 | 0 | 68.99 |
| Jan | 38.33 | 0 | 107.32 |
| Feb | 38.33 | 0 | 145.65 |
| Mar | 38.33 | 19 | 164.98 |
| Apr | 38.33 | 42 | 161.31 |
| May | 38.33 | 65 | 134.64 |
| Jun | 38.33 | 78 | 94.97 |
| Jul | 38.33 | 79 | 54.3 |
| Aug | 38.33 | 71 | 21.63 |
| Sep | 38.33 | 60 | -0.04 |
| TOTAL | 460 | 460 | |

In this case, demand is proportioned using the Ripley Pacific distribution in Appendix TM 5-A, but adjusted to the nominal rate of 2 feet per year (which means we are talking about 230 acres of ag land to cover the demand listed above). For example, in April, the listed demand in Appendix TM 5-A is 3.70 inches (0.308 ft), which is 9.05 percent of the total annual demand of 40.9 inches. The corresponding water demand in April (adjusted to 2 ft/yr) would be 0.181 feet (2ft * 0.0905), and over 230 acres, the demand in April would be 41.6 acre-feet. Note that no water is applied from December through February, which is why the maximum storage requirement of 165 acre-feet in March is almost as much as the spray fields needs, even though the ag disposal capacity is less than half of the spray fields. The storage requirements for spray fields and ag reuse are redundant, such that only the greater value (not the sum) is actually needed.

At buildout, if ag reuse is assumed to be 460 AFY, and the balance (996 AFY) in spray fields, the actual required reservoir capacity will decline from 170 AFY to 165 AFY. This is because in the initial flows

(1,120 AFY) analysis, spray fields have the option to take all the flow. If, however, spray fields are needed to take all the flow at buildout, the needed reservoir capacity will go up. With expansion to handle full capacity (on an annual basis), the reservoir storage calculations in AFY are as follows:

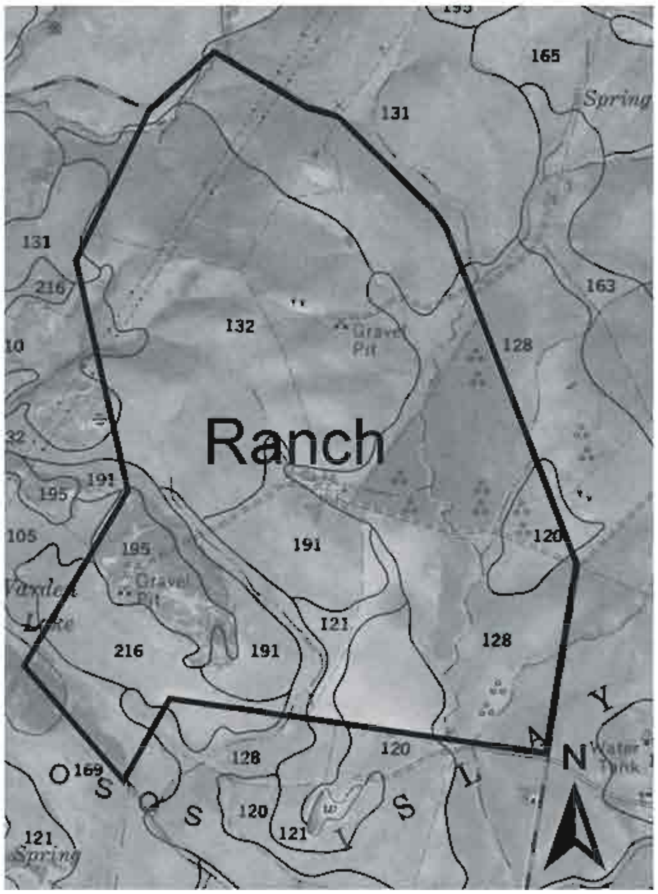
Calculation 3 - Spray Field at 1456 AFY

| | Capacity | Flows | Storage |
|---|---|---|---|
| Oct | 111.3 | 111.8 | 0.5 |
| Nov | 88.8 | 140.4 | 52.1 |
| Dec | 79.22 | 140.4 | 113.28 |
| Jan | 79.85 | 140.4 | 173.83 |
| Feb | 88.38 | 140.4 | 225.85 |
| Mar | 113.58 | 111.8 | 224.07 |
| Apr | 127.94 | 111.8 | 207.93 |
| May | 157.3 | 111.8 | 162.43 |
| Jun | 162.3 | 111.8 | 111.93 |
| Jul | 162.92 | 111.8 | 60.81 |
| Aug | 150.64 | 111.8 | 21.97 |
| Sep | 133.77 | 111.8 | 0 |
| TOTAL | 1456 | 1456 | |

Maximum storage would be 226 acre-feet in February, an increase of **56 acre-feet** over the 170 acre-feet initial requirement. *The disposal memo dated March 13, 2007 incorrectly states that the expansion to buildout would require an increase of 120 acre-feet in storage (total of 290 acre-feet). The 120 acre-feet value was actually the amount of storage required by the spray field for 996 AFY disposal rate at buildout (assuming 460 AFY to ag reuse), and inadvertently got mixed up with the other value.*

*Revise cost items 8 and 9 to reflect expansion to 225 acre-feet, not 290 acre-feet.*

Wet years would limit ET and ag demand, and increase inflow to the reservoir. Once viable projects are identified, a wet year analysis would be warranted. Credit for reservoir evaporation has also not been factored in, which is cumulative from year to year and likely significant. The cumulative reservoir evaporation could offset some or all of the wet year impacts.




Map Source. SCS Soil Survey of San Luis
Obispo County - Coastal Part
September 1984

Map Scale. 1 inch = 2,000 feet

Legend:

128 - Cropley clay
131, 132 - Diablo and Cibo clays
191 - Pismo-Tierra complex
120, 121 - Conception loam
216 - Tierra sandy loam
169 - Marimel sandy clay loam

Figure 1
Soils Map
Tonini Ranch
Los Osos Wastewater Project

Cleath & Associates

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# Memorandum

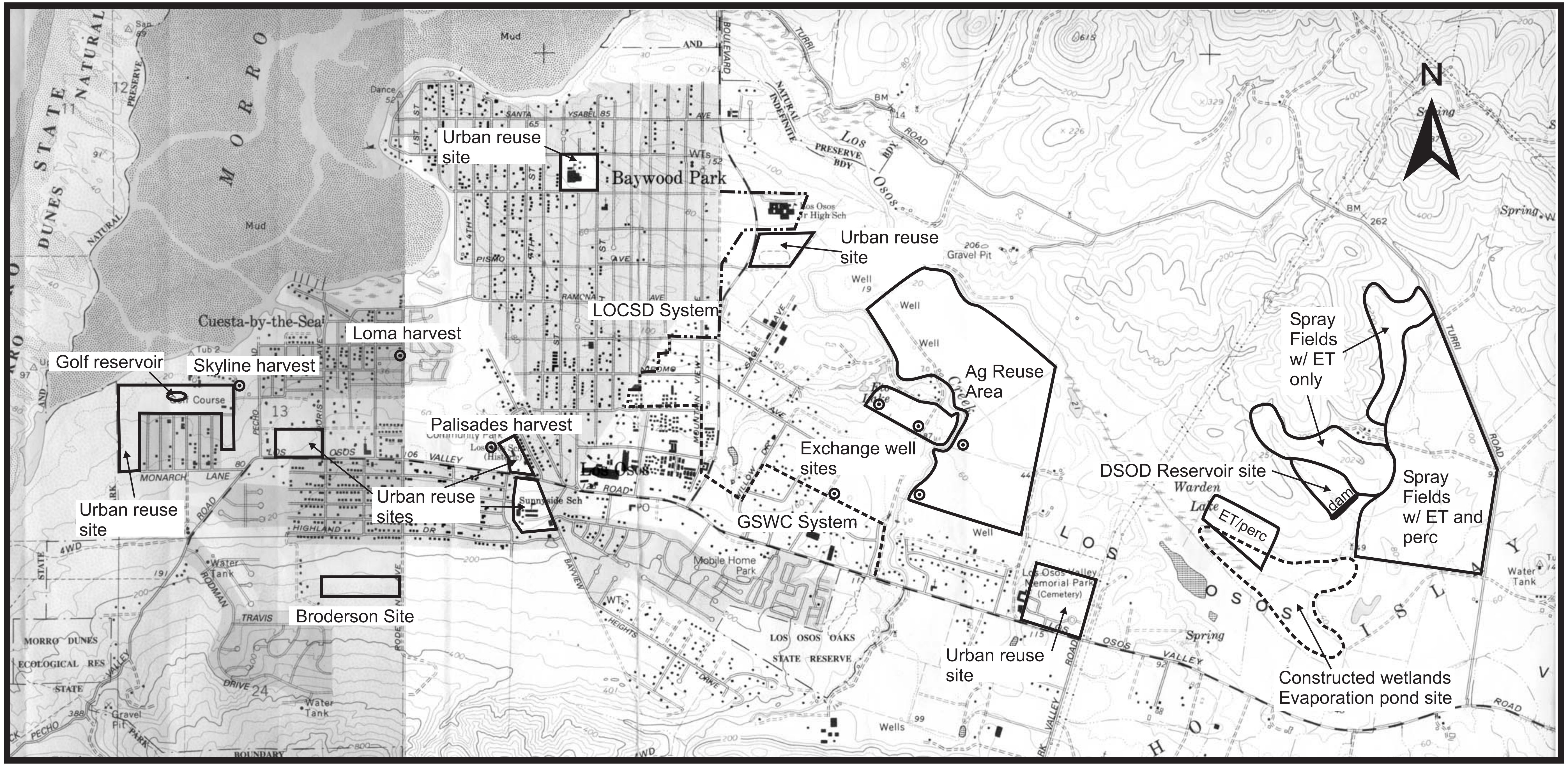
**Date:** February 7, 2008
**From:** Spencer Harris, Cleath & Associates
**To:** Mark Hutchinson, SLO County

**Subject:** **Disposal Options Summary (DRAFT)**

This memo summarizes disposal option parameters that have been requested by the EIR Team for use in upcoming discussions. Two figures are attached.

**Fine Screening Disposal Options:**

| Location | Area for wastewater applications | Disposal Capacity | Slope |
|---|---|---|---|
| Spray Fields - Tonini Ranch | | | |
| w/ET and percolation | 190 acres | 910 AFY | 0-10% |
| ET only | 80 acres | 240 AFY | <25% |
| Constructed terminal wetlands (ET) | 60 acres | 180 AFY | flat |
| Ag reuse areas (irrigation): | | | |
| west of Los Osos Creek | 20 acres | 40 AFY | flat |
| east of Los Osos Creek | 210 acres | 420 AFY | flat |
| Urban reuse sites (irrigation): | | | |
| Cemetery | 20 acres | 50 AFY | flat |
| Los Osos Middle School | 10 acres | 25 AFY | flat |
| Baywood Elementary | 3 acres | 7 AFY | flat |
| Sunnyside Elementary | 2 acres | 5 AFY | flat |
| Monarch Grove Elementary | 2 acres | 5 AFY | flat |
| South Bay Community Center | 2 acres | 5 AFY | flat |
| Sea Pines Golf (portion only) | 7 acres | 16 AFY | <10% |
| Broderson site (high-rate percolation): | | | |
| with harvest well pumping | 7 acres | 896 AFY | <10% |
| without harvest well pumping | 7 acres | 448 AFY | <10% |




Base Map: USGS topographic map: Morro Bay South, revised 1994
Base Map Scale: 1 inch = 2000 feet

DRAFT FOR DISCUSSION ONLY
FEBRUARY 2008

Figure 1A
Disposal Options (Topo Base)
Los Osos Wastewater Project
San Luis Obispo County

Cleath & Associates


Base Map: Orthophotograph from County Archives, August 1999
Base Map Scale: 1 inch = 2000 feet

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FEBRUARY 2008

Figure 1B
Disposal Options (Aerial Base)
Los Osos Wastewater Project
San Luis Obispo County

Cleath & Associates

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## Memorandum

**Date:** June 4, 2008
**From:** Spencer Harris, Cleath & Associates
**To:** County Staff, LOWWP Consultants

**Subject:** **Tonini Site Reconnaissance**

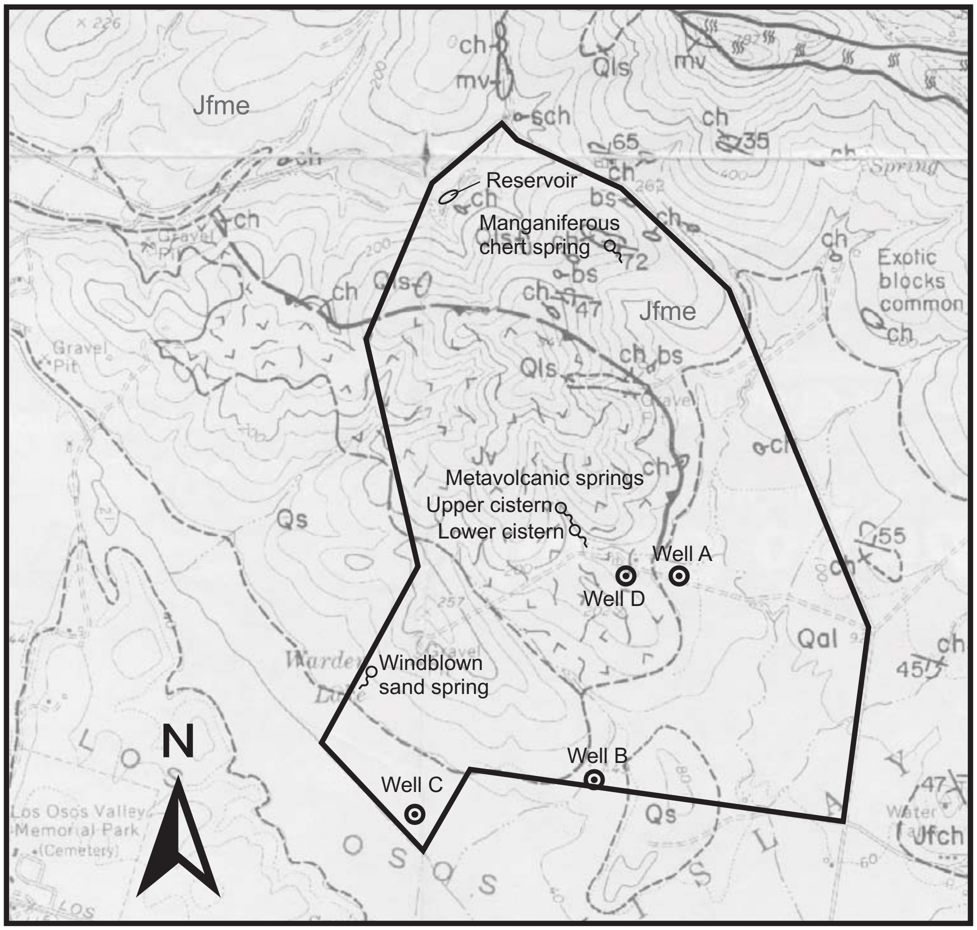
This memorandum presents information gathered during hydrogeologic site reconnaissance at Tonini Ranch on May 20, 2008. Photographs of selected features and laboratory analytical results of water samples are attached.

### Water Well/Spring Locations

Four wells were found on the property. Three of the wells were equipped and operational. The fourth well (Well D) was disconnected and out of service, although the adjacent pressure tank had been reconnected to another source, presumably Well A. Four springs were found in the property, three of which had been developed for stock water. The approximate locations of these features are given in Table 1 and Figure 1.

**Table 1**
**Approximate Well and Spring Coordinates**
**Tonini Ranch**

| Well/Spring ID | Latitude | Longitude | Elevation |
|---|---|---|---|
| Well A (entry road): | N 35$^{O}$ 18' 48.5" | W 120$^{O}$ 46' 53.3" | 109 ft. |
| Well B (south property line) | N 35$^{O}$ 18' 27.5" | W 120$^{O}$ 47' 03.8" | 49 ft. |
| Well C (Warden Lake area) | N 35$^{O}$ 18' 24.2" | W 120$^{O}$ 47' 26.8" | 23 ft. |
| Well D (barn well) | N 35$^{O}$ 18' 48.7" | W 120$^{O}$ 46' 58.8" | 150 ft. |
| Upper cistern metavolcanics spring | N 35$^{O}$ 18' 55.9" | W 120$^{O}$ 47' 07.9" | 225 ft. |
| Lower cistern metavolcanics spring | N 35$^{O}$ 18' 53.4" | W 120$^{O}$ 47' 05.9" | 190 ft. |
| Manganiferous chert spring | N 35$^{O}$ 19' 21.9" | W 120$^{O}$ 46' 59.4" | 355 ft. |
| Windblown sand spring | N 35$^{O}$ 18' 39.8" | W 120$^{O}$ 47' 31.1" | 80 ft. |




Geology: C.A. Hall, 1973, Geologic Map of the Morro Bay
South and Port San Luis Quadrangles

Map Scale: 1 inch = 2000 feet

Legend

Well
Spring

Qal - alluvial deposits
Qs - sand dune deposits, including older stabilized dune deposits. Portions possibly Paso Robles Fm.
Qls - landslide deposits
Jv - Franciscan Fm. metavolcanics
Jfme - Franciscan Fm. Mélange with ch (chert), mv (metavolcanics) and bs (blue schist)

Figure 1

Tonini Geology
and Water Features
Los Osos Wastewater Project

Cleath & Associates

## Well Information

Three of the water wells were sampled for general mineral analyses (attached). Some construction information was available on these wells from in-house files. The available wells information is summarized in Table 2.

**Table 2**
**Well Information**
**Tonini Ranch**

| Well ID | Casing Diameter | Perforations (depth in ft) | Depth to Water (ft) | Air Lift (gpm) | Temp (F) | Field EC (µmhos/cm) | Discharge Pipe Diameter |
|---|---|---|---|---|---|---|---|
| Well A | 8" PVC | 20-60 | 19.5 | 75 | 67.8 | 830 | 2.5" |
| Well B | 6" PVC | 35-65 | 7.1 | 50 | -- | -- | 2.5" |
| Well C | 8" PVC | 35-95 | 7.5 | 150+ | 63.3 | 1086 | 3" |
| Well D | -- | -- | 42 | -- | -- | -- | -- |

Notes: Depth to water measured 5/20/08
Air lift gpm is from initial driller reports which are typically greater than pump discharge rates
ft = feet; gpm = gallons per minute; F = Fahrenheit
µmhos/cm = micromhos per centimeter

## Metavolcanics Springs

Two springs issuing from Franciscan Formation metavolcanics have been developed into rock-lined cisterns along the drainage channel northwest of the ranch compound. Flow from a one-inch diameter pipe leading from the upper cistern was measured at 80 seconds for one quart (0.2 gpm) with a temperature of 65.5$^{O}$ Fahrenheit (F) and a field electrical conductivity (EC) of 545 micromhos per centimeter (µmhos/cm). The upper cistern flow was sampled for analytical testing. The lower cistern is connected to a stock water trough. Water from the lower cistern measured 68$^{O}$ F with a field EC of 581 µmhos/cm.

**Manganiferous Chert Spring**

A spring draining manganese-bearing chert was visited at a relatively high elevation on the property. The spring is located inside a small rock hollow, where a cement dam pools the flow, which is then connected to a nearby stock water trough. The spring water was $66.5^{O}$ F, with a field EC of 280 µmhos/cm. The manganiferous chert zone extends to a lower elevation on the property where it has been mined.

**Windblown Sand Spring Zone**

A linear exposure of spring seeps was observed mid-slope in the area of stabilized sand dune deposits on the southern portion of the property. One of the seeps had pooled in a small depression, where water temperature was $70^{O}$ F with a field EC of 574 µmhos/cm. The spring zone extends onto the adjacent property to the west. An impermeable layer such as bedrock is interpreted to be present at a relatively shallow depth beneath the spring zone, causing water within the dune sands to surface along the slope.

**Other Information**

The drillers log for the entry road well indicates alluvial deposits in that area (between Turri Road and the ranch compound) are close to 20 feet thick, underlain by another 20 feet of weathered bedrock, and then hard bedrock. The alluvium increases in thickness to the south, toward the Los Osos Valley. Field notes from drilling in the late 1980's indicates the on-site alluvial deposits reach depths of approximately 50-70 feet in the Warden Lake area. Ground water wells produce water from both the alluvium and underlying fractured/weathered bedrock.

A small reservoir is located on the property in a drainage along the northern property boundary. This reservoir is fed by runoff supplemented by spring flow. The reservoir and nearby spring(s) were not visited during site reconnaissance.

There are two gravel pit symbols on the U.S.G.S. topographic map for the ranch. The pit shown on an east-facing slope in the northeast portion of the property is an inactive manganese mine which is cut into the manganiferous chert body. The pit shown on a southwest-facing slope near the Warden Lake area was probably used as a source of sand. The area is now vegetated with some topographic depressions that may have been former excavations.

Peas are being grown on the ranch using drip irrigation. Cattle were grazing on areas of the ranch near Warden Lake during the site inspection. Nothing was observed from a hydrogeologic perspective that would preclude using portions of the site for spray fields as identified in previous work.

Attachments:

Photographs from site visit on May 20, 2008
Water quality results

# Tonini Ranch Wells

Image 1: Well A (Entry road)

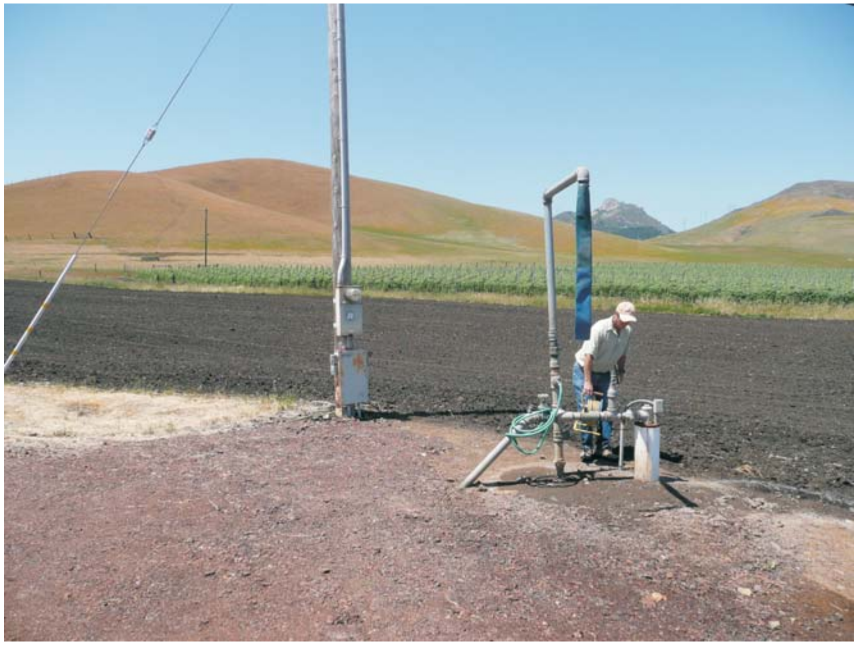


Image 2: Well B (Southern property line)


Image 3: Well C (Warden Lake)


Image 4: Well D (Old barn)

# Tonini Ranch Springs and Mine

Image 5: Metavolcanics springs

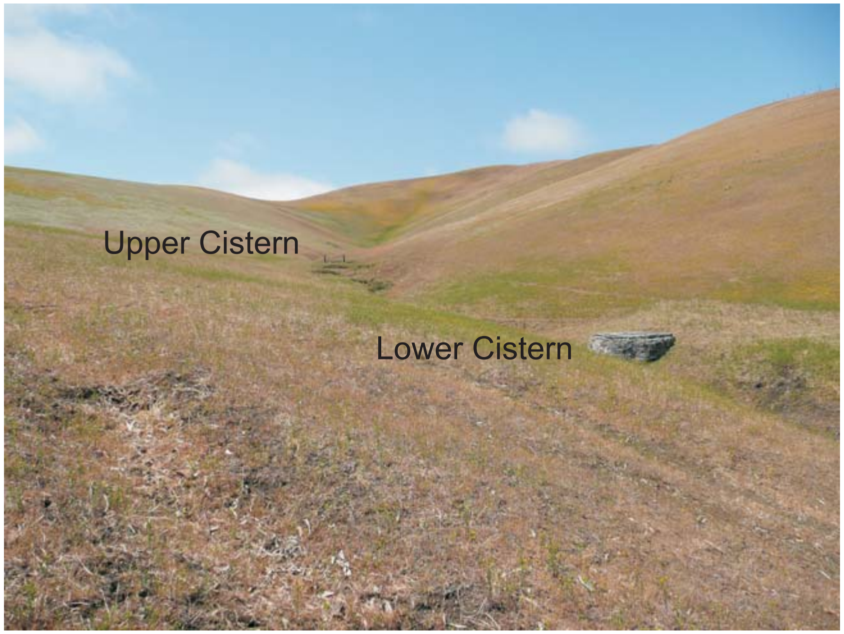
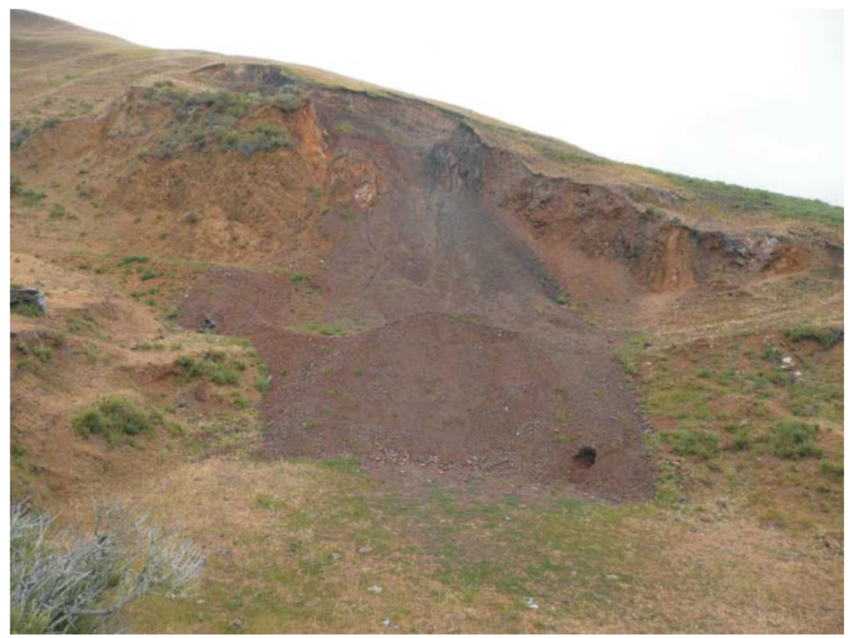



Image 6: Manganiferous chert spring

Image 7: Windblown sand spring

Image 8: Manganese open pit mine (in chert)



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1390 Oceanaire Drive
San Luis Obispo, CA 93405

Log Number: 08-C7078
Order: P2638
Project: Los Osos Wastewater Project
Received: 05/21/08
Printed: 06/02/08

## REPORT OF ANALYTICAL RESULTS

| Sample Description | Sampled By | Sampled Date @ Time | Matrix |
|---|---|---|---|
| Tonini Well A | S. Harris | 05/20/08@14:10 | Drinking Water |

| Analyte | Result | DLR | Dilution Factor | Units | Method | Date Analyzed | Date Prepared | Batch |
|---|---|---|---|---|---|---|---|---|
| Total Alkalinity as CaCO3 | 200 | 2 | 1 | mg/L | SM 2320B | 06/02/08 | | 8079 |
| Chloride | 100 | 10 | 10 | mg/L | EPA 300.0 | 05/24/08 | | 7868 |
| Electrical Conductance | 850 | 1 | 1 | umhos/cm | SM 2510 B | 05/21/08 | | 7847 |
| Nitrate as N | 8.4 | 0.1 | 1 | mg/L | EPA 300.0 | 05/21/08 | | 7701 |
| Nitrate as NO3 | 37 | 0.4 | 1 | mg/L | EPA 300.0 | | | |
| pH | 7.5 | 0.1 | 1 | pH units | SM 4500-H B | 05/21/08 | | 7847 |
| Sulfate | 39 | 0.5 | 1 | mg/L | EPA 300.0 | 05/21/08 | | 7701 |
| Total Dissolved Solids | 490 | 10 | 1 | mg/L | SM 2540C | 05/23/08 | | 7907 |
| Boron | 0.21 | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Calcium | 63 | 0.03 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Hardness as CaCO3 | 310 | 1 | NA | mg/L | EPA 200.7 | | | |
| Sodium Adsorption Ratio (SAR) | 2.5 | 0.1 | 1 | | EPA 200.7 | 05/27/08 | | 7887 |
| Copper | Not Detected | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Iron | 0.13 | 0.02 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Potassium | 0.6 | 0.1 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Magnesium | 37 | 0.03 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Manganese | Not Detected | 0.02 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Sodium | 99 | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Zinc | Not Detected | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

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Lab Director, Michael Ng

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Log Number: 08-C7079
Order: P2638
Project: Los Osos Wastewater Project
Received: 05/21/08
Printed: 06/02/08

## REPORT OF ANALYTICAL RESULTS

| Sample Description | Sampled By | Sampled Date @ Time | Matrix |
|---|---|---|---|
| Tonini Spring | S. Harris | 05/20/08@14:34 | Drinking Water |

| Analyte | Result | DLR | Dilution Factor | Units | Method | Date Analyzed | Date Prepared | Batch |
|---|---|---|---|---|---|---|---|---|
| Total Alkalinity as CaCO3 | 190 | 2 | 1 | mg/L | SM 2320B | 06/02/08 | | 8079 |
| Chloride | 41 | 1 | 1 | mg/L | EPA 300.0 | 05/21/08 | | 7701 |
| Electrical Conductance | 560 | 1 | 1 | umhos/cm | SM 2510 B | 05/21/08 | | 7847 |
| Nitrate as N | 3.5 | 0.1 | 1 | mg/L | EPA 300.0 | 05/21/08 | | 7701 |
| Nitrate as NO3 | 15 | 0.4 | 1 | mg/L | EPA 300.0 | | | |
| pH | 7.7 | 0.1 | 1 | pH units | SM 4500-H B | 05/21/08 | | 7847 |
| Sulfate | 15 | 0.5 | 1 | mg/L | EPA 300.0 | 05/21/08 | | 7701 |
| Total Dissolved Solids | 320 | 10 | 1 | mg/L | SM 2540C | 05/23/08 | | 7907 |
| Boron | 0.07 | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Calcium | 43 | 0.03 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Hardness as CaCO3 | 170 | 1 | NA | mg/L | EPA 200.7 | | | |
| Sodium Adsorption Ratio (SAR) | 2.1 | 0.1 | 1 | | EPA 200.7 | 05/27/08 | | 7887 |
| Copper | Not Detected | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Iron | 0.02 | 0.02 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Potassium | 1.4 | 0.1 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Magnesium | 15 | 0.03 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Manganese | 0.48 | 0.02 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Sodium | 62 | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Zinc | Not Detected | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

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Log Number: 08-C7080
Order: P2638
Project: Los Osos Wastewater Project
Received: 05/21/08
Printed: 06/02/08

## REPORT OF ANALYTICAL RESULTS

| Sample Description | Sampled By | Sampled Date @ Time | Matrix |
|---|---|---|---|
| Tonini Well B | S. Harris | 05/20/08@14:55 | Drinking Water |

| Analyte | Result | DLR | Dilution Factor | Units | Method | Date Analyzed | Date Prepared | Batch |
|---|---|---|---|---|---|---|---|---|
| Total Alkalinity as CaCO3 | 140 | 2 | 1 | mg/L | SM 2320B | 06/02/08 | | 8079 |
| Chloride | 230 | 10 | 10 | mg/L | EPA 300.0 | 05/24/08 | | 7868 |
| Electrical Conductance | 1,100 | 1 | 1 | umhos/cm | SM 2510 B | 05/21/08 | | 7847 |
| Nitrate as N | 6.6 | 0.1 | 1 | mg/L | EPA 300.0 | 05/21/08 | | 7701 |
| Nitrate as NO3 | 29 | 0.4 | 1 | mg/L | EPA 300.0 | | | |
| pH | 7.0 | 0.1 | 1 | pH units | SM 4500-H B | 05/21/08 | | 7847 |
| Sulfate | 24 | 0.5 | 1 | mg/L | EPA 300.0 | 05/21/08 | | 7701 |
| Total Dissolved Solids | 660 | 10 | 1 | mg/L | SM 2540C | 05/23/08 | | 7907 |
| Boron | 0.20 | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Calcium | 61 | 0.03 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Hardness as CaCO3 | 300 | 1 | NA | mg/L | EPA 200.7 | | | |
| Sodium Adsorption Ratio (SAR) | 2.4 | 0.1 | 1 | | EPA 200.7 | 05/27/08 | | 7887 |
| Copper | Not Detected | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Iron | 0.12 | 0.02 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Potassium | 0.6 | 0.1 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Magnesium | 35 | 0.03 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Manganese | Not Detected | 0.02 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Sodium | 94 | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Zinc | Not Detected | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

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Log Number: 08-C7081
Order: P2638
Project: Los Osos Wastewater Project
Received: 05/21/08
Printed: 06/02/08

## REPORT OF ANALYTICAL RESULTS

| Sample Description | Sampled By | Sampled Date @ Time | Matrix |
|---|---|---|---|
| Tonini Well C | S. Harris | 05/20/08@15:48 | Drinking Water |

| Analyte | Result | DLR | Dilution Factor | Units | Method | Date Analyzed | Date Prepared | Batch |
|---|---|---|---|---|---|---|---|---|
| Total Alkalinity as CaCO3 | 130 | 2 | 1 | mg/L | SM 2320B | 06/02/08 | | 8079 |
| Chloride | 230 | 10 | 10 | mg/L | EPA 300.0 | 05/24/08 | | 7868 |
| Electrical Conductance | 1,100 | 1 | 1 | umhos/cm | SM 2510 B | 05/21/08 | | 7847 |
| Nitrate as N | 6.6 | 0.1 | 1 | mg/L | EPA 300.0 | 05/21/08 | | 7701 |
| Nitrate as NO3 | 29 | 0.4 | 1 | mg/L | EPA 300.0 | | | |
| pH | 7.0 | 0.1 | 1 | pH units | SM 4500-H B | 05/21/08 | | 7847 |
| Sulfate | 24 | 0.5 | 1 | mg/L | EPA 300.0 | 05/21/08 | | 7701 |
| Total Dissolved Solids | 670 | 10 | 1 | mg/L | SM 2540C | 05/23/08 | | 7907 |
| Boron | 0.20 | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Calcium | 58 | 0.03 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Hardness as CaCO3 | 280 | 1 | NA | mg/L | EPA 200.7 | | | |
| Sodium Adsorption Ratio (SAR) | 2.5 | 0.1 | 1 | | EPA 200.7 | 05/27/08 | | 7887 |
| Copper | Not Detected | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Iron | 0.16 | 0.02 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Potassium | 1.8 | 0.1 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Magnesium | 34 | 0.03 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Manganese | 0.45 | 0.02 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Sodium | 96 | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |
| Zinc | Not Detected | 0.05 | 1 | mg/L | EPA 200.7 | 05/23/08 | | 7879 |

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

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# APPENDIX C
# GROUNDWATER MODEL
# HYDROGEOLOGIC BUDGET RESULTS

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# Memorandum

**Date:** August 7, 2008
**From:** Spencer Harris, Cleath & Associates
**To:** County staff and LOWWP consultants

**Subject:** **Basin hydrologic budget with simulated ground water elevation contour maps.**

This memorandum presents hydrologic budgets for the Los Osos Valley ground water basin under current conditions and under Los Osos Wastewater Project (LOWWP) viable project alternative (VPA) 2a and 2b. In addition, hydrologic budgets were prepared that isolate specific project components for use in environmental impacts analyses. The hydrologic budgets included in this memorandum and their description are shown in Table 1.

**Table 1**
**Hydrologic Budget Scenario Descriptions**

| Scenario ID | Water Conservation (AFY) | Wastewater Disposal Method (AFY) | | |
|---|---|---|---|---|
| | | Spray Field | Broderson | Ag Reuse |
| Current Conditions | 0 | 0 | 0 | 0 |
| Spray Field | 0 | 1157 | 0 | 0 |
| Conservation | 160 | 997 | 0 | 0 |
| Broderson | 0 | 709 | 448 | 0 |
| Ag Reuse | 0 | 677 | 0 | 480 |
| VPA 2a | 160 | 69 | 448 | 480 |
| VPA 2b | 160 | 549 | 448 | 0 |

Wastewater collection and disposal flows in the model are 1,157 AFY, which was the current condition estimated in 2003. Increasing wastewater flows to match plant design capacity increases spray field disposal in the above scenarios. Wastewater project scenarios were simulated based on current conditions well production to maintain consistency.

Ag reuse (combined with cemetery irrigation) was simulated at 480 AFY, which is slightly less than the sum assigned to wastewater project VPA 2a (460 AFY crop irrigation plus 50 AFY cemetery turf grass irrigation). The estimate for VPA2a was based on a nominal 230 acres of agricultural land at 2 feet of applied irrigation per year and 20 acres of cemetery turf at 2.5 feet of applied irrigation per year. Production assignments in the model are linked to individual fields and cropping patterns. The model production estimates were retained for the simulations, being more detailed and slightly conservative.

Attached to this memo are detailed hydrologic budgets, flow diagrams, and simulated ground water elevation contour maps for the seven scenarios, including a recharge zone map with pertinent accompanying tables from Yates (2003), Simulated Effects of a Proposed Sewer Project on Nitrate Concentrations in the Los Osos Valley Groundwater Basin.

**Status of EFH steady state basin model**

The equivalent freshwater head (EFH) steady-state basin model was used to generate the hydrologic budgets and the accompanying water level contours. Several updates have been made to the model since the 2005 sea water intrusion study. The changes include:

- Revising a portion of the Los Osos creek bed elevations to more closely match the topographic gradient of the stream channel
- Adding of Warden Creek as a drainage channel in the northeast creek valley
- Adding a general head boundary representing leakage from the Bayview Heights area into the upper aquifer.
- Merging the first two layers of the 2005 EFH model into one upper aquifer layer. The separation of the upper aquifer was a carry-over from 2003 solute transport modeling.
- Shifting a portion of purveyor production from the west side lower aquifer inland, and some production to the upper aquifer.

The current and prior model calibration statistics are shown in Table 1 below.

**Table 1**
**Residuals Statistics**

| Parameter | Steady-State (2003) | Steady-State (2004 Update) | Steady-State (2005 EFH) | Steady-State (2008 EFH) |
|---|---|---|---|---|
| Residual Mean | 2.44 feet | 0.03 feet | 0.57 feet | 0.93 feet |
| Residual Standard Deviation | 7.17 feet | 5.61 feet | 5.34 feet | 4.66 feet |
| Absolute Residual Mean | 5.59 feet | 4.42 feet | 4.24 feet | 3.73 feet |
| Ratio of RSD to range | 11.4% | 8.9% | 8.0% | 7.0% |
| Range in head | 63 feet | 63 feet | 67 feet | 67 feet |
| Residual difference <10 feet | 81% | 92% | 92% | 95% |
| Residual difference <20 feet | 100% | 100% | 100% | 100% |

A summary of the scenario hydrologic budgets are shown in Table 2. Attached to this memo are detailed hydrologic budgets, flow diagrams, and simulated upper (Zone C) and lower (Zone D) aquifer ground water elevation contour maps for the seven scenarios, including a recharge zone map with pertinent accompanying tables from Yates (2003), Simulated Effects of a Proposed Sewer Project on Nitrate Concentrations in the Los Osos Valley Groundwater Basin.

**Table 2**
**Hydrologic Budget Summary**
**June 2008**

| Aquifer | Budget Item (Basin IN/OUT) | Current Condition (AFY) | Component-Specific Scenarios (AFY) | | | | Project Scenarios (AFY) | |
|---|---|---|---|---|---|---|---|---|
| | | | Spray Field | Conservation | Broderson | Ag Reuse | VPA 2a | VPA 2b |
| Perched Aquifer | Septic Return (IN) | 631 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Percolation of precipitation/irrigation return (IN) | 736 | 736 | 736 | 736 | 736 | 736 | 736 |
| | Leakage/subsurface outflow to upper aquifer | 698 | 634 | 634 | 634 | 634 | 634 | 634 |
| | Leakage/subsurface outflow to creek compartment | 117 | 103 | 103 | 103 | 103 | 103 | 103 |
| | Willow Creek outflow/evapotranspiration (OUT) | 552 | 35 | 35 | 35 | 35 | 35 | 35 |
| Upper Aquifer | Septic Return (IN) | 606 | 44 | 44 | 44 | 44 | 44 | 44 |
| | Percolation of precipitation/irrigation return (IN) | 1489 | 1489 | 1489 | 1489 | 1489 | 1489 | 1489 |
| | Subsurface inflow from creek compartment | 187 | 255 | 231 | 206 | 219 | 148 | 182 |
| | Subsurface inflow from Bayview Heights (IN) | 112 | 120 | 117 | 109 | 113 | 100 | 107 |
| | Broderson recharge (IN) | 0 | 0 | 0 | 448 | 0 | 448 | 448 |
| | Subsurface outflow to bay/ocean (OUT) | 1310 | 871 | 916 | 1121 | 910 | 1209 | 1169 |
| | Well production (OUT) | 803 | 803 | 803 | 803 | 803 | 803 | 803 |
| | Leakage to lower aquifer | 882 | 771 | 699 | 909 | 689 | 754 | 835 |
| Creek Compartment | Septic Return (IN) | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | Percolation of precipitation/irrigation return (IN) | 430 | 430 | 430 | 430 | 430 | 430 | 430 |
| | Los Osos Creek inflow (IN) | 665 | 714 | 701 | 674 | 524 | 492 | 665 |
| | Subsurface inflow from bedrock (IN) | 167 | 170 | 169 | 167 | 141 | 137 | 166 |
| | Los Osos Creek outflow (OUT) | 77 | 32 | 38 | 52 | 126 | 168 | 60 |
| | Warden drain (OUT) | 6 | 2 | 4 | 6 | 76 | 88 | 9 |
| | Well production (OUT) | 870 | 870 | 870 | 870 | 390 | 390 | 870 |
| | Subsurface flow to Urban Area upper aquifer | 90 | 158 | 134 | 109 | 122 | 51 | 85 |
| | Subsurface flow to Urban Area lower aquifer | 366 | 385 | 387 | 367 | 514 | 495 | 370 |
| Lower Aquifer | Sea water intrusion (IN) | 469 | 561 | 471 | 441 | 514 | 308 | 352 |
| | Well production (OUT) | 1717 | 1717 | 1557 | 1717 | 1717 | 1557 | 1557 |

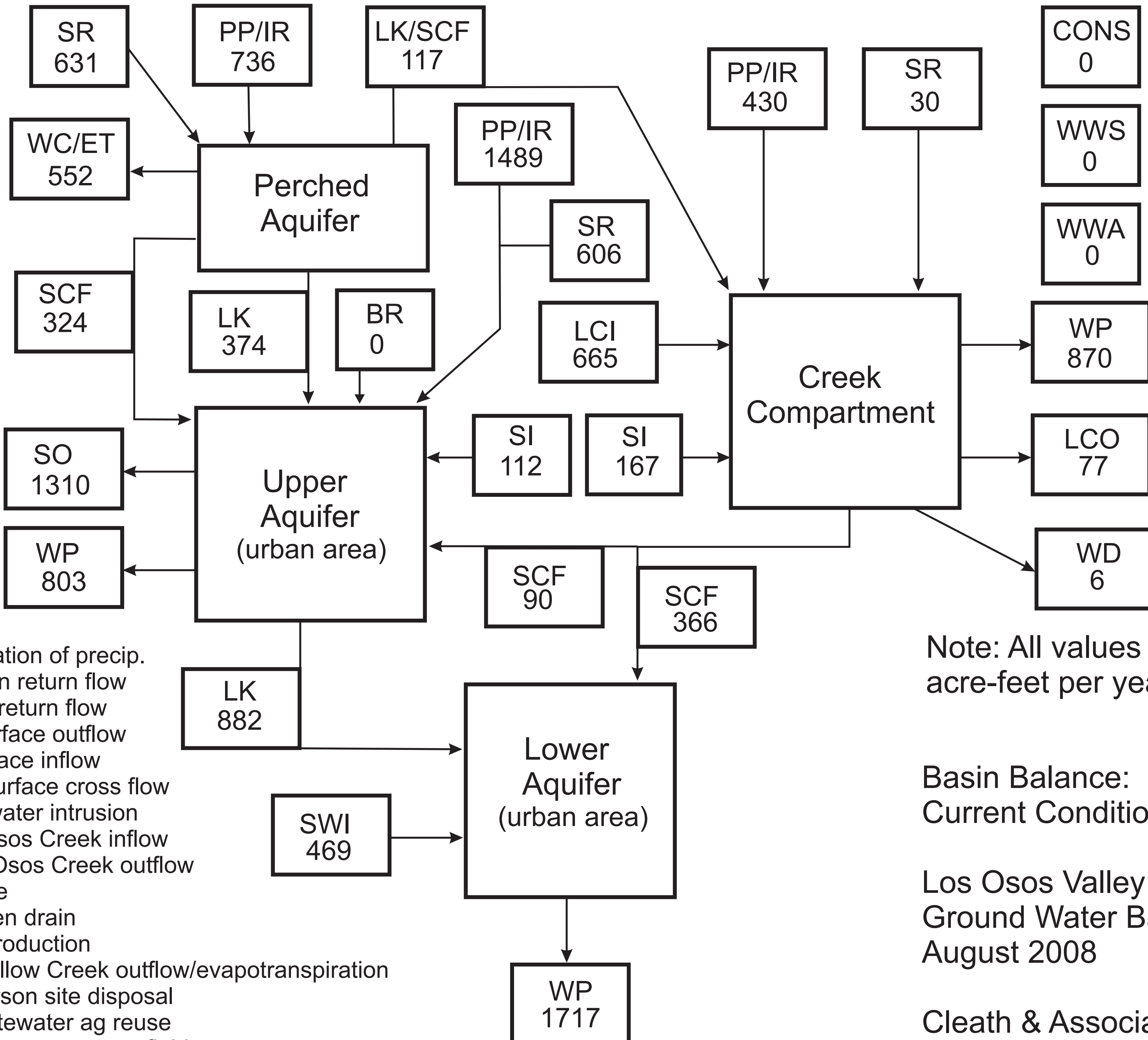
**ATTACHMENTS**

Hydrologic budget flow diagrams
Simulated ground water elevation contour maps
Hydrologic budget details for:

- Current Condition
- Spray Field
- Conservation
- Broderson
- Ag Reuse
- VPA 2a
- VPA 2b

Recharge Zone Map

Table 4 and Table 9 from Yates (2003)




Legend

PP = percolation of precip.
IR = irrigation return flow
SR = septic return flow
SO = subsurface outflow
SI = subsurface inflow
SCF = subsurface cross flow
SWI = sea water intrusion
LCI = Los Osos Creek inflow
LCO = Los Osos Creek outflow
LK = leakage
WD = Warden drain
WP = well production
WC/ET = Willow Creek outflow/evapotranspiration
BR = Broderson site disposal
WWA = wastewater ag reuse
WWS = wastewater spray field
CONS = water conservation

Note: All values in acre-feet per year

Basin Balance: Current Conditions

Los Osos Valley Ground Water Basin
August 2008

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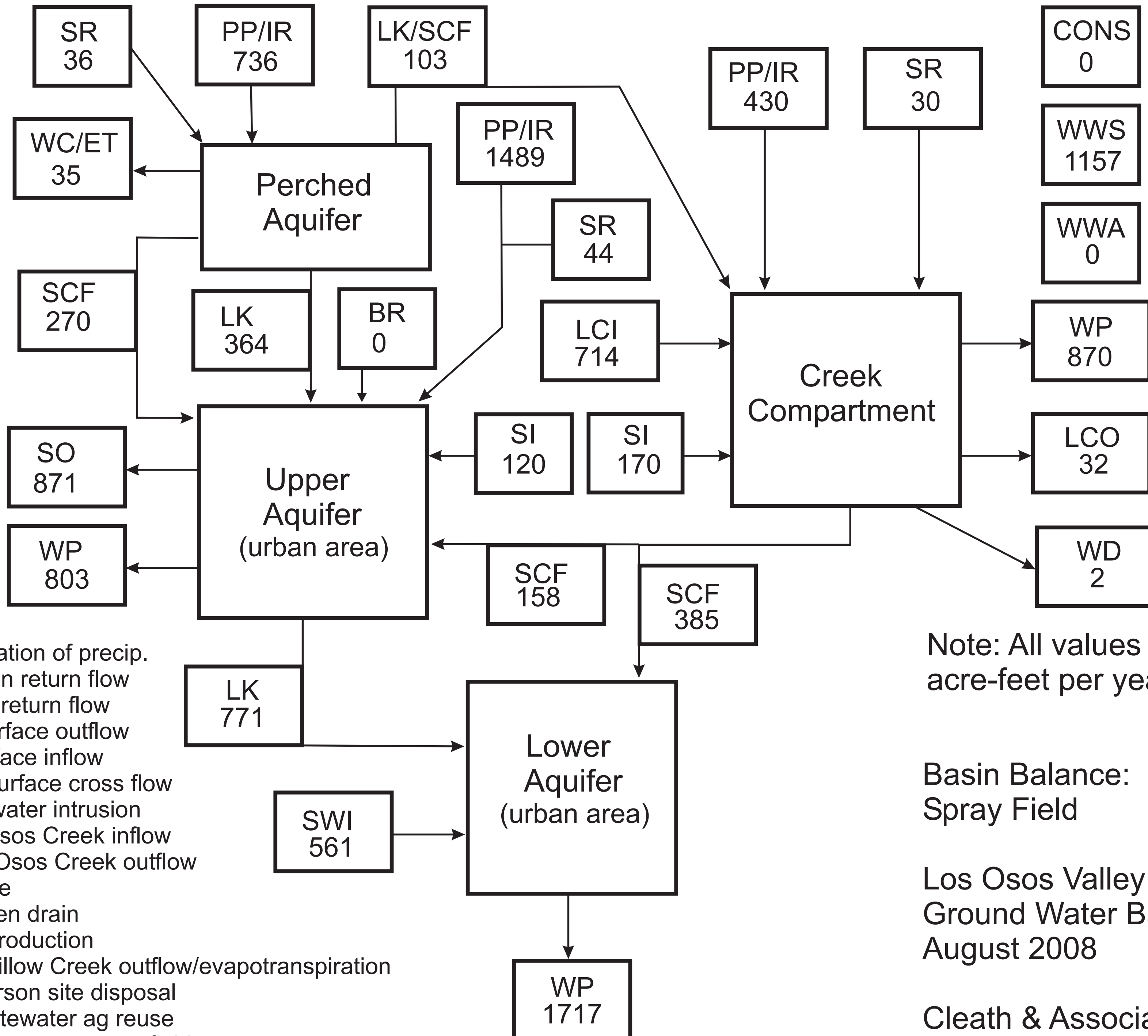


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Basin Balance:
Spray Field

Los Osos Valley
Ground Water Basin
August 2008

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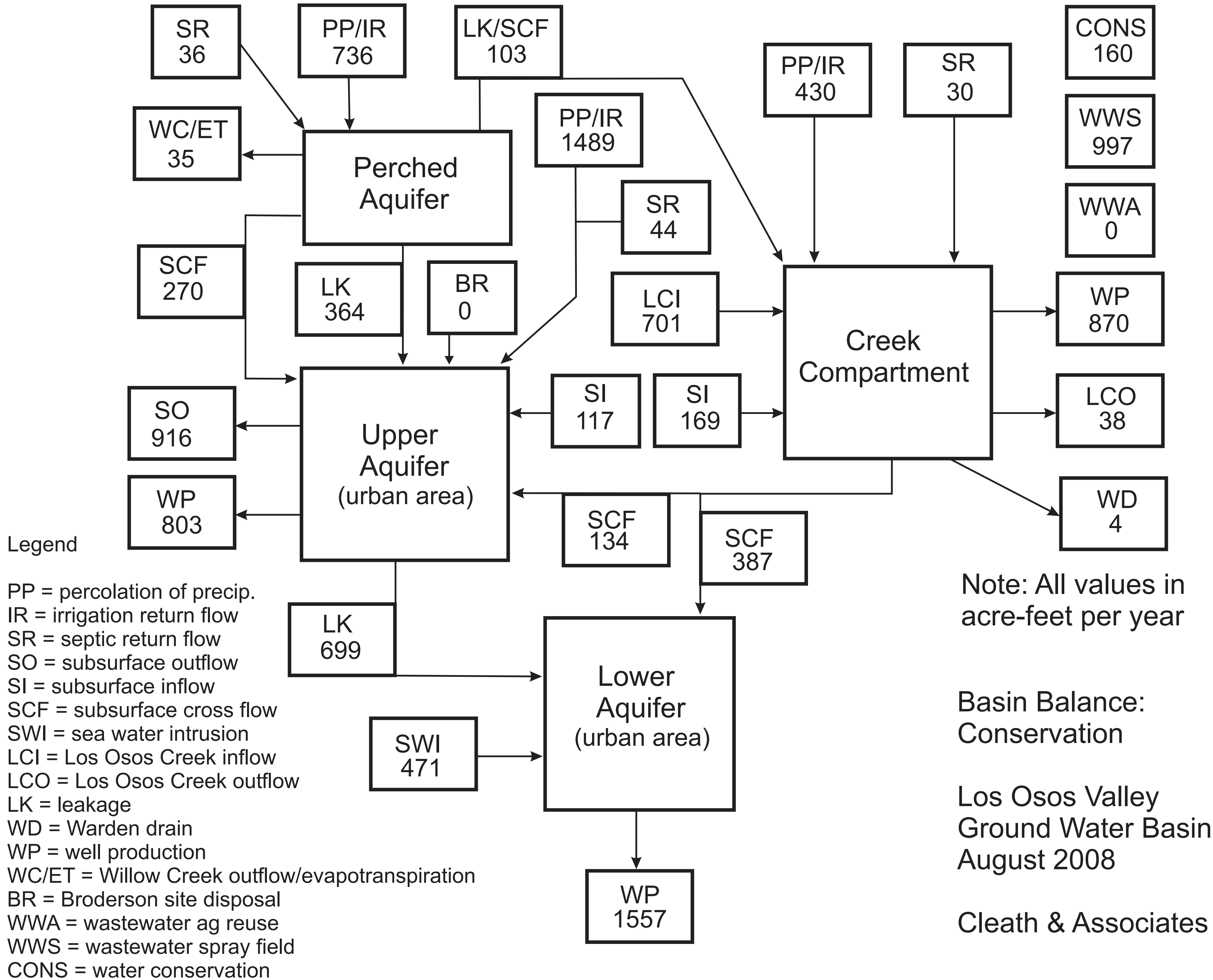
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PP/IR 736
LK/SCF 103
WC/ET 35
Perched Aquifer
SCF 270
LK 364
BR 0
PP/IR 1489
SR 44
LCI 701
PP/IR 430
SR 30
CONS 160
WWS 997
WWA 0
Creek Compartment
WP 870
LCO 38
WD 4
SO 916
WP 803
Upper Aquifer (urban area)
SI 117
SI 169
SCF 134
SCF 387
LK 699
Lower Aquifer (urban area)
SWI 471
WP 1557
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Basin Balance: Conservation
Los Osos Valley Ground Water Basin August 2008
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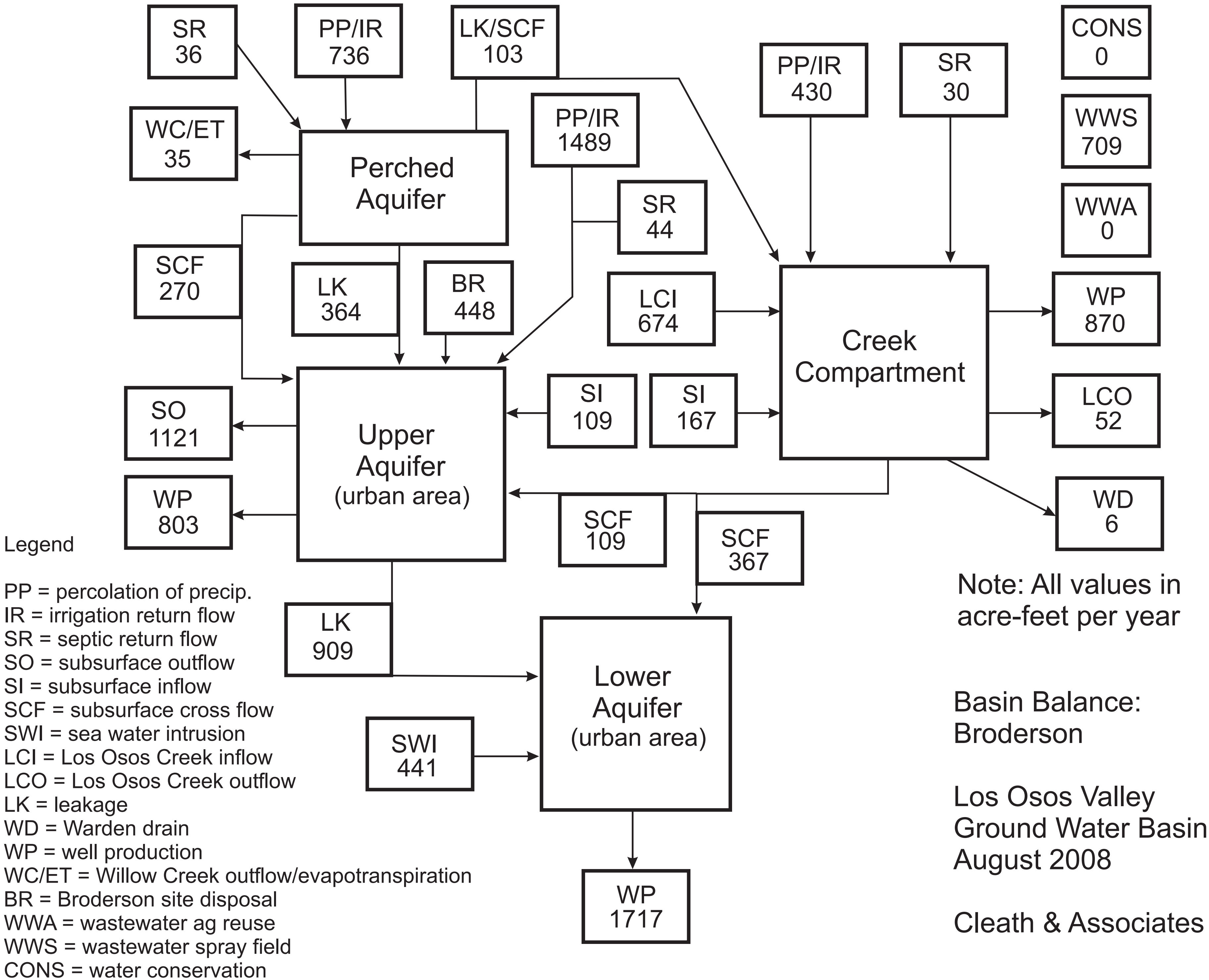
SR 36
PP/IR 736
LK/SCF 103
WC/ET 35
Perched Aquifer
PP/IR 1489
SR 44
PP/IR 430
SR 30
CONS 0
WWS 709
WWA 0
SCF 270
LK 364
BR 448
LCI 674
Creek Compartment
WP 870
Upper Aquifer (urban area)
SO 1121
WP 803
SI 109
SI 167
LCO 52
WD 6
SCF 109
SCF 367
LK 909
Lower Aquifer (urban area)
SWI 441
WP 1717
Legend
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Basin Balance: Broderson
Los Osos Valley Ground Water Basin August 2008
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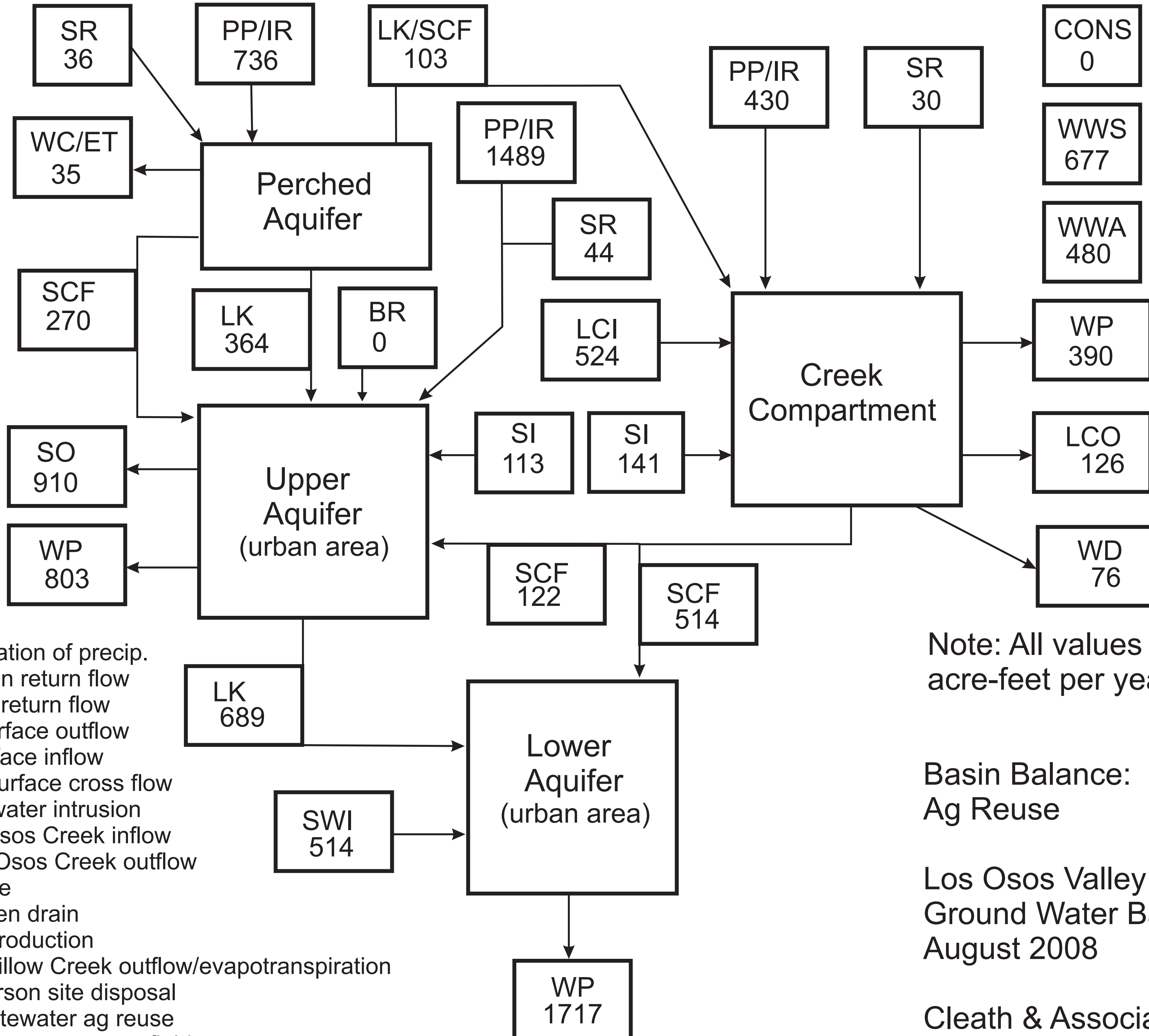


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CONS = water conservation

Note: All values in acre-feet per year

Basin Balance:
Ag Reuse

Los Osos Valley
Ground Water Basin
August 2008

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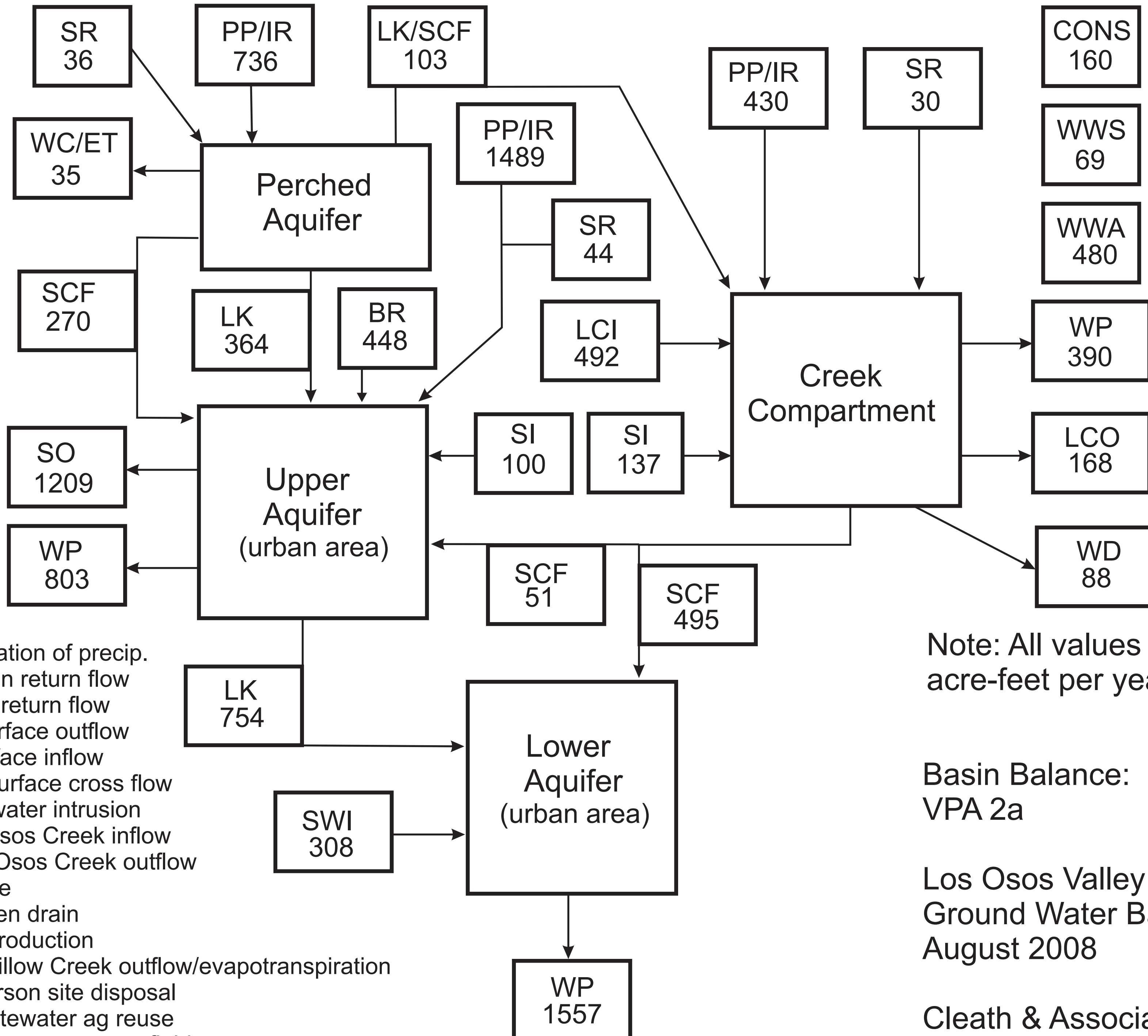


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Note: All values in acre-feet per year

Basin Balance:
VPA 2a

Los Osos Valley
Ground Water Basin
August 2008

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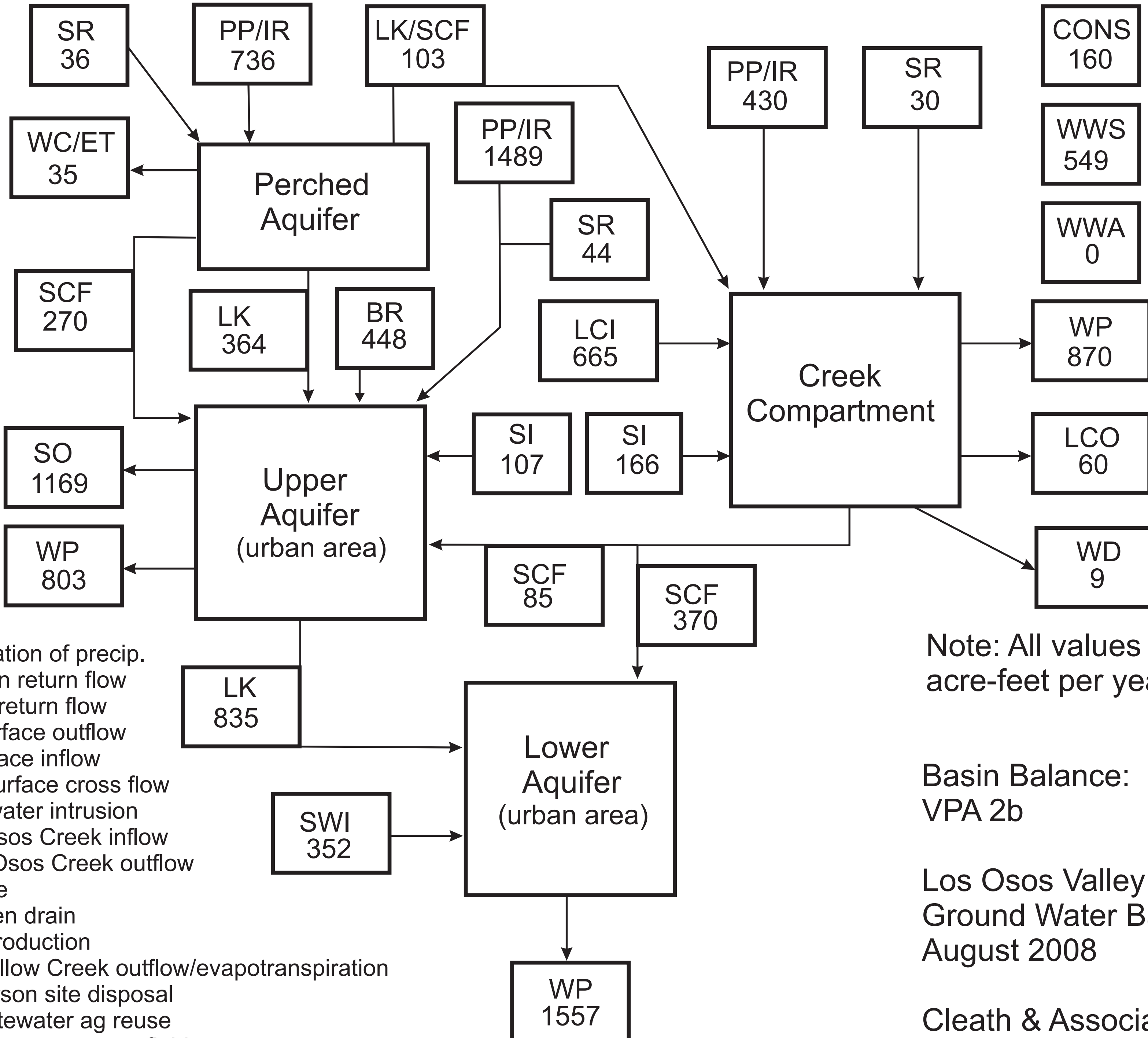


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BR = Broderson site disposal
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WWS = wastewater spray field
CONS = water conservation

Note: All values in acre-feet per year

Basin Balance:
VPA 2b

Los Osos Valley
Ground Water Basin
August 2008

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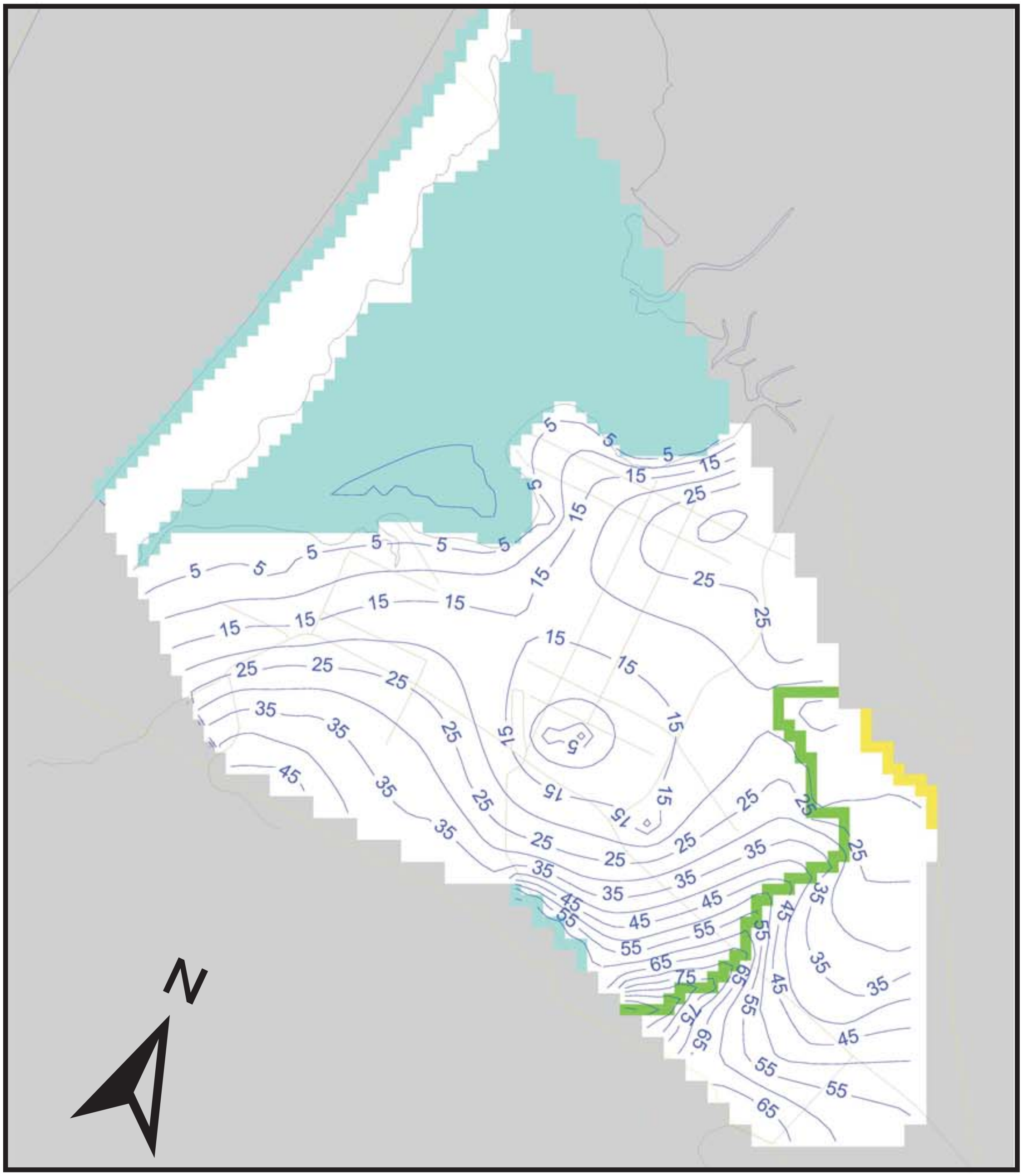


Scale 1" = 4000 feet

Simulated Ground Water Elevations
Upper Aquifer
Current Conditions
June 2008 EFH Model
Los Osos Wastewater Project

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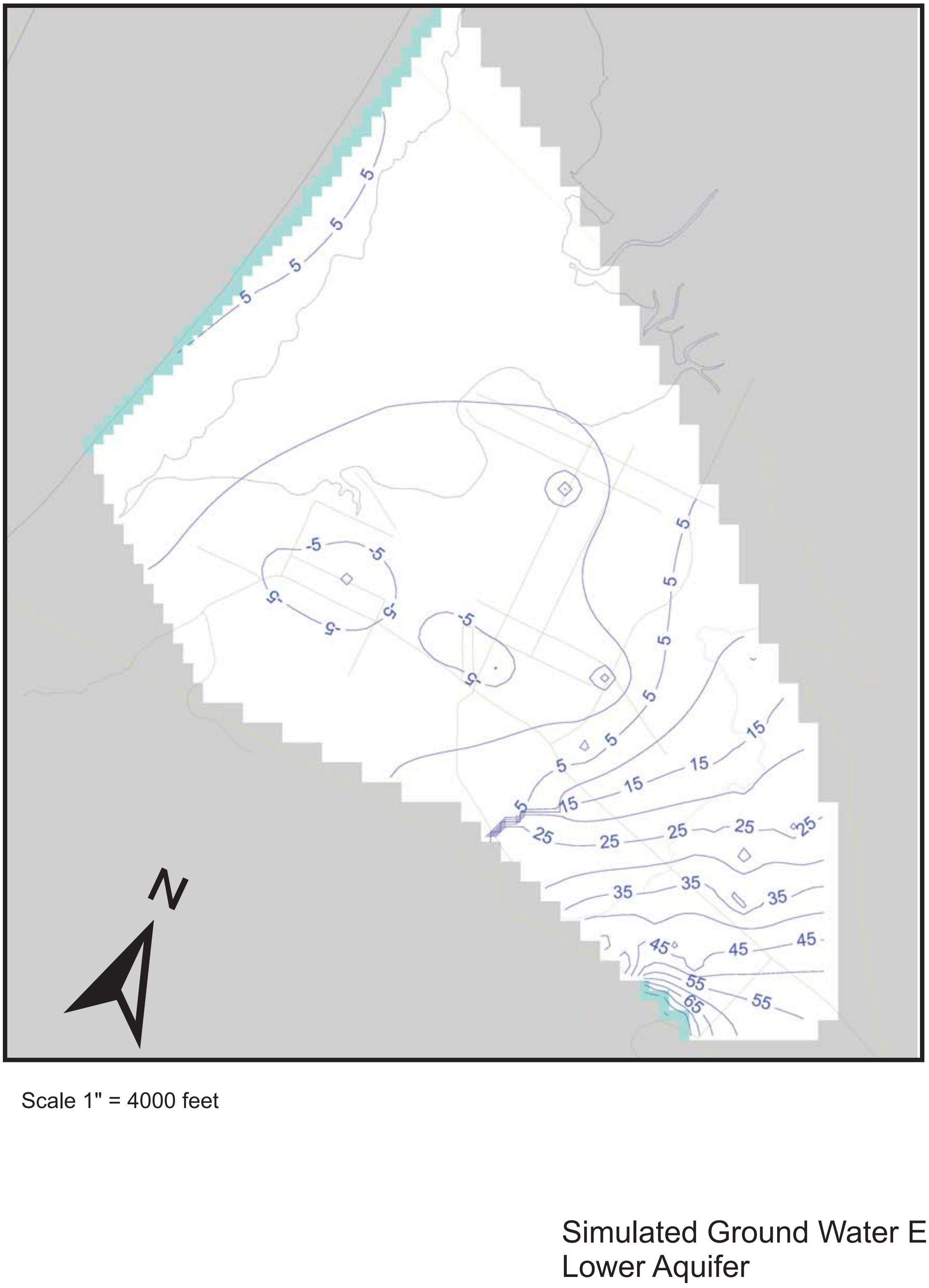


Scale 1" = 4000 feet

Simulated Ground Water Elevations
Lower Aquifer
Current Conditions
June 2008 EFH Model
Los Osos Wastewater Project

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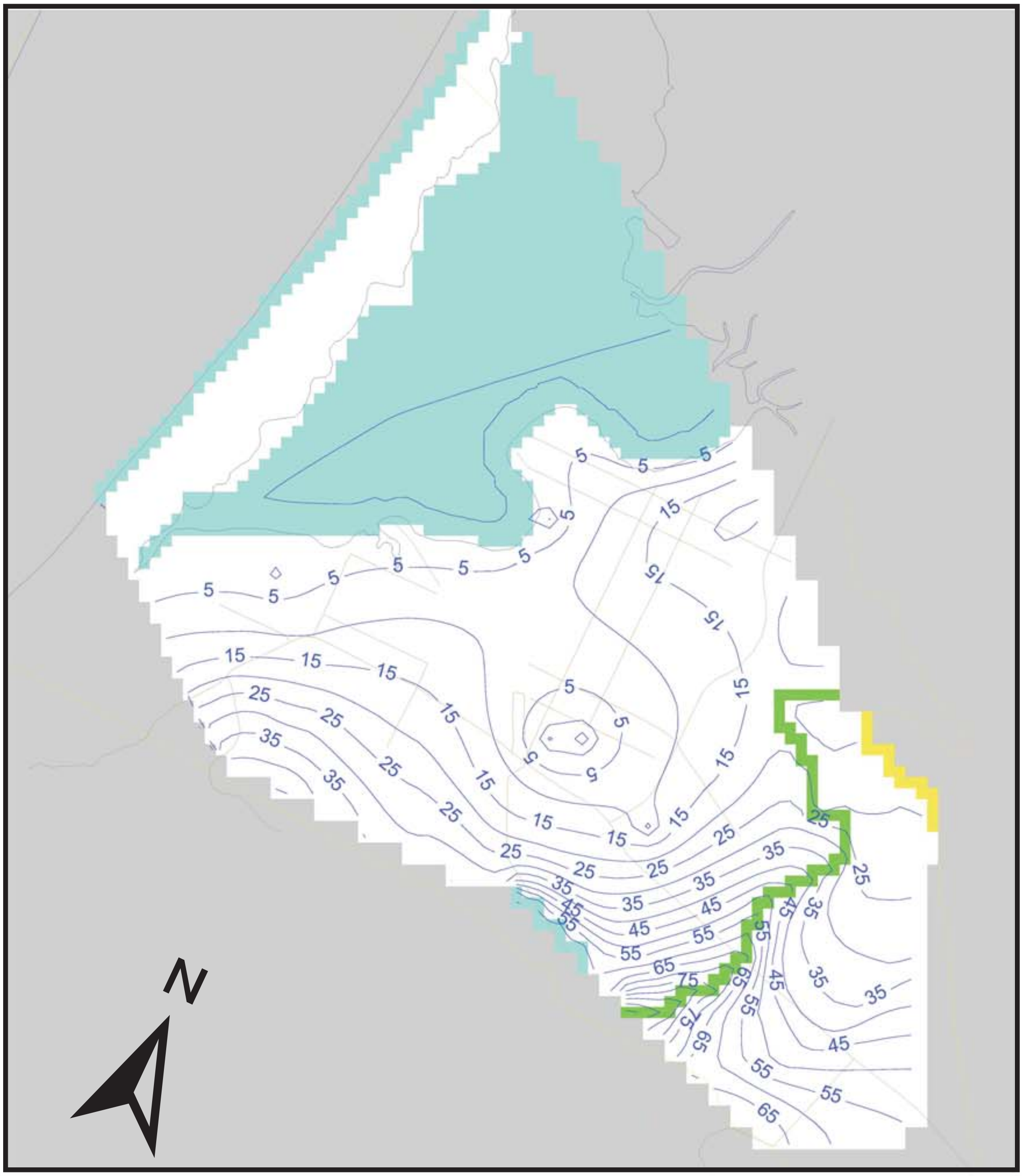
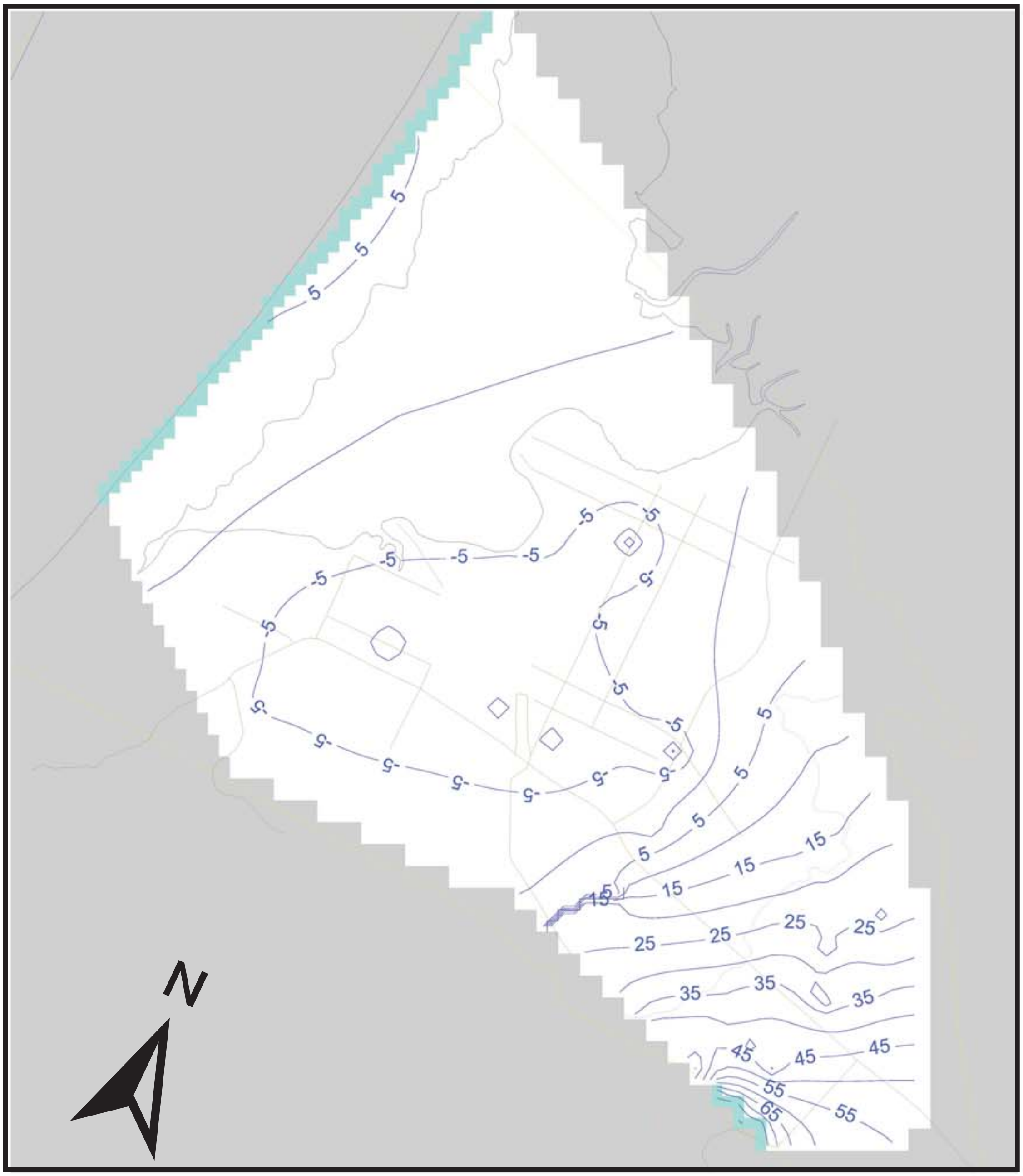



Scale 1" = 4000 feet

Simulated Ground Water Elevations
Upper Aquifer
Spray Field
June 2008 EFH Model
Los Osos Wastewater Project

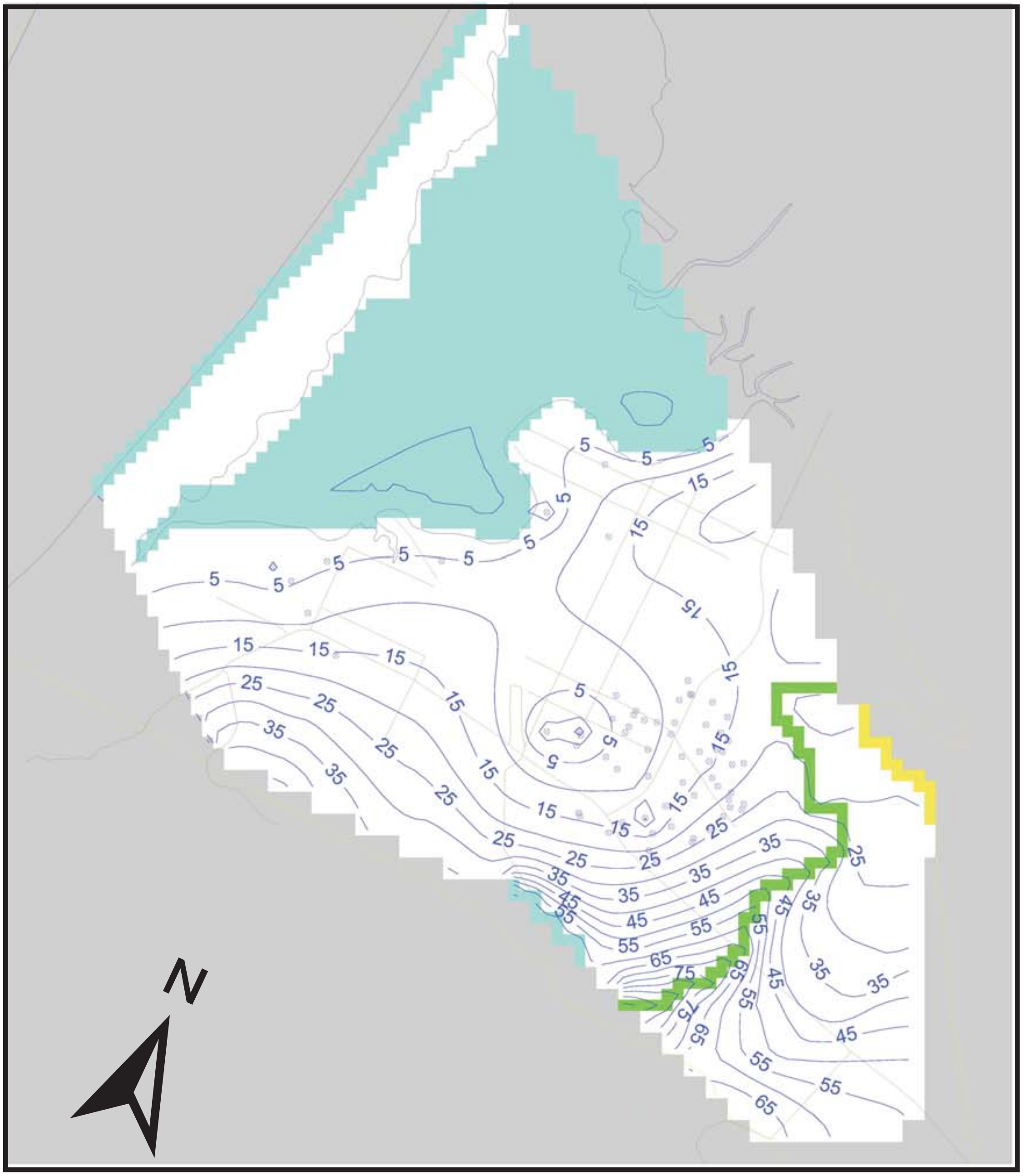
Cleath & Associates




Scale 1" = 4000 feet

Simulated Ground Water Elevations
Lower Aquifer
Spray Field
June 2008 EFH Model
Los Osos Wastewater Project

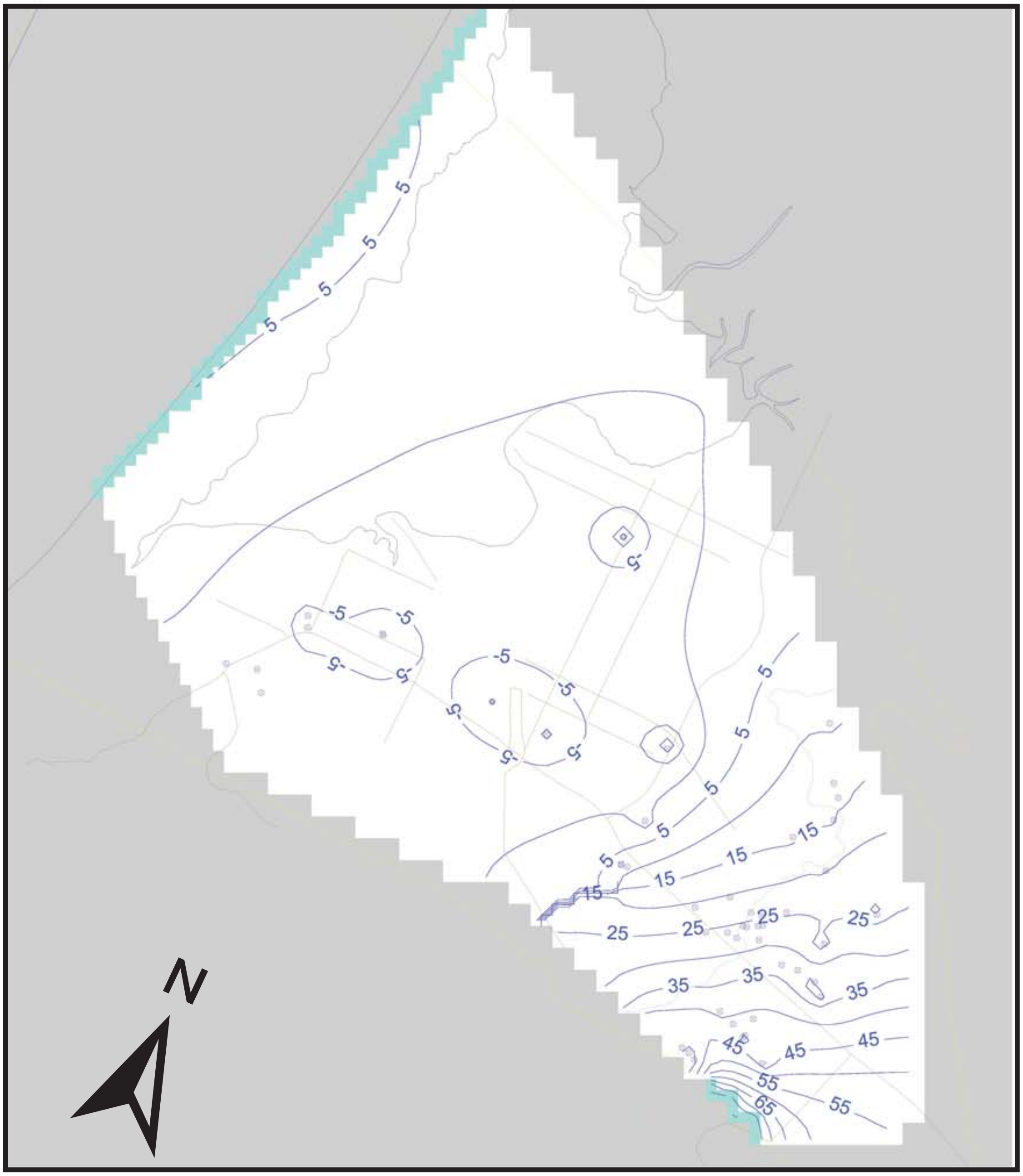
Cleath & Associates




Scale 1" = 4000 feet

Simulated Ground Water Elevations
Upper Aquifer
Conservation
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates

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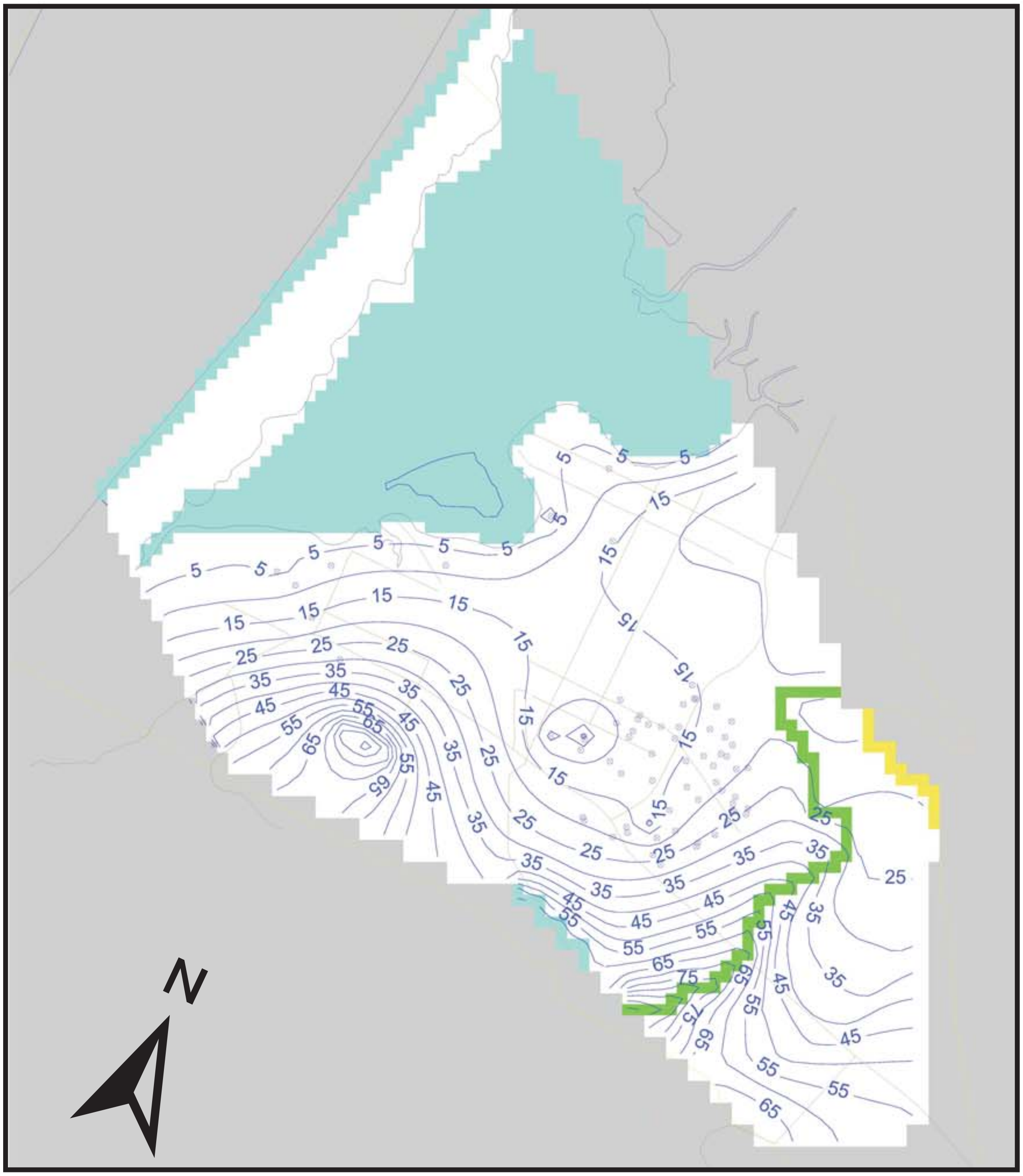
Simulated Ground Water Elevations
Lower Aquifer
Conservation
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates

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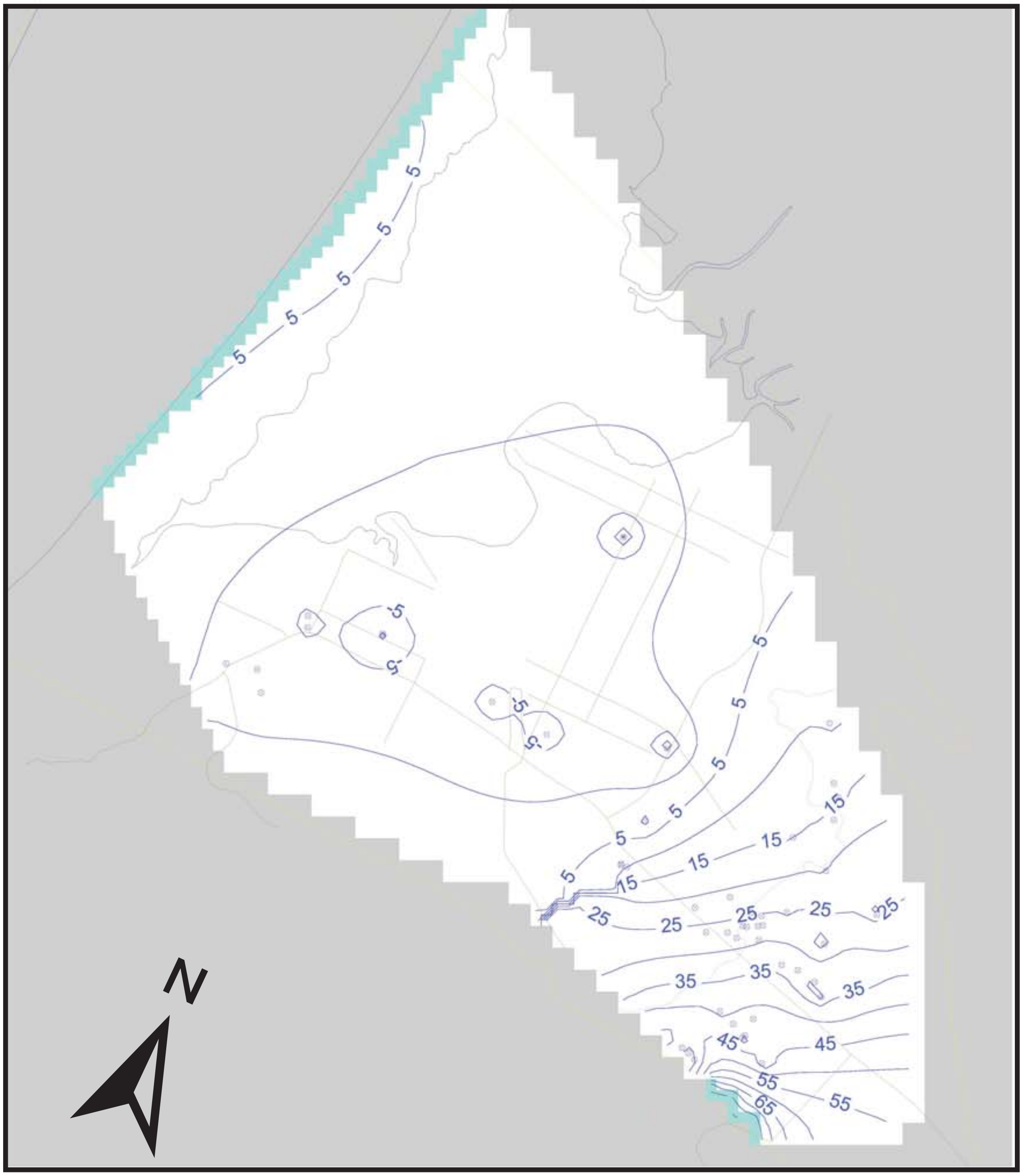
Simulated Ground Water Elevations
Upper Aquifer
Broderson
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates

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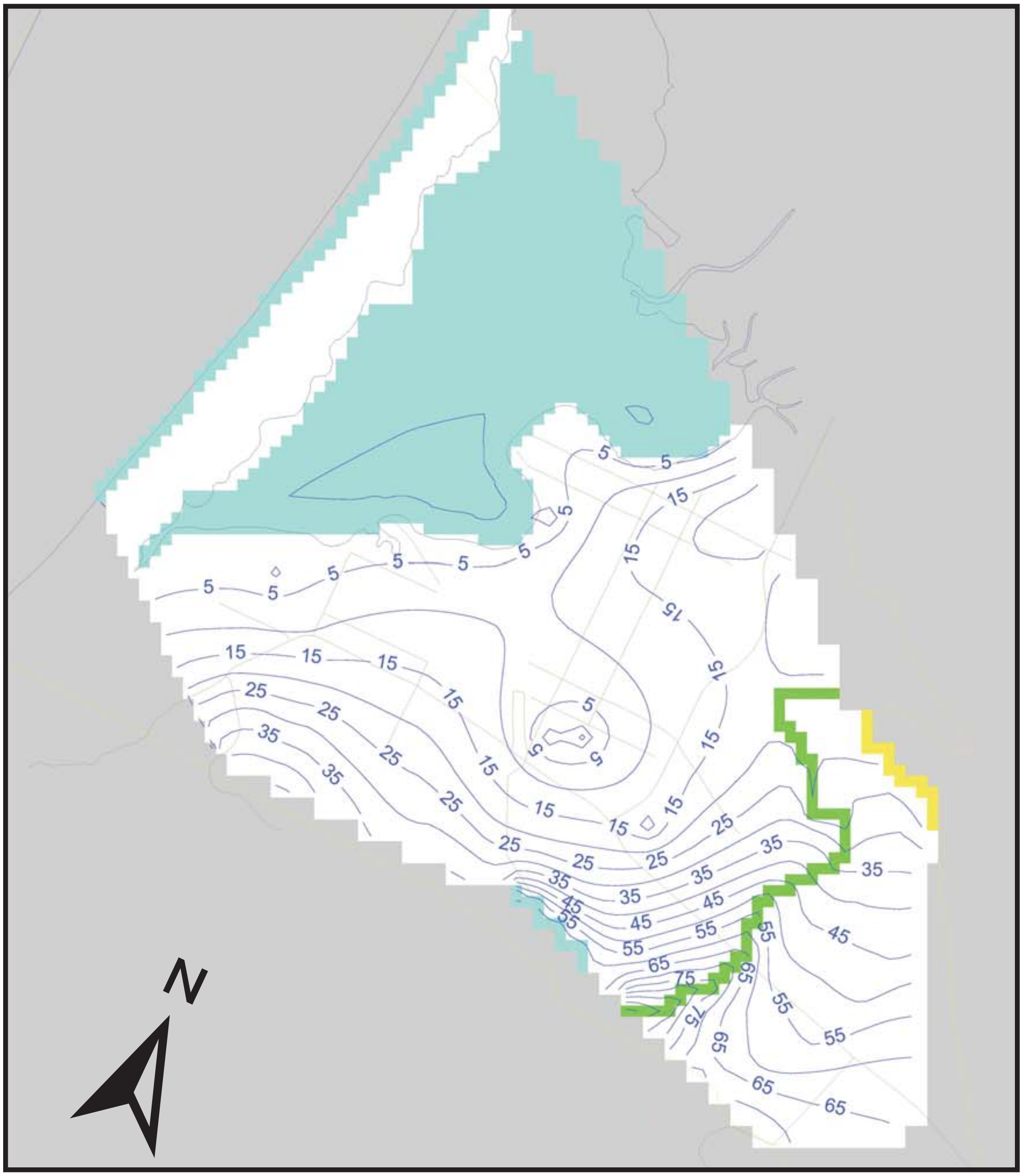
Simulated Ground Water Elevations
Lower Aquifer
Broderson
June 2008 EFH Model
Los Osos Wastewater Project

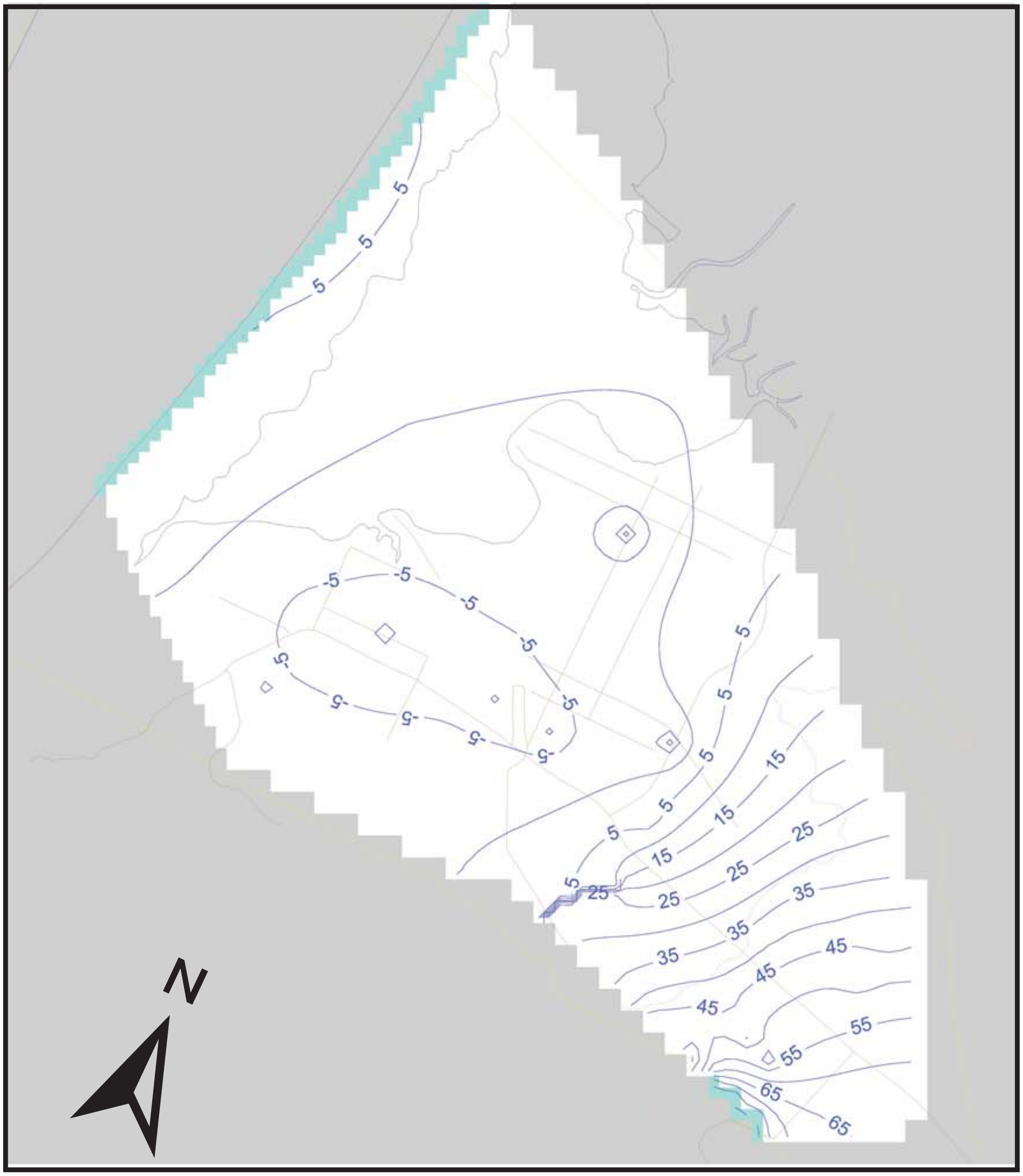
Cleath & Associates




Scale 1" = 4000 feet

Simulated Ground Water Elevations
Upper Aquifer
Ag Reuse
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates

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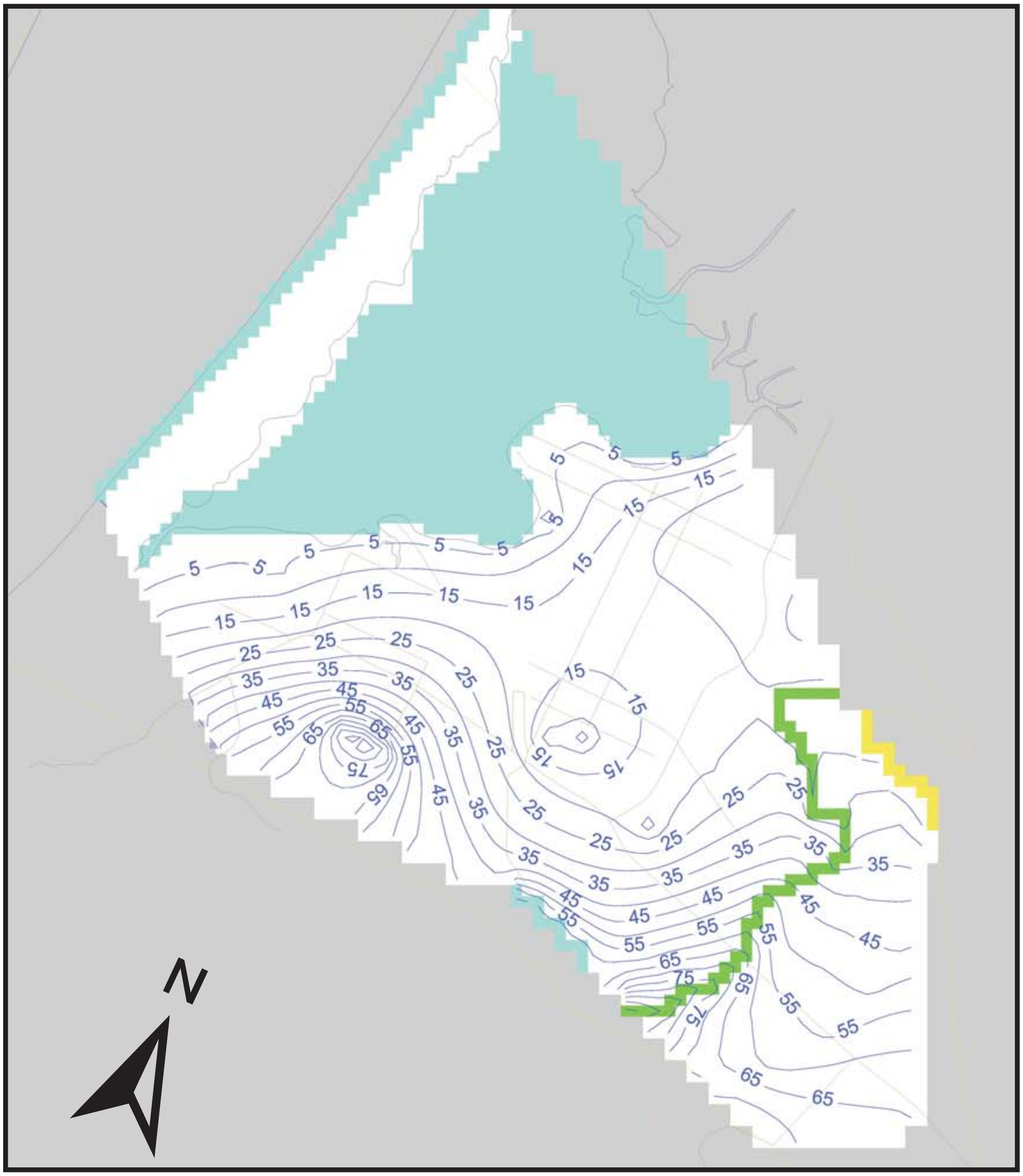
Simulated Ground Water Elevations
Lower Aquifer
Ag Reuse
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates

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Simulated Ground Water Elevations
Upper Aquifer
VPA2a
June 2008 EFH Model
Los Osos Wastewater Project

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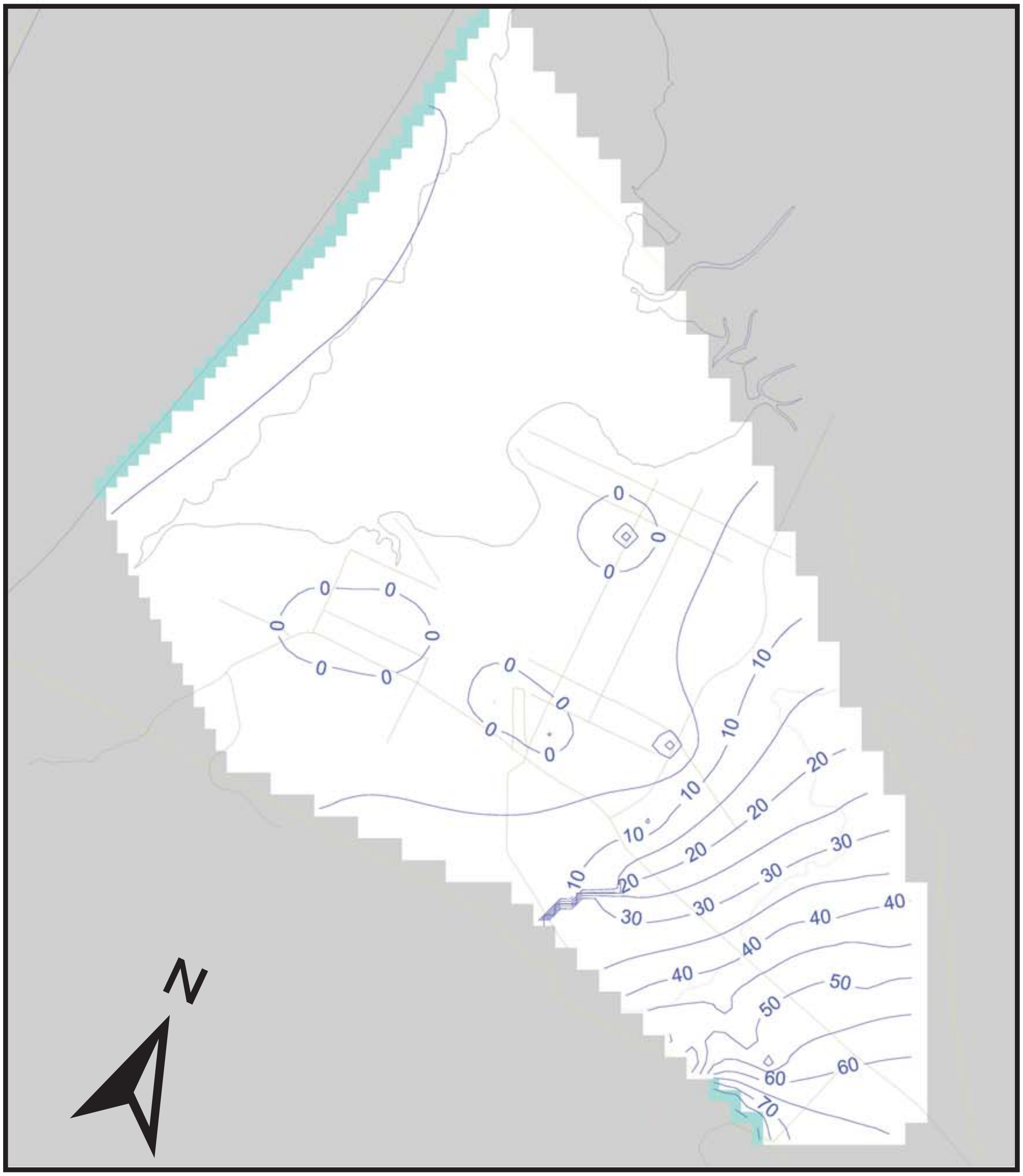


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Simulated Ground Water Elevations
Lower Aquifer
VPA2a
June 2008 EFH Model
Los Osos Wastewater Project

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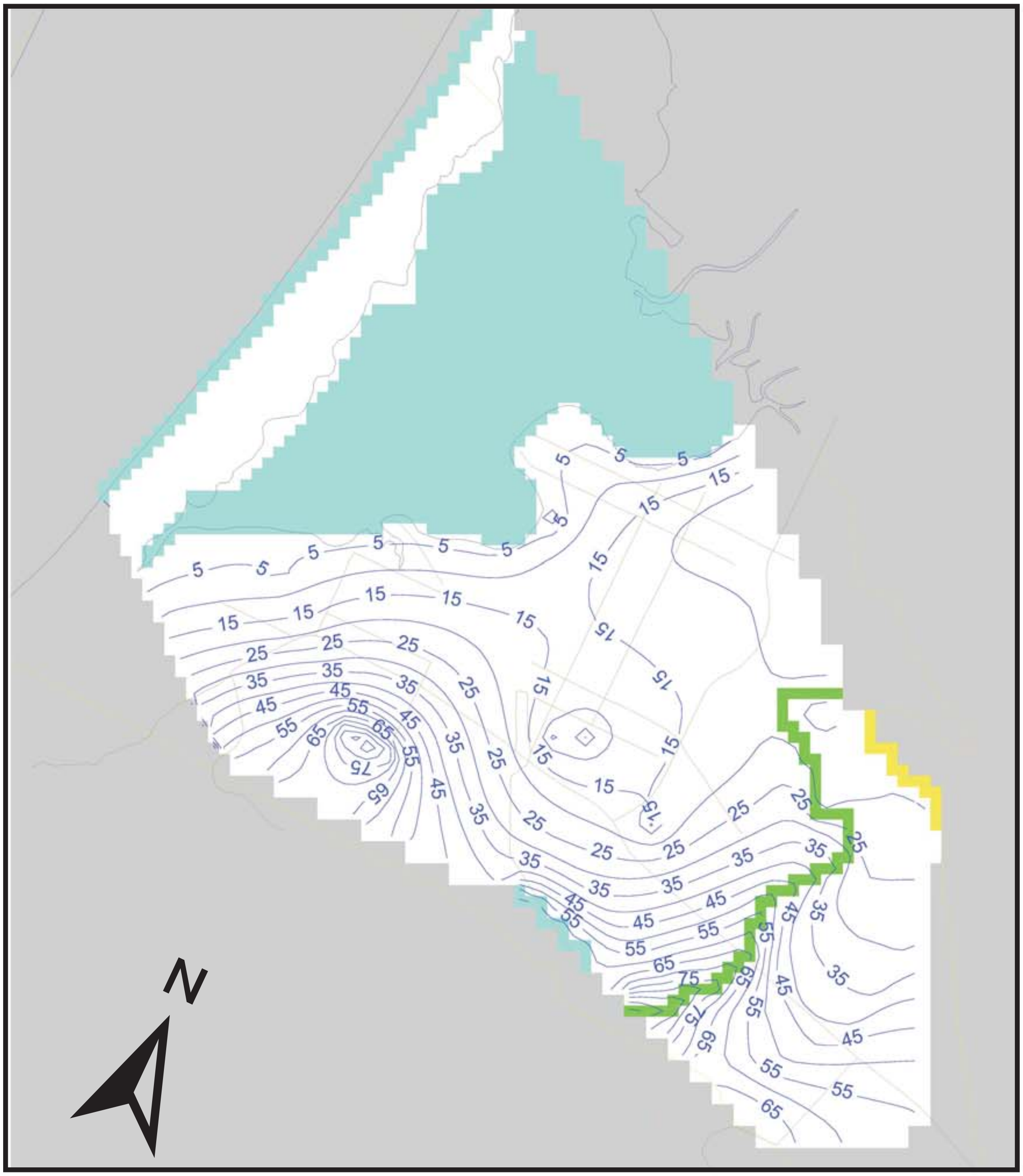


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Simulated Ground Water Elevations
Upper Aquifer
VPA2b
June 2008 EFH Model
Los Osos Wastewater Project

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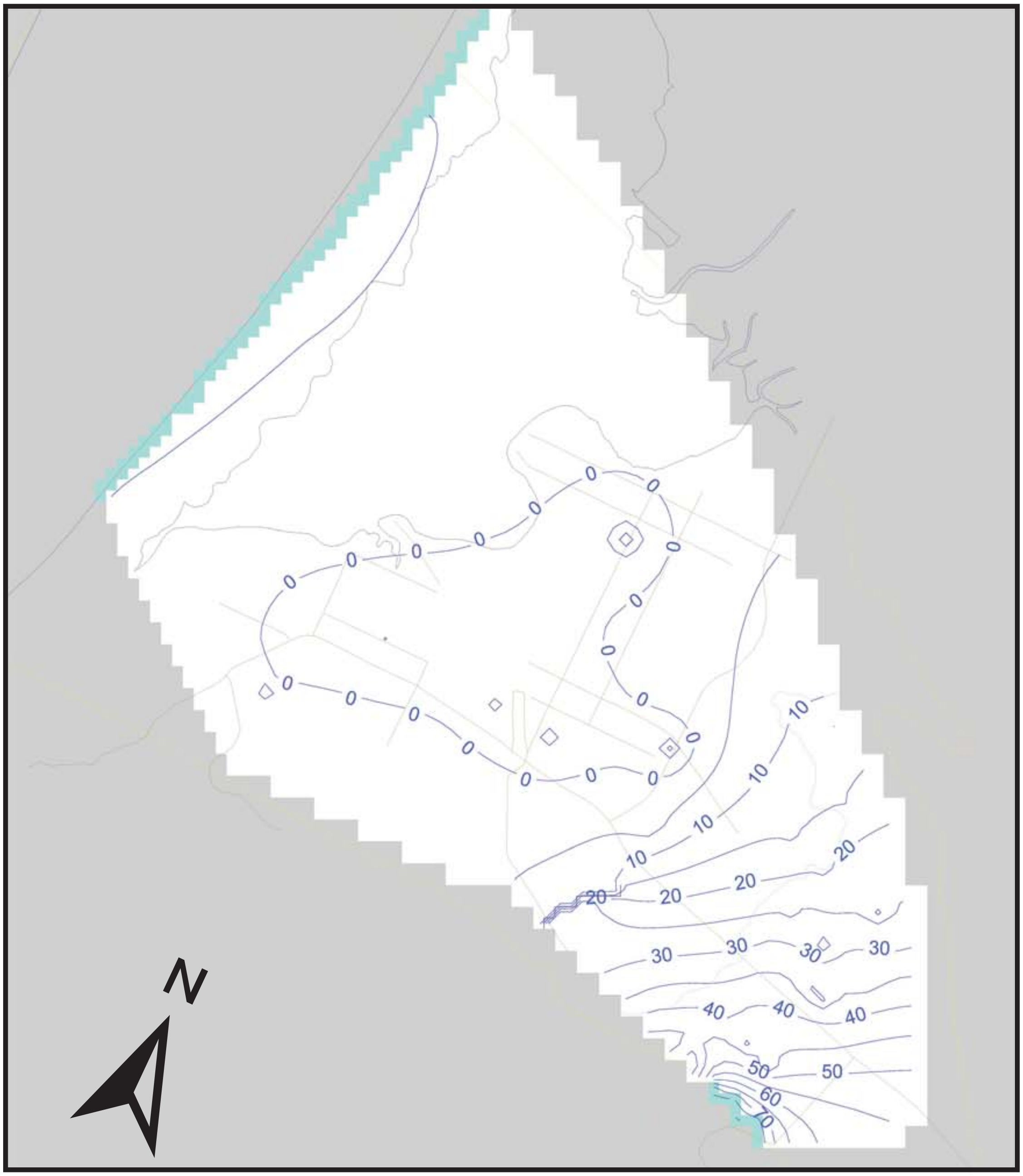


Simulated Ground Water Elevations
Lower Aquifer
VPA2b
June 2008 EFH Model
Los Osos Wastewater Project

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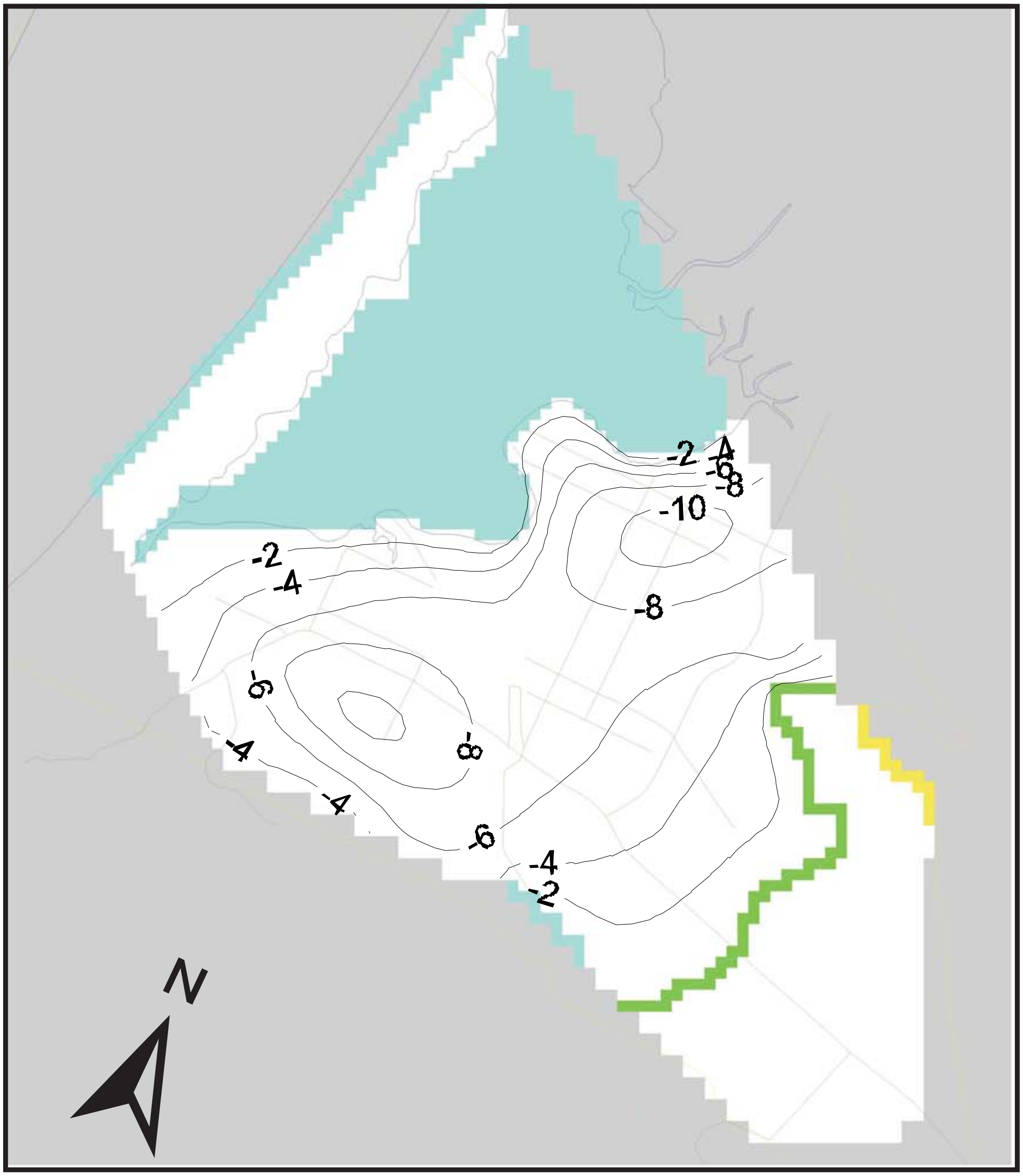


Scale 1" = 4000 feet

Simulated Change in Upper Aquifer
Ground Water Elevations
Spray Field Only
June 2008 EFH Model
Los Osos Wastewater Project

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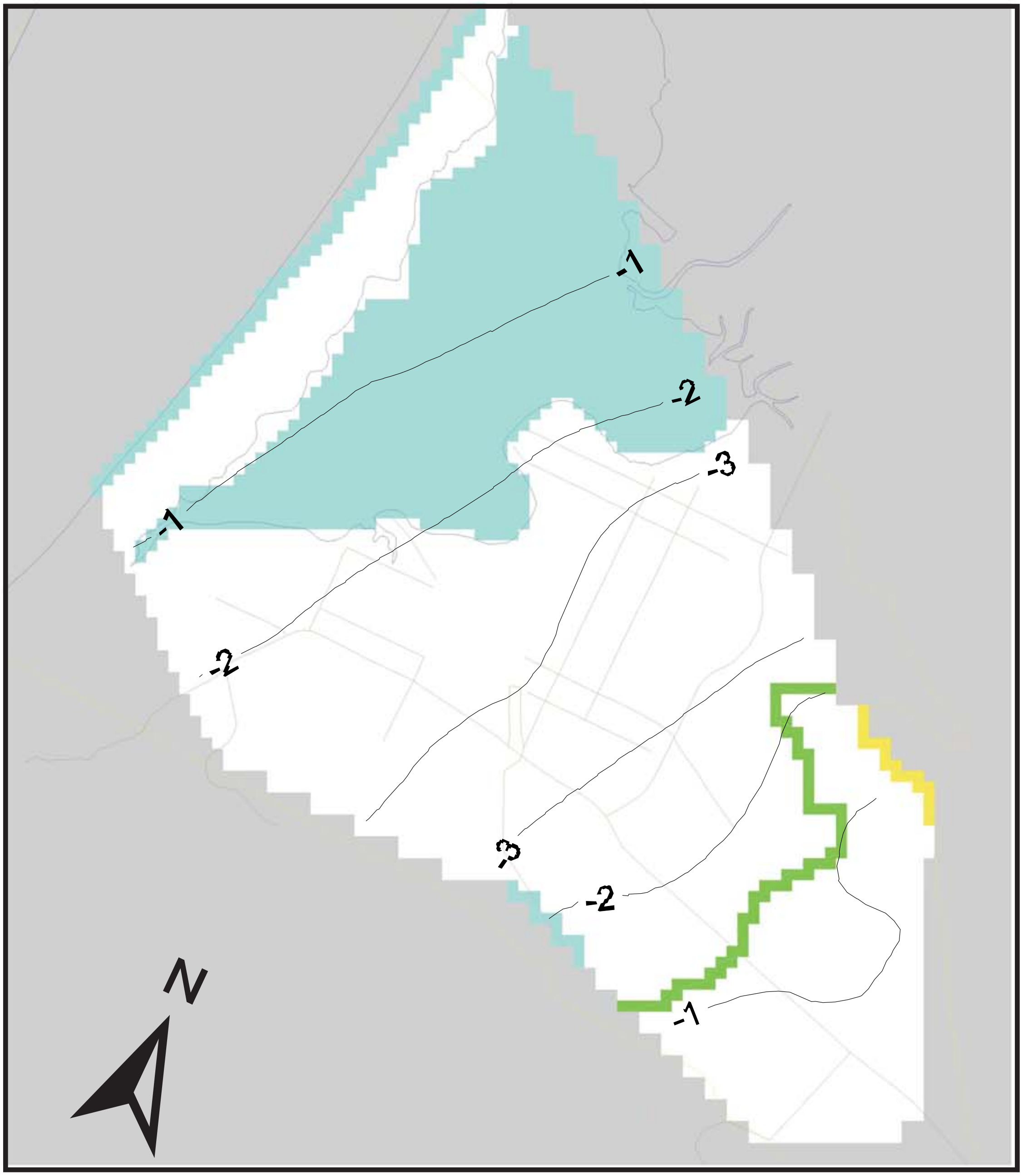


Scale 1" = 4000 feet

Simulated Change in Lower Aquifer
Ground Water Elevations
Spray Field Only
June 2008 EFH Model
Los Osos Wastewater Project

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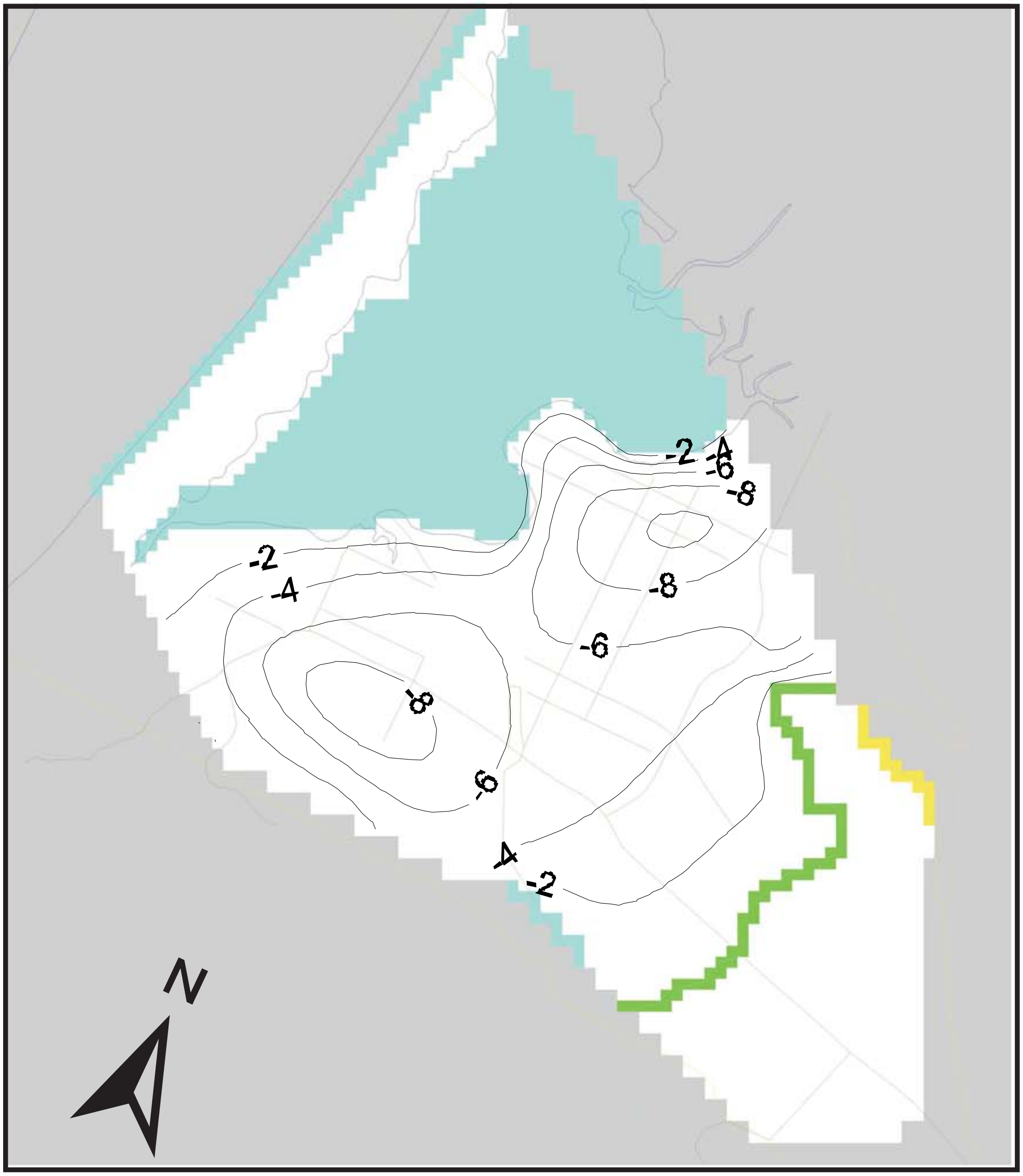
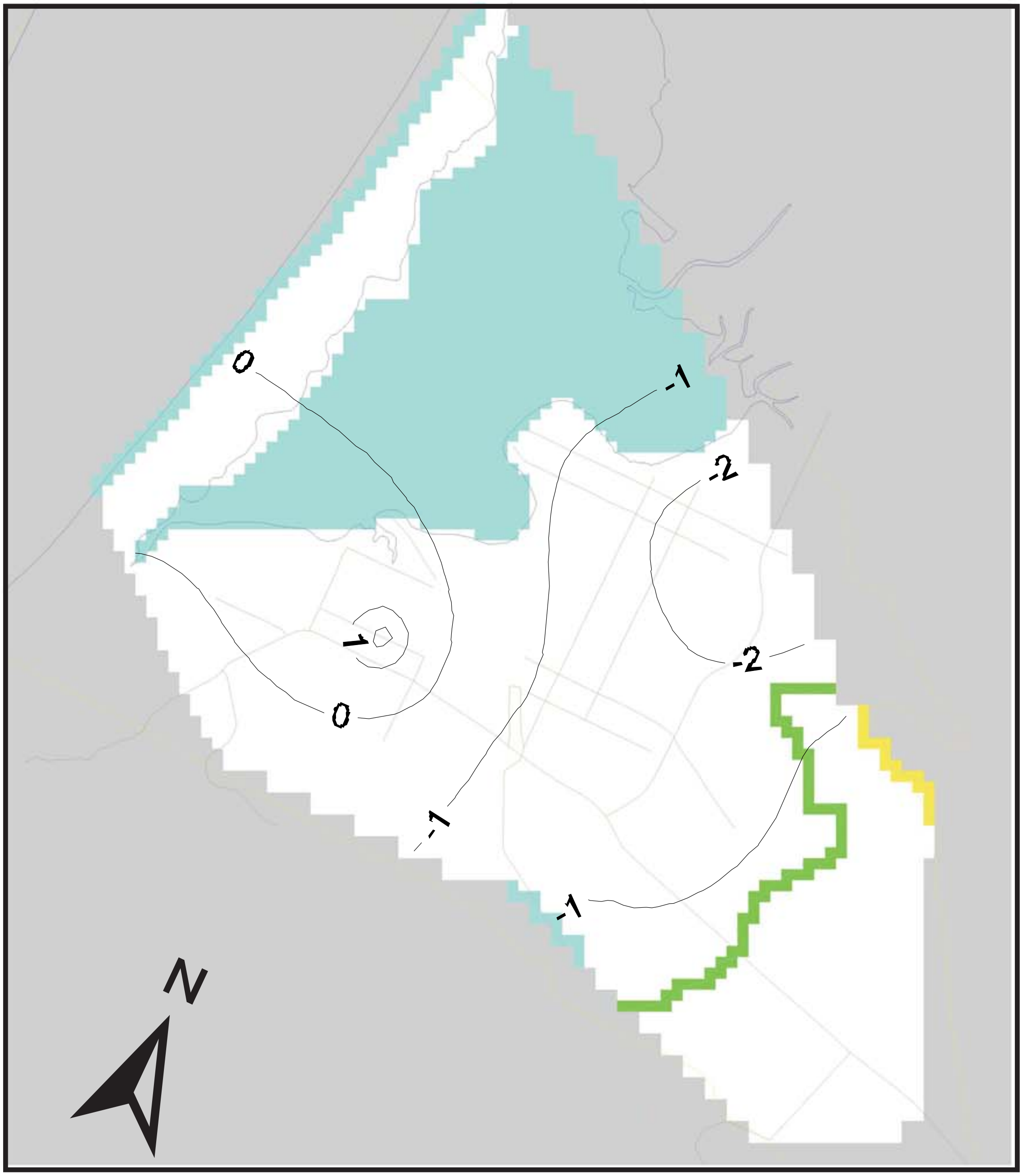



Scale 1" = 4000 feet

Simulated Change in Upper Aquifer
Ground Water Elevations
Conservation Only
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates

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Simulated Change in Lower Aquifer
Ground Water Elevations
Conservation Only
June 2008 EFH Model
Los Osos Wastewater Project

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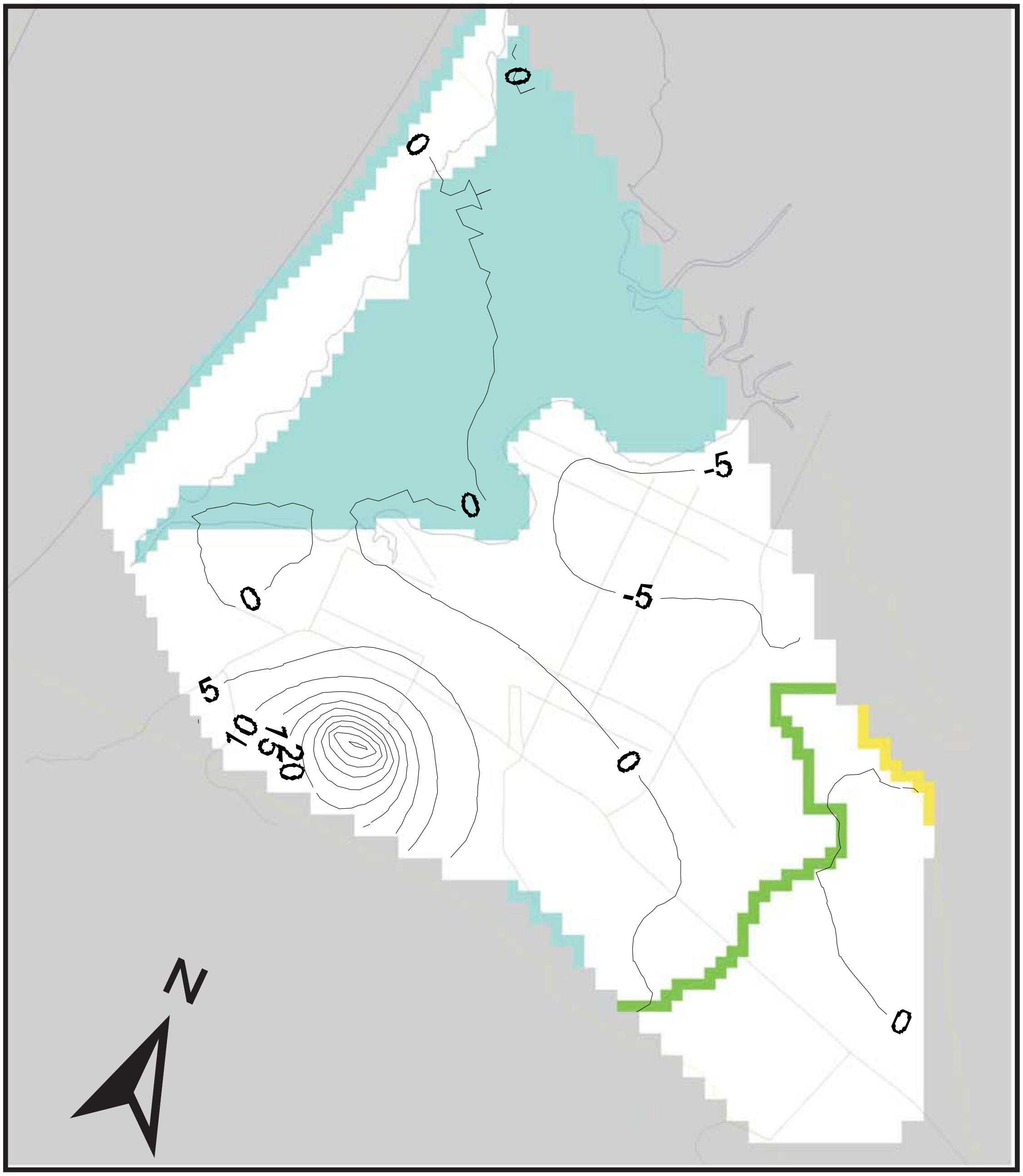
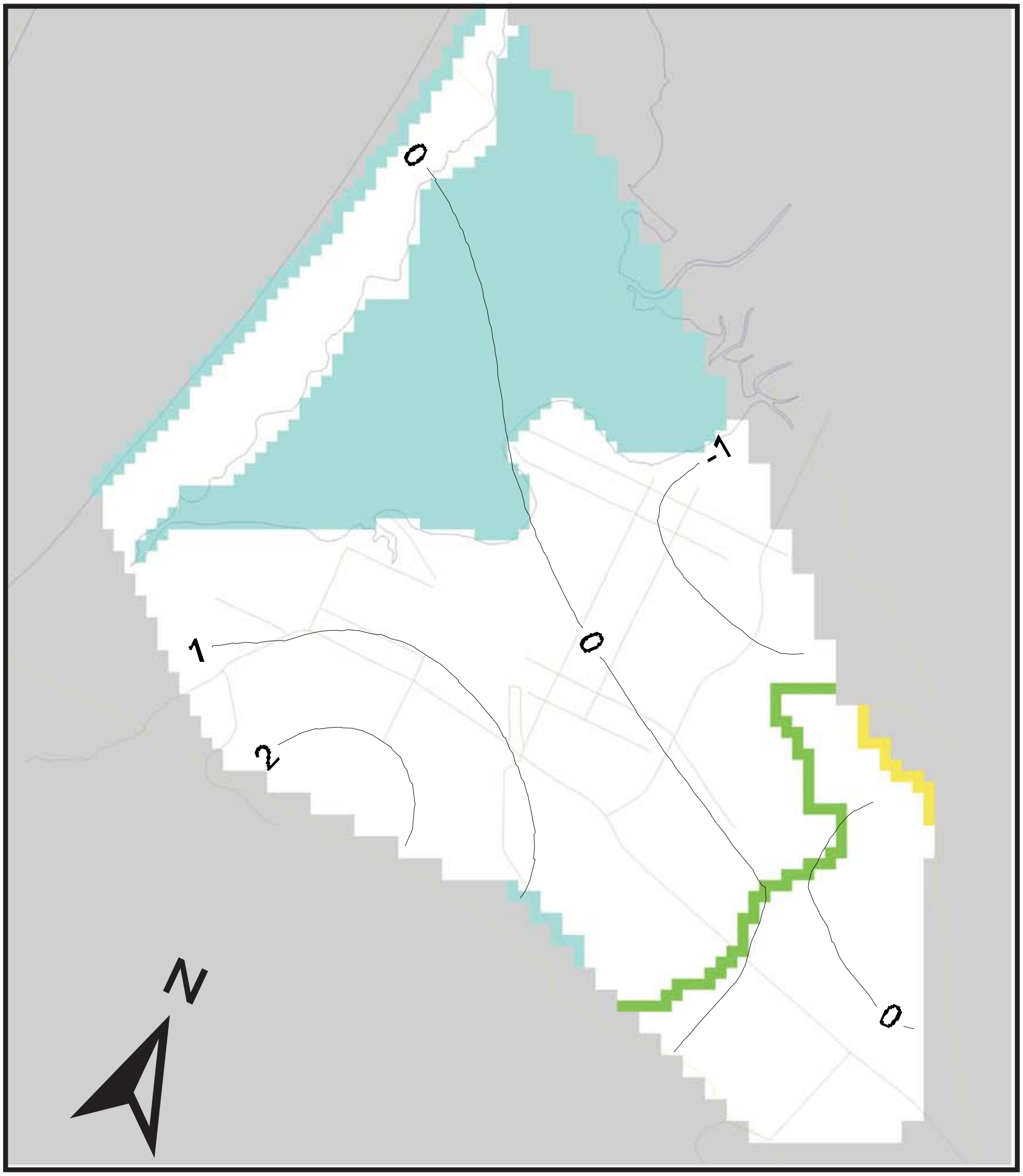



Scale 1" = 4000 feet

Simulated Change in Upper Aquifer
Ground Water Elevations
Broderson Only
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates

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Simulated Change in Lower Aquifer
Ground Water Elevations
Broderson Only
June 2008 EFH Model
Los Osos Wastewater Project

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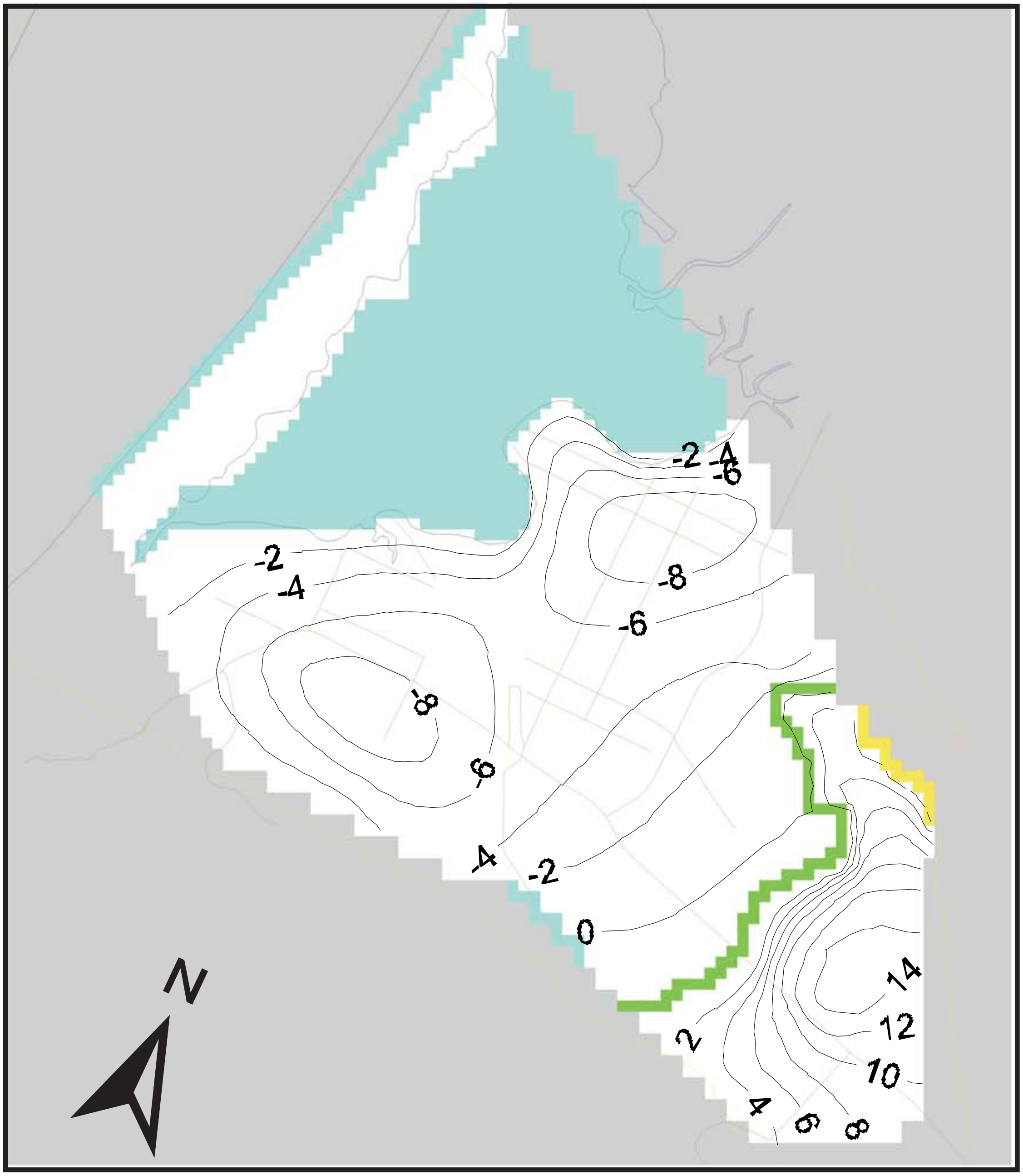
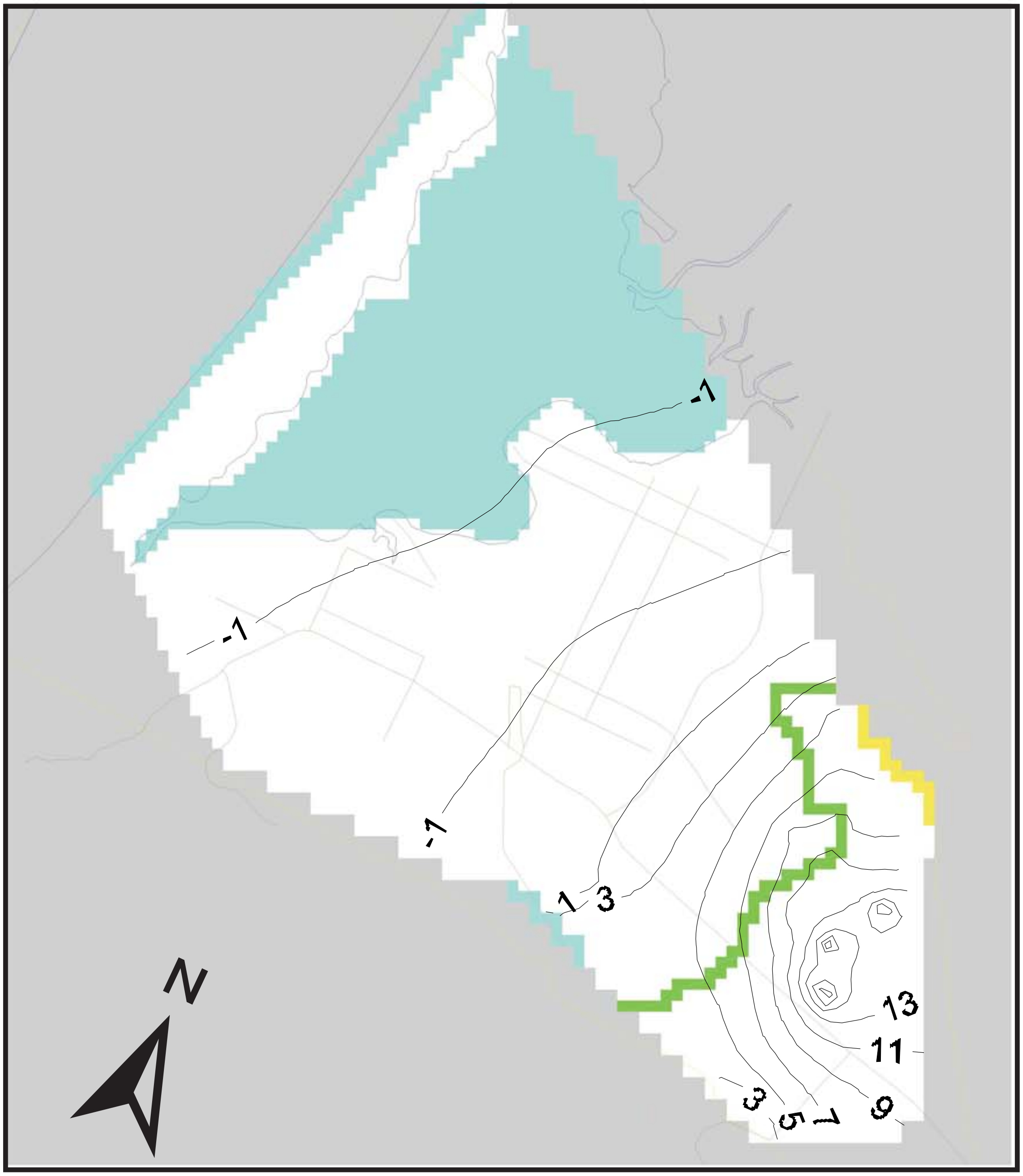



Scale 1" = 4000 feet

Simulated Change in Upper Aquifer
Ground Water Elevations
Agricultural Reuse Only
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates




Scale 1" = 4000 feet

Simulated Change in Lower Aquifer
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Agricultural Reuse Only
June 2008 EFH Model
Los Osos Wastewater Project

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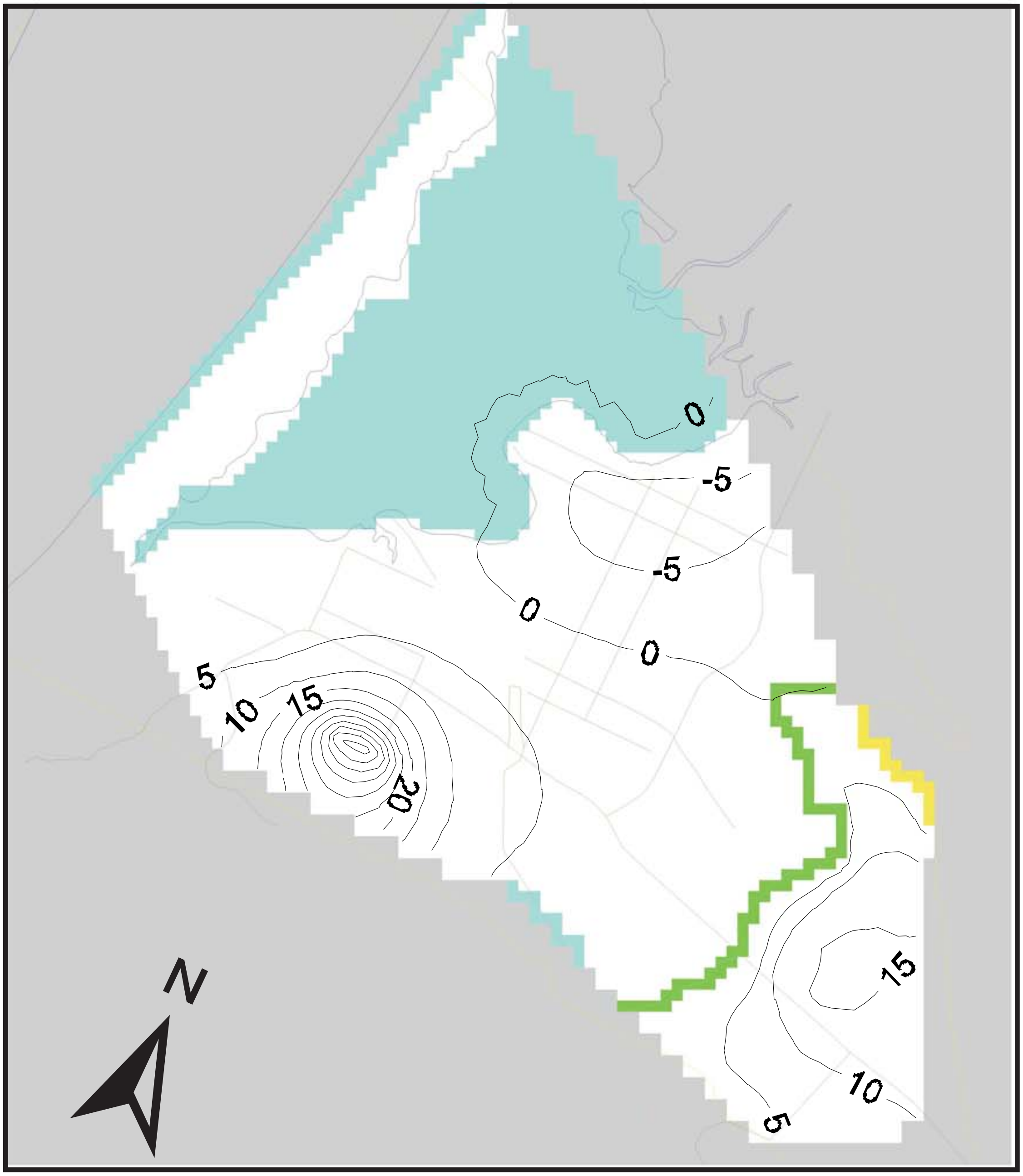


Scale 1" = 4000 feet

Simulated Change in Upper Aquifer
Ground Water Elevations
VPA 2A
June 2008 EFH Model
Los Osos Wastewater Project

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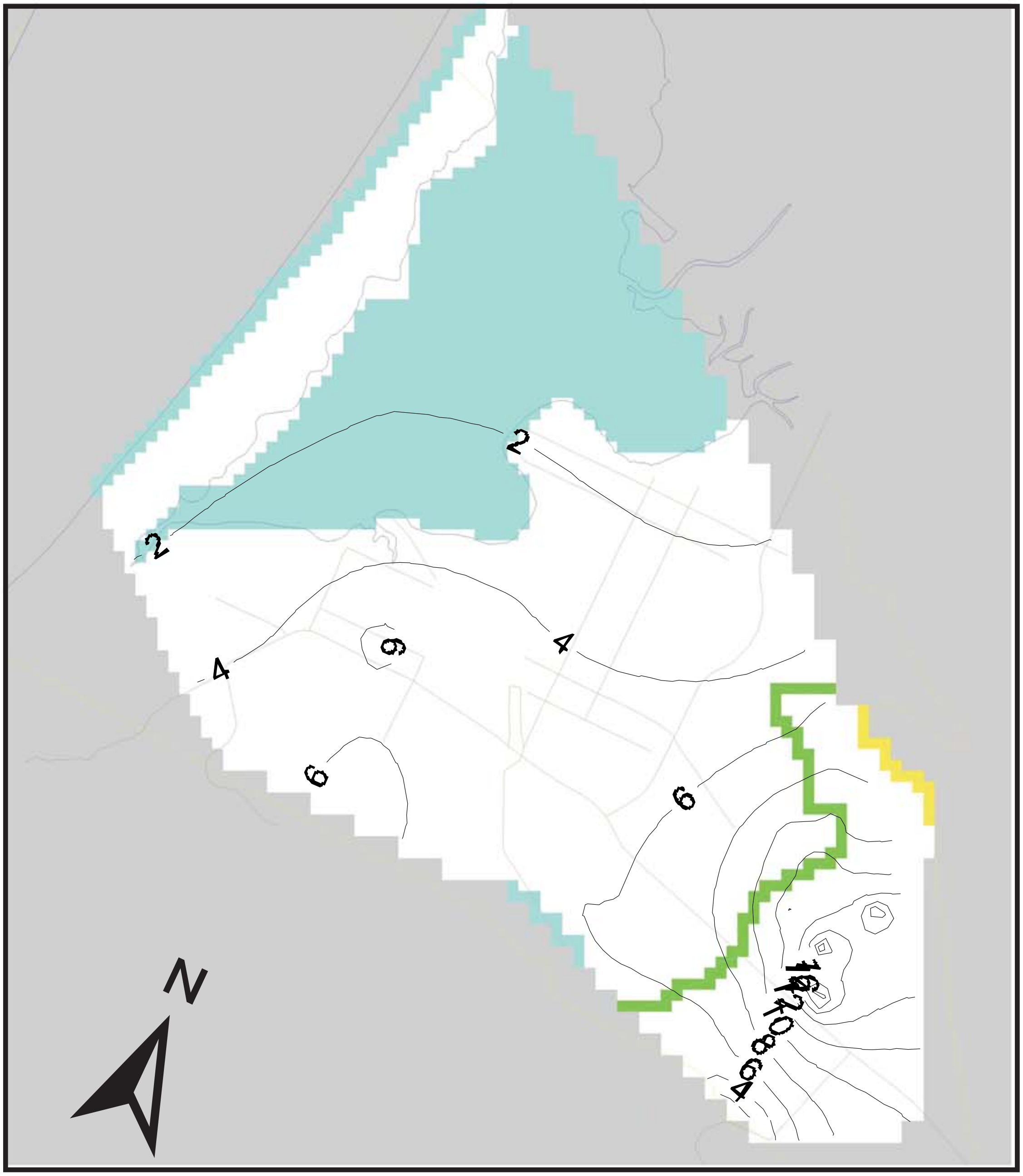


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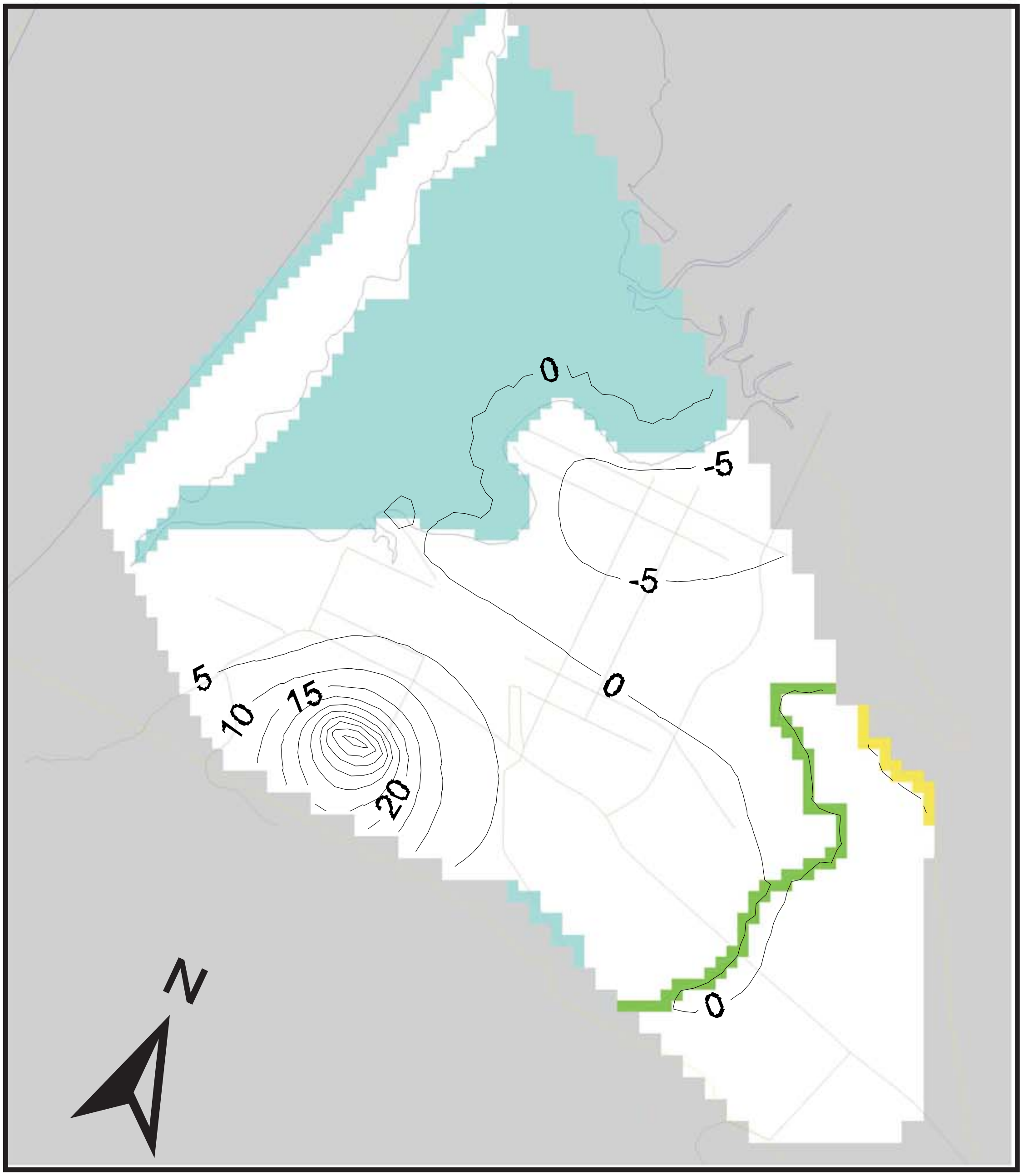
Simulated Change in Lower Aquifer
Ground Water Elevations
VPA 2A
June 2008 EFH Model
Los Osos Wastewater Project

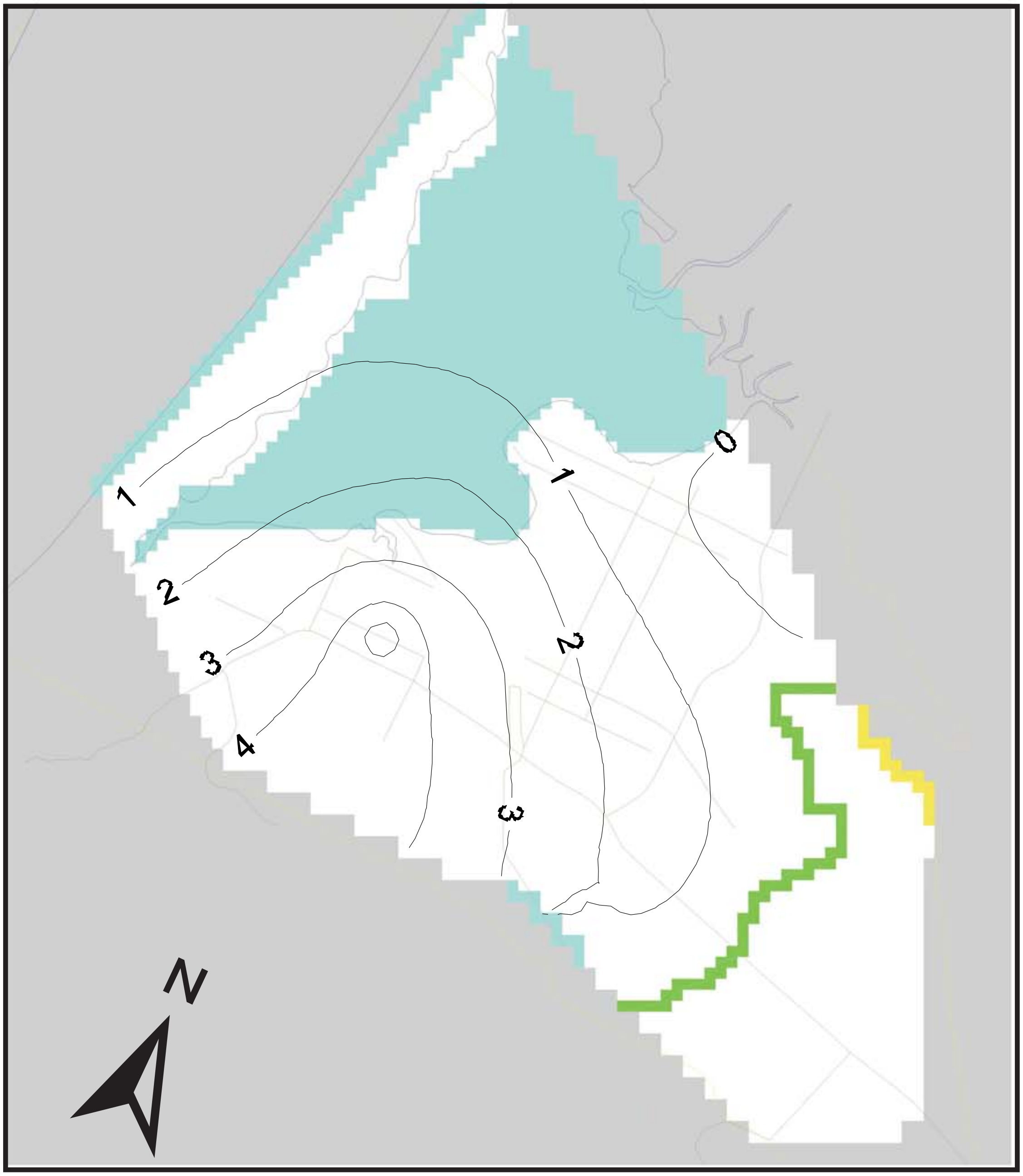
Cleath & Associates




Scale 1" = 4000 feet

Simulated Change in Upper Aquifer
Ground Water Elevations
VPA 2B
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates




Scale 1" = 4000 feet

Simulated Change in Lower Aquifer
Ground Water Elevations
VPA 2B
June 2008 EFH Model
Los Osos Wastewater Project

Cleath & Associates

## HYDROLOGIC BUDGET

## CURRENT CONDITIONS

**Flow Model (Upper Aquifer, Creek Compartment, Lower Aquifer)**

Recharge (PP/IR/SR) = 3,370 AFY
Yates (2003) Table 4, column 11 minus 155 AFY due to a reduction in model area from revised interpretation of model southwest boundary in 2005 Sea Water Intrusion study.

Los Osos Creek inflow = 665 AFY
This value is calculated by model. Intermittent stream gage data shows average surface flows of 3,900 AFY and median flows of 2,200 AFY (1977-2000), indicating water is available.

Subsurface inflow from bedrock = 167 AFY
Calibration derived (discussed in 2005 Sea Water Intrusion study). Modified from fixed inflow to head-dependent.

Subsurface inflow to upper aquifer from uplifted basin area in Bayview Heights = 112 AFY

Subsurface inflow from ocean (general head boundary inflow) = 526 AFY
Includes 469 AFY net sea water intrusion and 57 AFY of recirculating water beneath the Morro Bay sandspit (model derived).

**Total Inflow: 4,840 AFY**

Basin well production (WP) = 3,390 AFY
2440 AFY purveyor w/sea pines golf (production records)
800 AFY creek valley irrigation (approx 400 acres of ag lands, mostly truck crops)
70 AFY creek valley domestic (approx 75 homes)
80 AFY urban area non-purveyor domestic (approx 100 homes)

Los Osos Creek outflow = 77 AFY
This value is calculated by model. Does not include surface water runoff from watershed.

Warden drain outflow = 6 AFY

Subsurface outflow to ocean (general head boundary outflow) = 1,367 AFY
Includes 1310 AFY net upper aquifer outflow and 57 AFY of recirculating water beneath the Morro Bay sandspit.

**Total Outflow: 4,840 AFY**

**Perched Aquifer**

Septic Return (SR) = 631 AFY
Yates Table 4, column 9, zones 105-128.

Perc of Precip/Irrigation Return (PP/IR) = 736 AFY
Yates Table 4, column 10, zones 105-128 (1,367 AFY), minus septic return.

Total leakage through perching clay (LK) = 391 AFY
Yates Table 4, column 11, zones 105-128 (389 AFY in table, 391 AFY in model). Out of the 391 AFY total leakage, 374 AFY enters upper aquifer and 17 AFY enters creek compartment (model derived).

Total Subsurface Cross Flow (SCF) = 424 AFY
Yates Table 4, column 11, zones 205-229 minus column 10, zones 205-229
Out of the 424 AFY total subsurface cross flow (spilling off edge of perching clay), 324 AFY enters upper aquifer and 100 AFY enters creek compartment (difference between column 11 and 10 for approximately 20% of zone 206 and zones 220, 221, and 229).

Willow Creek/Evapotranspiration (WC/ET) = 552 AFY
WC/ET = SR + PP/IR - LK - SCF

**Creek Compartment**

Recharge (from LK/SCF, PP/IR, and SR) = 577 AFY
Yates Table 4, column 11, zones 20-28, plus approx. 20% of zone 206, and zones 220, 221, and 229.

Septic Return (SR) = 30 AFY
Yates Table 4, column 9, zones 20, 24, 25, 220, and 229.

Perc of Precip/Irrigation Return (PP/IR) = 430 AFY
PP/IR = Total recharge - SR - LK/SCF from perched aquifer

Los Osos Creek Inflow (LCI) = 665 AFY
See model totals above

Los Osos Creek Outflow (LCO) = 77 AFY
Model derived. This is ground water rising into Los Osos Creek, not an estimate of total surface flows.

Warden Drain Outflow = 6 AFY        Model derived.

Well Production (WP) = 870 AFY
800 AFY irrigation; 70 AFY domestic

Subsurface Cross Flow (SCF) = 456 AFY
SCF = PP/IR + SR + LCI + SI - WP - LOC. The amount of SCF moving into upper aquifer is 90 AFY and the amount moving into the lower aquifer is 366 AFY, which is calculated from the known budget items using the flow diagram

**Upper Aquifer**

Total recharge = 2,793 AFY
Total model recharge (3,370 AFY) minus creek compartment recharge (577 AFY)

Septic Return (SR) = 606 AFY
Yates Table 4, column 9 total minus perched aquifer and creek compartment septic return.

Perc of Precip/Irrigation Return (PP/IR) = 1,489 AFY
Upper aquifer recharge (2,793 AFY) minus perched aquifer LK/SCF (698 AFY) minus septic return (606 AFY).

Subsurface Inflow (SI) = 112 AFY
Model derived. Leakage from uplifted basin area in Bayview Heights.

Well Production (WP) = 803 AFY
Purveyor production records and domestic well estimates

Subsurface Outflow (SO) = 1,310 AFY
General head boundary (see model totals).

Leakage to lower aquifer (LK): 882 AFY
Model derived.

**Lower Aquifer**

Well Production (WP) = 1,717 AFY
Purveyor production records

Sea Water Intrusion (SWI) = 469 AFY
General head boundary (see model totals).

## HYDROLOGIC BUDGET

## SPRAY FIELD

### Scenario Description

Septic flow collection: 1,157 AFY (estimated initial flows in model).
Water conservation: 0 AFY
Wastewater disposal at Broderson Site: 0 AFY
Wastewater disposal at spray field (out of basin): 1157 AFY

### Flow Model (Upper Aquifer, Creek Compartment, Lower Aquifer)

Recharge (PP/IR/SR) = 2,730 AFY

Yates (2003) Table 9, column 12, zones 2-229 (2,885 AFY), minus 155 AFY due to a reduction in model area. Note that the middle school septic was not collected in 2003 analysis. Adjustment has been made to collect 13 AFY middle school wastewater from zone 209, which is where the leach field is. Zone 109 septic returns also identified as the school (8 AFY) are reassigned to several existing homes outside of prohibition zone in this area and are not collected. Another modification from the Yates 2003 tables is that zone 107 (east side low density) is not in the prohibition zone and septic flows would not be collected, adding 28 AFY of recharge.

Los Osos Creek inflow = 714 AFY

Calculated by model. Intermittent stream gage data shows average surface flows of 3,900 AFY and median flows of 2,200 AFY (1977-2000), indicating water is available.

Subsurface inflow to creek compartment from bedrock = 170 AFY

Calibration derived (discussed in 2005 Sea Water Intrusion study). Modified from fixed inflow to head-dependent.

Subsurface inflow to upper aquifer from uplifted basin area in Bayview Heights = 120 AFY

Subsurface inflow from ocean (general head boundary inflow) = 606 AFY

Includes 561 AFY net sea water intrusion and 45 AFY of recirculating water beneath the Morro Bay sandspit (model derived).

**Total Inflow: 4,340 AFY**

Basin well production (WP) = 3,390 AFY

2440 AFY purveyor w/sea pines golf (production records)
800 AFY creek valley irrigation (approx 150 acres of ag lands, mostly truck crops)
70 AFY creek valley domestic (approx 75 homes)
80 AFY urban area non-purveyor domestic (approx 100 homes)

Los Osos Creek outflow = 32 AFY

This value is calculated by model. Does not include surface water runoff from watershed.

Warden drain outflow = 2 AFY

Subsurface outflow to ocean (general head boundary outflow) = 916 AFY

Includes 871 AFY net upper aquifer outflow and 45 AFY of recirculating water beneath the Morro Bay sandspit.

**Total Outflow: 4,340 AFY**

**Perched Aquifer**

Septic Return (SR) = 36 AFY

Yates (2003) Table 9, column 9, zones 105-128, plus 28 AFY added for zone 107 which is not in prohibition zone.

Perc of Precip/Irrigation Return (PP/IR) = 736 AFY

Yates Table 4, column 10, zones 105-128 (1,367) minus pre-project Septic Return (631 AFY). Note that the PP/IR value using Table 9 column 11 (with 28 AFY adjustment for zone 107) would be 714 AFY (750 AFY - 36AFY), mainly because the area of zone 116 is reduced in Table 9 to allow for east side disposal zones 304, 305, and 306. To conform to the County VPA's, the 300-series zones have been reassigned back to their 100-series counterparts, except Broderson. Therefore, in the perched aquifer columns, Table 9 should be the same as Table 4.

Total leakage through clay (LK) = 381 AFY

Yates Table 9, column 12, zones 105-128, with the zone 107 adjusted from Table 4. Out of the 381 AFY total perched aquifer leakage, 364 AFY enters upper aquifer and 17 AFY enters creek compartment (model derived).

Total Subsurface Cross Flow (SCF) = 356 AFY

Yates Table 9, column 12, zones 205-229 minus column 11, zones 205-229 with adjustment for zone 209. Out of the 356 AFY total subsurface cross flow (spilling off edge of perching clay), 270 AFY enters upper aquifer and 86 AFY enters creek compartment (difference for 20% of zone 206 and zones 220, 221, and 229).

Willow Creek/Evapotranspiration (WC/ET) = 35 AFY

WC/ET = SR + PP/IR - LK - SCF. Note that this outflow from ground water system, and does not include surface water inflow/outflow.

**Creek Compartment**

Recharge (from LK/SCF, PP/IR, and SR) = 563 AFY

Yates Table 9, column 12, zones 20-28, plus approx. 20% of zone 206, and zones 220, 221, and 229 (558 AFY in tables, 563 AFY in model).

Septic Return (SR) = 30 AFY

Yates Table 9, column 9, zones 20, 24, 25, 220, and 229.

Perc of Precip/Irrigation Return (PP/IR) = 430 AFY

PP/IR = Total recharge (563 AFY) - SR (30 AFY) - LK/SCF (103 AFY)

Subsurface Inflow (SI) = 170 AFY from bedrock. Model calibration value.

Los Osos Creek Inflow (LCI) = 714 AFY

Model derived (see model totals above).

Los Osos Creek Outflow (LCO) = 32 AFY

Model derived. This does not include surface water runoff from watershed.

Warden Drain Outflow = 2 AFY

Model derived.

Well Production (WP) = 870 AFY

800 AFY irrigation; 70 AFY domestic

Subsurface Cross Flow (SCF) = 543 AFY

SCF = PP/IR + SR + LCI + SI - WP - LOC. The amount of SCF moving into upper aquifer is 158 AFY and the amount moving into the lower aquifer is 385 AFY, which is calculated from the known budget items using the flow diagram

**Upper Aquifer**

Total recharge = 2,167 AFY
Total model recharge (2,730 AFY) minus creek compartment recharge (563 AFY)

Septic Return (SR) = 44 AFY
Yates Table 9, column 9, zones 2-16.

Perc of Precip/Irrigation Return (PP/IR) = 1,489 AFY
Upper aquifer recharge (2,167 AFY) minus perched aquifer LK/SCF (634 AFY) minus septic return (44 AFY).

Subsurface Inflow (SI) = 120 AFY
Model derived. Leakage from uplifted basin area in Bayview Heights.

Well Production (WP) = 803 AFY
Purveyor production records and domestic well estimates

Subsurface Outflow (SO) = 871 AFY
General head boundary (see model totals).

Leakage to lower aquifer (LK): 771 AFY
Model derived.

**Lower Aquifer**

Well Production (WP) = 1,717 AFY
Purveyor production records

Sea Water Intrusion (SWI) = 561 AFY
General head boundary (see model totals).

**HYDROLOGIC BUDGET**

**CONSERVATION**

**Scenario Description**

Septic flow collection: 997 AFY (estimated initial flows after conservation).
Water conservation: 160 AFY
Wastewater disposal at Broderson Site: 0 AFY
Wastewater disposal at spray field (out of basin): 997 AFY

**Model totals**

Recharge (PP/IR/SR) = 2,730 AFY

Yates (2003) Table 9, column 12, zones 2-229 (2,885 AFY), minus 155 AFY due to a reduction in model area. Note that the middle school septic was not collected in 2003 analysis. Adjustment has been made to collect 13 AFY middle school wastewater from zone 209, which is where the leach field is. Zone 109 septic returns also identified as the school (8 AFY) are reassigned to several existing homes outside of prohibition zone in this area and are not collected. Another modification from the Yates 2003 tables is that zone 107 (east side low density) is not in the prohibition zone and septic flows would not be collected, adding 28 AFY of recharge.

Los Osos Creek inflow = 701 AFY

Calculated by model. Intermittent stream gage data shows average surface flows of 3,900 AFY and median flows of 2,200 AFY (1977-2000), indicating water is available.

Subsurface inflow from bedrock = 169 AFY

Calibration derived (discussed in 2005 Sea Water Intrusion study). Modified from fixed inflow to head-dependent.

Subsurface inflow to upper aquifer from uplifted basin area in Bayview Heights = 117 AFY

Subsurface inflow from ocean (general head boundary inflow) = 530 AFY

Includes 471 AFY net sea water intrusion and 59 AFY of recirculating water beneath the Morro Bay sandspit (model derived).

**Total Inflow: 4,247 AFY**

Basin well production (WP) = 3,230 AFY

2280 AFY purveyor w/sea pines golf (production records)
800 AFY creek valley irrigation (approx 400 acres of ag lands, mostly truck crops)
70 AFY creek valley domestic (approx 75 homes)
80 AFY urban area non-purveyor domestic (approx 100 homes)

Los Osos Creek outflow = 38 AFY

This value is calculated by model. Does not include surface water runoff from watershed.

Warden drain outflow = 4 AFY

Subsurface outflow to ocean (general head boundary outflow) = 975 AFY

Includes 916 AFY net upper aquifer outflow and 59 AFY of recirculating water beneath the Morro Bay sandspit.

**Total Outflow: 4,247 AFY**

**Perched Aquifer**

Septic Return (SR) = 36 AFY

Yates (2003) Table 9, column 9, zones 105-128, plus 28 AFY added for zone 107 which is not in prohibition zone.

Perc of Precip/Irrigation Return (PP/IR) = 736 AFY

Yates Table 4, column 10, zones 105-128 (1,367) minus pre-project Septic Return (631 AFY). Note that the PP/IR value using Table 9 column 11 (with 28 AFY adjustment for zone 107) would be 714 AFY (750 AFY - 36AFY), mainly because the area of zone 116 is reduced in Table 9 to allow for east side disposal zones 304, 305, and 306. To conform to the County VPA's, the 300-series zones have been reassigned back to their 100-series counterparts, except Broderson. Therefore, in the perched aquifer columns, Table 9 should be the same as Table 4.

Total leakage through clay (LK) = 381 AFY

Yates Table 9, column 12, zones 105-128, with the zone 107 adjusted from Table 4. Out of the 381 AFY total perched aquifer leakage, 364 AFY enters upper aquifer and 17 AFY enters creek compartment (model derived).

Total Subsurface Cross Flow (SCF) = 356 AFY

Yates Table 9, column 12, zones 205-229 minus column 11, zones 205-229 with adjustment for zone 209. Out of the 356 AFY total subsurface cross flow (spilling off edge of perching clay), 270 AFY enters upper aquifer and 86 AFY enters creek compartment (difference for 20% of zone 206 and zones 220, 221, and 229).

Willow Creek/Evapotranspiration (WC/ET) = 35 AFY

WC/ET = SR + PP/IR - LK - SCF. Note that this outflow from ground water system, and does not include surface water inflow/outflow.

**Creek Compartment**

Recharge (from LK/SCF, PP/IR, and SR) = 563 AFY

Yates Table 9, column 12, zones 20-28, plus approx. 20% of zone 206, and zones 220, 221, and 229 (558 AFY in tables, 563 AFY in model).

Septic Return (SR) = 30 AFY

Yates Table 9, column 9, zones 20, 24, 25, 220, and 229.

Perc of Precip/Irrigation Return (PP/IR) = 430 AFY

PP/IR = Total recharge (563 AFY) - SR (30 AFY) - LK/SCF (103 AFY)

Subsurface Inflow (SI) = 169 AFY from bedrock. Model calibration value.

Los Osos Creek Inflow (LCI) = 701 AFY

Model derived (see model totals above).

Los Osos Creek Outflow (LCO) = 38 AFY

Model derived. This does not include surface water runoff from watershed.

Warden Drain Outflow = 4 AFY

Model derived.

Well Production (WP) = 870 AFY

800 AFY irrigation; 70 AFY domestic

Subsurface Cross Flow (SCF) = 521 AFY

SCF = PP/IR + SR + LCI + SI - WP - LOC. The amount of SCF moving into upper aquifer is 134 AFY and the amount moving into the lower aquifer is 387 AFY, which is calculated from the known budget items using the flow diagram

**Upper Aquifer**

Total recharge = 2,167 AFY
    Total model recharge (2,730 AFY) minus creek compartment recharge (563 AFY)

Septic Return (SR) = 44 AFY
    Yates Table 9, column 9, zones 2-16.

Perc of Precip/Irrigation Return (PP/IR) = 1,489 AFY
    Upper aquifer recharge (2,167 AFY) minus perched aquifer LK/SCF (634 AFY) minus septic return (44 AFY).

Subsurface Inflow (SI) = 117 AFY
    Model derived. Leakage from uplifted basin area in Bayview Heights.

Well Production (WP) = 803 AFY
    Purveyor production records and domestic well estimates

Subsurface Outflow (SO) = 916 AFY
    General head boundary (see model totals).

Leakage to lower aquifer (LK): 699 AFY
    Model derived.

**Lower Aquifer**

Well Production (WP) = 1,557 AFY
    Purveyor production records with 160 AFY conservation applied.

Sea Water Intrusion (SWI) = 471 AFY
    General head boundary (see model totals).

## HYDROLOGIC BUDGET

## BRODERSON

### Scenario Description

Septic flow collection: 1,157 AFY (estimated initial flows in model).
Water conservation: 0 AFY
Wastewater disposal at Broderson Site: 448 AFY
Wastewater disposal at spray field (out of basin): 709 AFY

### Model totals

Recharge (PP/IR/SR) = 3,178 AFY

Yates (2003) Table 9, column 12, zones 2-229 (2,885 AFY), plus 448 AFY Broderson disposal, minus 155 AFY due to a reduction in model area. Note that the middle school septic was not collected in 2003 analysis. Adjustment has been made to collect 13 AFY middle school wastewater from zone 209, which is where the leach field is. Zone 109 septic returns also identified as the school (8 AFY) are reassigned to several existing homes outside of prohibition zone in this area and are not collected. Another modification from the Yates 2003 tables is that zone 107 (east side low density) is not in the prohibition zone and septic flows would not be collected, adding 28 AFY of recharge.

Los Osos Creek inflow = 674 AFY

Calculated by model. Intermittent stream gage data shows average surface flows of 3,900 AFY and median flows of 2,200 AFY (1977-2000), indicating water is available.

Subsurface inflow from bedrock = 167 AFY

Calibration derived (discussed in 2005 Sea Water Intrusion study). Modified from fixed inflow to head-dependent.

Subsurface inflow to upper aquifer from uplifted basin area in Bayview Heights = 109 AFY

Subsurface inflow from ocean (general head boundary inflow) = 502 AFY

Includes 441 AFY net sea water intrusion and 61 AFY of recirculating water beneath the Morro Bay sandspit (model derived).

**Total Inflow: 4,630 AFY**

Basin well production (WP) = 3,390 AFY

2440 AFY purveyor w/sea pines golf (production records)
800 AFY creek valley irrigation (approx 650 acres of ag lands, mostly truck crops)
70 AFY creek valley domestic (approx 75 homes)
80 AFY urban area non-purveyor domestic (approx 100 homes)

Los Osos Creek outflow = 52 AFY

This value is calculated by model. Does not include surface water runoff from watershed.

Warden drain outflow = 6 AFY

Subsurface outflow to ocean (general head boundary outflow) = 1182 AFY

Includes 1121 AFY net upper aquifer outflow and 61 AFY of recirculating water beneath the Morro Bay sandspit.

**Total Outflow: 4,630 AFY**

**Perched Aquifer**

Septic Return (SR) = 36 AFY

Yates (2003) Table 9, column 9, zones 105-128, plus 28 AFY added for zone 107 which is not in prohibition zone.

Perc of Precip/Irrigation Return (PP/IR) = 736 AFY

Yates Table 4, column 10, zones 105-128 (1,367) minus pre-project Septic Return (631 AFY). Note that the PP/IR value using Table 9 column 11 (with 28 AFY adjustment for zone 107) would be 714 AFY (750 AFY - 36AFY), mainly because the area of zone 116 is reduced in Table 9 to allow for east side disposal zones 304, 305, and 306. To conform to the County VPA's, the 300-series zones have been reassigned back to their 100-series counterparts, except Broderson. Therefore, in the perched aquifer columns, Table 9 should be the same as Table 4.

Total leakage through clay (LK) = 381 AFY

Yates Table 9, column 12, zones 105-128, with the zone 107 adjusted from Table 4. Out of the 381 AFY total perched aquifer leakage, 364 AFY enters upper aquifer and 17 AFY enters creek compartment (model derived).

Total Subsurface Cross Flow (SCF) = 356 AFY

Yates Table 9, column 12, zones 205-229 minus column 11, zones 205-229 with adjustment for zone 209. Out of the 356 AFY total subsurface cross flow (spilling off edge of perching clay), 270 AFY enters upper aquifer and 86 AFY enters creek compartment (difference for 20% of zone 206 and zones 220, 221, and 229).

Willow Creek/Evapotranspiration (WC/ET) = 35 AFY

WC/ET = SR + PP/IR - LK - SCF. Note that this outflow from ground water system, and does not include surface water inflow/outflow.

**Creek Compartment**

Recharge (from LK/SCF, PP/IR, and SR) = 563 AFY

Yates Table 9, column 12, zones 20-28, plus approx. 20% of zone 206, and zones 220, 221, and 229 (558 AFY in tables, 563 AFY in model).

Septic Return (SR) = 30 AFY

Yates Table 9, column 9, zones 20, 24, 25, 220, and 229.

Perc of Precip/Irrigation Return (PP/IR) = 430 AFY

PP/IR = Total recharge (563 AFY) - SR (30 AFY) - LK/SCF (103 AFY)

Subsurface Inflow (SI) = 167 AFY from bedrock. Model calibration value.

Los Osos Creek Inflow (LCI) = 674 AFY

Model derived (see model totals above).

Los Osos Creek Outflow (LCO) = 52 AFY

Model derived. This does not include surface water runoff from watershed.

Warden Drain Outflow = 6 AFY

Model derived.

Well Production (WP) = 870 AFY

800 AFY irrigation; 70 AFY domestic

Subsurface Cross Flow (SCF) = 476 AFY

SCF = PP/IR + SR + LCI + SI - WP - LOC. The amount of SCF moving into upper aquifer is 109 AFY and the amount moving into the lower aquifer is 367 AFY, which is calculated from the known budget items using the flow diagram

**Upper Aquifer**

Total recharge = 2,615 AFY
Total model recharge (3,178 AFY) minus creek compartment recharge (563 AFY)

Septic Return (SR) = 44 AFY
Yates Table 9, column 9, zones 2-16.

Perc of Precip/Irrigation Return (PP/IR) = 1,489 AFY
Upper aquifer recharge (2,615 AFY) minus perched aquifer LK/SCF (634 AFY) minus septic return (44 AFY), minus Broderson site disposal (448 AFY).

Subsurface Inflow (SI) = 109 AFY
Model derived. Leakage from uplifted basin area in Bayview Heights.

Well Production (WP) = 803 AFY
Purveyor production records and domestic well estimates

Subsurface Outflow (SO) = 1121 AFY
General head boundary (see model totals).

Leakage to lower aquifer (LK): 909 AFY
Model derived.

**Lower Aquifer**

Well Production (WP) = 1,717 AFY
Purveyor production records

Sea Water Intrusion (SWI) = 441 AFY
General head boundary (see model totals).

## HYDROLOGIC BUDGET

## AG REUSE

**Scenario Description**

Septic flow collection: 1,157 AFY (estimated initial flows in model).
Water conservation: 0 AFY
Wastewater disposal at Broderson Site: 0 AFY
Ag Reuse: 480 AFY (Creek compartment irrigation north of Los Osos Valley Road)
Wastewater disposal at spray field (out of basin): 677 AFY

**Model totals**

Recharge (PP/IR/SR) = 2,730 AFY

Yates (2003) Table 9, column 12, zones 2-229 (2,885 AFY), minus 155 AFY due to a reduction in model area. Note that the middle school septic was not collected in 2003 analysis. Adjustment has been made to collect 13 AFY middle school wastewater from zone 209, which is where the leach field is. Zone 109 septic returns also identified as the school (8 AFY) are reassigned to several existing homes outside of prohibition zone in this area and are not collected. Another modification from the Yates 2003 tables is that zone 107 (east side low density) is not in the prohibition zone and septic flows would not be collected, adding 28 AFY of recharge.

Los Osos Creek inflow = 524 AFY

Calculated by model. Intermittent stream gage data shows average surface flows of 3,900 AFY and median flows of 2,200 AFY (1977-2000), indicating water is available.

Subsurface inflow from bedrock = 141 AFY

Calibration derived (discussed in 2005 Sea Water Intrusion study). Modified from fixed inflow to head-dependent.

Subsurface inflow to upper aquifer from uplifted basin area in Bayview Heights = 113 AFY

Subsurface inflow from ocean (general head boundary inflow) = 566 AFY

Includes 514 AFY net sea water intrusion and 52 AFY of recirculating water beneath the Morro Bay sandspit (model derived).

**Total Inflow: 4,074 AFY**

Basin well production (WP) = 2,910 AFY

2440 AFY purveyor w/sea pines golf (production records)
320 AFY creek valley irrigation (approx 150 acres of ag lands, mostly truck crops)
70 AFY creek valley domestic (approx 75 homes)
80 AFY urban area non-purveyor domestic (approx 100 homes)

Los Osos Creek outflow = 126 AFY

This value is calculated by model. Does not include surface water runoff from watershed.

Warden drain outflow = 76 AFY

Subsurface outflow to ocean (general head boundary outflow) = 962 AFY

Includes 910 AFY net upper aquifer outflow and 52 AFY of recirculating water beneath the Morro Bay sandspit.

**Total Outflow: 4,074 AFY**

**Perched Aquifer**

Septic Return (SR) = 36 AFY

Yates (2003) Table 9, column 9, zones 105-128, plus 28 AFY added for zone 107 which is not in prohibition zone.

Perc of Precip/Irrigation Return (PP/IR) = 736 AFY

Yates Table 4, column 10, zones 105-128 (1,367) minus pre-project Septic Return (631 AFY). Note that the PP/IR value using Table 9 column 11 (with 28 AFY adjustment for zone 107) would be 714 AFY (750 AFY - 36AFY), mainly because the area of zone 116 is reduced in Table 9 to allow for east side disposal zones 304, 305, and 306. To conform to the County VPA's, the 300-series zones have been reassigned back to their 100-series counterparts, except Broderson. Therefore, in the perched aquifer columns, Table 9 should be the same as Table 4.

Total leakage through clay (LK) = 381 AFY

Yates Table 9, column 12, zones 105-128, with the zone 107 adjusted from Table 4. Out of the 381 AFY total perched aquifer leakage, 364 AFY enters upper aquifer and 17 AFY enters creek compartment (model derived).

Total Subsurface Cross Flow (SCF) = 356 AFY

Yates Table 9, column 12, zones 205-229 minus column 11, zones 205-229 with adjustment for zone 209. Out of the 356 AFY total subsurface cross flow (spilling off edge of perching clay), 270 AFY enters upper aquifer and 86 AFY enters creek compartment (difference for 20% of zone 206 and zones 220, 221, and 229).

Willow Creek/Evapotranspiration (WC/ET) = 35 AFY

WC/ET = SR + PP/IR - LK - SCF. Note that this outflow from ground water system, and does not include surface water inflow/outflow.

**Creek Compartment**

Recharge (from LK/SCF, PP/IR, and SR) = 563 AFY

Yates Table 9, column 12, zones 20-28, plus approx. 20% of zone 206, and zones 220, 221, and 229 (558 AFY in tables, 563 AFY in model).

Septic Return (SR) = 30 AFY

Yates Table 9, column 9, zones 20, 24, 25, 220, and 229.

Perc of Precip/Irrigation Return (PP/IR) = 430 AFY

PP/IR = Total recharge (563 AFY) - SR (30 AFY) - LK/SCF (103 AFY)

Subsurface Inflow (SI) = 141 AFY from bedrock. Model calibration value.

Los Osos Creek Inflow (LCI) = 524 AFY

Model derived (see model totals above).

Los Osos Creek Outflow (LCO) = 126 AFY

Model derived. This does not include surface water runoff from watershed.

Warden Drain Outflow = 76 AFY

Model derived.

Well Production (WP) = 390 AFY

320 AFY irrigation; 70 AFY domestic

Subsurface Cross Flow (SCF) = 636 AFY

SCF = PP/IR + SR + LCI + SI - WP - LOC. The amount of SCF moving into upper aquifer is 122 AFY and the amount moving into the lower aquifer is 514 AFY, which is calculated from the known budget items using the flow diagram

**Upper Aquifer**

Total recharge = 2,167 AFY
  Total model recharge (2,730 AFY) minus creek compartment recharge (563 AFY)

Septic Return (SR) = 44 AFY
  Yates Table 9, column 9, zones 2-16.

Perc of Precip/Irrigation Return (PP/IR) = 1,489 AFY
  Upper aquifer recharge (2,167 AFY) minus perched aquifer LK/SCF (634 AFY) minus septic return (44 AFY).

Subsurface inflow to upper aquifer from uplifted basin area in Bayview Heights = 113 AFY
  Model derived

Well Production (WP) = 803 AFY
  Purveyor production records and domestic well estimates

Subsurface Outflow (SO) = 910 AFY
  General head boundary (see model totals).

Leakage to lower aquifer (LK): 689 AFY
  Model derived.

**Lower Aquifer**

Well Production (WP) = 1,717 AFY
  Purveyor production records

Sea Water Intrusion (SWI) = 514 AFY
  General head boundary (see model totals).

**HYDROLOGIC BUDGET**

**PROJECT VPA2a**

**Project Description**

Septic flow collection: 997 AFY (initial prohibition zone flows after conservation).
Water conservation: 160 AFY (entered as reduction in west side lower aquifer production)
Wastewater disposal at Broderson Site: 448 AFY
Ag Reuse: 480 AFY (current level of irrigation in creek compartment north of Los Osos Valley Road)
Wastewater disposal at spray field (out of basin): 69 AFY

**Model totals**

Recharge (PP/IR/SR) = 3,178 AFY

Yates (2003) Table 9, column 12, zones 2-229 (2,885 AFY), plus 448 AFY Broderson disposal, minus 155 AFY due to a reduction in model area. Note that middle school septic was not collected in 2003 analysis. Adjustment has been made to collect 13 AFY middle school wastewater from zone 209, which is where the leach field is. Zone 109 septic returns also identified as the school (8 AFY) are reassigned to several existing homes outside of PZ in this area and are not collected. Another modification from the Yates 2003 tables is that zone 107 (east side low density) is not in the prohibition zone and septic flows would not be collected, adding 28 AFY of recharge.

Los Osos Creek inflow = 492 AFY

This value is calculated by model. Intermittent stream gage data shows average surface flows of 3,900 AFY and median flows of 2,200 AFY (1977-2000), indicating water is available.

Subsurface inflow from bedrock = 137 AFY

Calibration derived (discussed in 2005 Sea Water Intrusion study). Modified from fixed inflow to head-dependent.

Subsurface inflow to upper aquifer from uplifted basin area in Bayview Heights = 100 AFY

Subsurface inflow from ocean (general head boundary inflow) = 396 AFY

Includes 308 AFY net sea water intrusion and 88 AFY of recirculating water beneath the Morro Bay sandspit (model derived).

**Total Inflow: 4,303 AFY**

Basin well production (WP) = 2,750 AFY

2280 AFY purveyor w/sea pines golf (production records)
320 AFY creek valley irrigation (approx 150 acres of ag lands, mostly truck crops)
70 AFY creek valley domestic (approx 75 homes)
80 AFY urban area non-purveyor domestic (approx 100 homes)

Los Osos Creek outflow = 168 AFY

This value is calculated by model. Does not include surface water runoff from watershed..

Warden drain outflow = 88 AFY

Subsurface outflow to ocean (general head boundary outflow) = 1,297 AFY

Includes 1,209 AFY net upper aquifer outflow and 88 AFY of recirculating water beneath the Morro Bay sandspit.

**Total Outflow: 4,303 AFY**

**Perched Aquifer**

Septic Return (SR) = 36 AFY

Yates (2003) Table 9, column 9, zones 105-128, plus 28 AFY added for zone 107 which is not in prohibition zone.

Perc of Precip/Irrigation Return (PP/IR) = 736 AFY

Yates Table 4, column 10, zones 105-128 (1,367) minus pre-project Septic Return (631 AFY). Note that the PP/IR value using Table 9 (with 28 AFY adjustment for zone 107) would be 714 AFY (750 AFY - 36AFY), mainly because the area of zone 116 is reduced in Table 9 to allow for east side disposal zones 304, 305, and 306. To conform to the County VPA's, the 300-series zones have been reverted back to their 100-series counterparts, except Broderson. Therefore, in the perched aquifer columns, Yates Table 9 becomes the same as Table 4.

Total leakage through clay (LK) = 381 AFY

Yates Table 9, column 12, zones 105-128, with the zone 107 adjusted from Table 4. Out of the 381 AFY total perched aquifer leakage, 364 AFY enters upper aquifer and 17 AFY enters creek compartment (model derived).

Total Subsurface Cross Flow (SCF) = 356 AFY

Yates Table 9, column 12, zones 205-229 minus column 11, zones 205-229 with adjustment for zone 209. Out of the 356 AFY total subsurface cross flow (spilling off edge of perching clay), 270 AFY enters upper aquifer and 86 AFY enters creek compartment (difference for 20% of zone 206 and zones 220, 221, and 229).

Willow Creek/Evapotranspiration (WC/ET) = 35 AFY

WC/ET = SR + PP/IR - LK - SCF. Note that this outflow from ground water system, and does not include surface water inflow/outflow.

**Creek Compartment**

Recharge (from LK/SCF, PP/IR, and SR) = 563 AFY

Yates Table 9, column 12, zones 20-28, plus approx. 20% of zone 206, and zones 220, 221, and 229 (558 AFY in tables, 563 AFY in model).

Septic Return (SR) = 30 AFY

Yates Table 9, column 9, zones 20, 24, 25, 220, and 229.

Perc of Precip/Irrigation Return (PP/IR) = 430 AFY

PP/IR = Total recharge - SR - LK/SCF (from perched aquifer)

Subsurface Inflow (SI) = 137 AFY from bedrock. Model calibration value.

Los Osos Creek Inflow (LCI) = 492 AFY

Model derived (see model totals above).

Los Osos Creek Outflow (LCO) = 168 AFY

Model derived. This is ground water rising into Los Osos Creek, not an estimate of total surface flows.

Warden Drain Outflow = 88 AFY

Model derived.

Well Production (WP) = 390 AFY

320 AFY irrigation; 70 AFY domestic

Subsurface Cross Flow (SCF) = 546 AFY

SCF = PP/IR + SR + LCI + SI - WP - LOC. The amount of SCF moving into upper aquifer is 51 AFY and the amount moving into the lower aquifer is 495 AFY, which is calculated from the known budget items using the flow diagram.

**Upper Aquifer**

Total recharge = 2,615 AFY
    Total model recharge (3,178 AFY) minus creek compartment recharge (563 AFY)

Septic Return (SR) = 44 AFY
    Yates Table 9, column 9, zones 2-16.

Perc of Precip/Irrigation Return (PP/IR) = 1,489 AFY
    Upper aquifer recharge (2,615 AFY) minus perched aquifer LK/SCF (634 AFY) minus septic return (44 AFY) minus Broderson site disposal (448 AFY).

Subsurface inflow to upper aquifer from uplifted basin area in Bayview Heights = 100 AFY
    Model derived

Well Production (WP) = 803 AFY
    Purveyor production records and domestic well estimates

Subsurface Outflow (SO) = 1,207 AFY
    General head boundary (see model totals).

Leakage to lower aquifer (LK): 754 AFY
    Model derived.

**Lower Aquifer**

Well Production (WP) = 1,557 AFY
    Purveyor production records minus 160 AFY conservation (applied to west side)

Sea Water Intrusion (SWI) = 308 AFY
    General head boundary (see model totals).

## HYDROLOGIC BUDGET

## PROJECT VPA2b

**Project Description**

Septic flow collection: 997 AFY (initial prohibition zone flows after conservation).
Water conservation: 160 AFY (entered as reduction in west side lower aquifer production)
Wastewater disposal at Broderson Site: 448 AFY
Wastewater disposal at spray field (out of basin): 549 AFY

**Model totals**

Recharge (PP/IR/SR) = 3,178 AFY

Yates (2003) Table 9, column 12, zones 2-229 (2,885 AFY), plus 448 AFY Broderson disposal, minus 155 AFY due to a reduction in model area. Note that middle school septic was not collected in 2003 analysis. Adjustment has been made to collect 13 AFY middle school wastewater from zone 209, which is where the leach field is. Zone 109 septic returns also identified as the school (8 AFY) are reassigned to several existing homes outside of PZ in this area and are not collected. Another modification from the Yates 2003 tables is that zone 107 (east side low density) is not in the prohibition zone and septic flows would not be collected, adding 28 AFY of recharge.

Los Osos Creek inflow = 665 AFY

This value is calculated by model. Intermittent stream gage data shows average surface flows of 3,900 AFY and median flows of 2,200 AFY (1977-2000), indicating water is available.

Subsurface inflow from bedrock = 166 AFY

Calibration derived (discussed in 2005 Sea Water Intrusion study). Modified from fixed inflow to head-dependent.

Subsurface inflow to upper aquifer from uplifted basin area in Bayview Heights = 107 AFY

Subsurface inflow from ocean (general head boundary inflow) = 430 AFY

Includes 352 AFY net sea water intrusion and 78 AFY of recirculating water beneath the Morro Bay sandspit (model derived).

**Total Inflow: 4,546 AFY**

Basin well production (WP) = 3,230 AFY

2280 AFY purveyor w/sea pines golf (production records)
800 AFY creek valley irrigation (approx 650 acres of ag lands, mostly truck crops)
70 AFY creek valley domestic (approx 75 homes)
80 AFY urban area non-purveyor domestic (approx 100 homes)

Los Osos Creek outflow = 60 AFY

This value is calculated by model. Does not include surface water runoff from watershed..

Warden drain outflow = 9 AFY

Subsurface outflow to ocean (general head boundary outflow) = 1,247 AFY

Includes 1,169 AFY net upper aquifer outflow and 78 AFY of recirculating water beneath the Morro Bay sandspit.

**Total Outflow: 4,546 AFY**

**Perched Aquifer**

Septic Return (SR) = 36 AFY

Yates (2003) Table 9, column 9, zones 105-128, plus 28 AFY added for zone 107 which is not in prohibition zone.

Perc of Precip/Irrigation Return (PP/IR) = 736 AFY

Yates Table 4, column 10, zones 105-128 (1,367) minus pre-project Septic Return (631 AFY). Note that the PP/IR value using Table 9 (with 28 AFY adjustment for zone 107) would be 714 AFY (750 AFY - 36AFY), mainly because the area of zone 116 is reduced in Table 9 to allow for east side disposal zones 304, 305, and 306. To conform to the County VPA's, the 300-series zones have been reverted back to their 100-series counterparts, except Broderson. Therefore, in the perched aquifer columns, Yates Table 9 becomes the same as Table 4.

Total leakage through clay (LK) = 381 AFY

Yates Table 9, column 12, zones 105-128, with the zone 107 adjusted from Table 4. Out of the 381 AFY total perched aquifer leakage, 364 AFY enters upper aquifer and 17 AFY enters creek compartment (model derived).

Total Subsurface Cross Flow (SCF) = 356 AFY

Yates Table 9, column 12, zones 205-229 minus column 11, zones 205-229 with adjustment for zone 209. Out of the 356 AFY total subsurface cross flow (spilling off edge of perching clay), 270 AFY enters upper aquifer and 86 AFY enters creek compartment (difference for 20% of zone 206 and zones 220, 221, and 229).

Willow Creek/Evapotranspiration (WC/ET) = 35 AFY

WC/ET = SR + PP/IR - LK - SCF. Note that this outflow from ground water system, and does not include surface water inflow/outflow.

**Creek Compartment**

Recharge (from LK/SCF, PP/IR, and SR) = 563 AFY

Yates Table 9, column 12, zones 20-28, plus approx. 20% of zone 206, and zones 220, 221, and 229 (558 AFY in tables, 563 AFY in model).

Septic Return (SR) = 30 AFY

Yates Table 9, column 9, zones 20, 24, 25, 220, and 229.

Perc of Precip/Irrigation Return (PP/IR) = 430 AFY

PP/IR = Total recharge - SR - LK/SCF (from perched aquifer)

Subsurface Inflow (SI) = 166 AFY from bedrock. Model calibration value.

Los Osos Creek Inflow (LCI) = 665 AFY

Model derived (see model totals above).

Los Osos Creek Outflow (LCO) = 60 AFY

Model derived. This is ground water rising into Los Osos Creek, not an estimate of total surface flows.

Warden Drain Outflow = 9 AFY

Model derived.

Well Production (WP) = 870 AFY

800 AFY irrigation; 70 AFY domestic

Subsurface Cross Flow (SCF) = 455 AFY

SCF = PP/IR + SR + LCI + SI - WP - LOC. The amount of SCF moving into upper aquifer is 85 AFY and the amount moving into the lower aquifer is 370 AFY, which is calculated from the known budget items using the flow diagram

**Upper Aquifer**

Total recharge = 2,615 AFY

Total model recharge (3,178 AFY) minus creek compartment recharge (563 AFY)

Septic Return (SR) = 44 AFY

Yates Table 9, column 9, zones 2-16.

Perc of Precip/Irrigation Return (PP/IR) = 1,489 AFY

Upper aquifer recharge (2,615 AFY) minus perched aquifer LK/SCF (634 AFY) minus septic return (44 AFY) minus Broderson site disposal (448 AFY).

Subsurface Inflow (SI) = 107 AFY

Model derived. Leakage from uplifted basin area in Bayview Heights.

Well Production (WP) = 803 AFY

Purveyor production records and domestic well estimates

Subsurface Outflow (SO) = 1,169 AFY

General head boundary (see model totals).

Leakage to lower aquifer (LK): 835 AFY

Model derived.

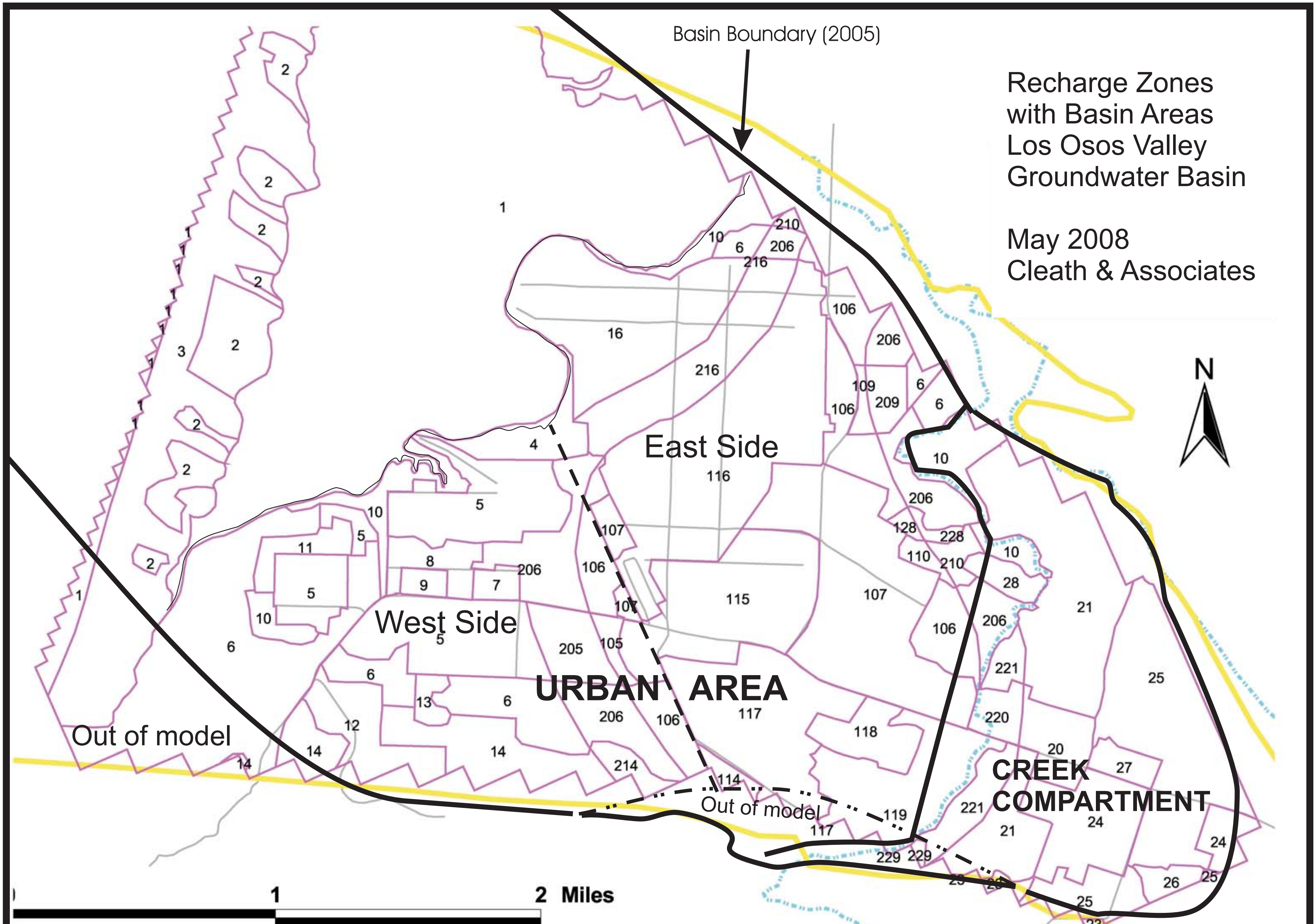
**Lower Aquifer**

Well Production (WP) = 1,557 AFY

Purveyor production records minus 160 AFY conservation (applied to west side)

Sea Water Intrusion (SWI) = 352 AFY

General head boundary (see model totals).



Recharge zone source: Yates and Williams (2003)
Basin area sources: Cleath & Associates (2002, 2005)

**Table 4. Simulated Average Annual Recharge and Nitrogen Loads under Existing Conditions with 2000-2002 Hydrology**

| | | | | | | | | | Groundwater Recharge | | | Nitrogen Before Perching Effects | | | Nitrogen After Perching Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zone Number | Land Use | Zone Area (acres) | Rainfall (ac-ft/yr) | Runoff (ac-ft/yr) | Evapo-transpir-ation (ET) (ac-ft/yr) | Irrigation (ac-ft/yr) | Residual Potential ET (ac-ft/yr) | Septic System Leachate (ac-ft/yr) | Before Perching Effects (ac-ft/yr) | After Perching Effects (ac-ft/yr) | After Perching Effects (in/yr) | Load (lb/yr) | Concentration (lb/ac-ft) | Concentration (mg/l) | Load (lb/yr) | Concentration (lb/ac-ft) | Concentration (mg/l) |
| 2 | Sandspit Shrubs | 202 | 274 | 22 | 165 | 0 | 0 | 0 | 64 | 64 | 3.8 | 1,008 | 15.9 | 5.8 | 1,007 | 15.9 | 5.8 |
| 3 | Sandspit Bare | 472 | 639 | 51 | 139 | 0 | 0 | 0 | 443 | 443 | 11.3 | 2,364 | 5.3 | 2.0 | 2,363 | 5.3 | 2.0 |
| 4 | Shoreline Shrubs/Trees | 47 | 66 | 6 | 41 | 0 | 61 | 0 | 13 | 13 | 3.3 | 228 | 17.5 | 6.4 | 229 | 17.5 | 6.4 |
| 5 | Residential Med. Density | 290 | 406 | 220 | 246 | 182 | 63 | 216 | 471 | 471 | 19.5 | 13,620 | 28.9 | 10.6 | 13,622 | 28.9 | 10.6 |
| 6 | Undeveloped Grass/Shrub | 452 | 633 | 53 | 342 | 0 | 0 | 0 | 198 | 198 | 5.2 | 5,160 | 26.1 | 9.6 | 5,159 | 26.1 | 9.6 |
| 7 | Residential Low Density | 14 | 19 | 5 | 11 | 4 | 3 | 2 | 11 | 11 | 9.4 | 708 | 65.8 | 24.2 | 706 | 65.8 | 24.2 |
| 8 | Residential Low Density | 34 | 47 | 13 | 30 | 9 | 51 | 2 | 20 | 20 | 7.0 | 816 | 41.8 | 15.4 | 815 | 41.8 | 15.4 |
| 9 | Monarch Elementary | 11 | 16 | 7 | 14 | 13 | 2 | 8 | 20 | 20 | 21.1 | 576 | 29.3 | 10.8 | 578 | 29.3 | 10.8 |
| 10 | Undeveloped Trees | 154 | 216 | 42 | 161 | 0 | 313 | 0 | 0 | 0 | 0.0 | 768 | undefined | undefined | undefined | undefined | undefined |
| 11 | Sea Pines Golf Course | 26 | 36 | 3 | 67 | 67 | 0 | 5 | 37 | 37 | 17.3 | 1,032 | 27.7 | 10.2 | 1,032 | 27.7 | 10.2 |
| 12 | Cabrillo Estates | 65 | 94 | 34 | 54 | 24 | 14 | 42 | 86 | 86 | 15.8 | 2,700 | 31.5 | 11.6 | 2,701 | 31.5 | 11.6 |
| 13 | Horse Ranch | 13 | 19 | 5 | 16 | 13 | 0 | 2 | 16 | 16 | 14.5 | 1,260 | 81.1 | 29.8 | 1,257 | 81.1 | 29.8 |
| 14 | Undeveloped Shrubs | 114 | 170 | 16 | 94 | 0 | 0 | 0 | 48 | 48 | 5.0 | 756 | 15.8 | 5.8 | 757 | 15.8 | 5.8 |
| 16 | Residential Med. Density | 209 | 292 | 158 | 174 | 131 | 45 | 187 | 404 | 404 | 23.2 | 11,592 | 28.7 | 10.5 | 11,592 | 28.7 | 10.5 |
| 20 | Residential Med. Density | 45 | 65 | 24 | 40 | 14 | 9 | 17 | 39 | 39 | 10.4 | 1,476 | 38.0 | 14.0 | 1,473 | 38.0 | 14.0 |
| 21 | Irrigated Crops | 259 | 375 | 76 | 277 | 191 | 0 | 0 | 200 | 200 | 9.3 | 7,020 | 35.1 | 12.9 | 7,024 | 35.1 | 12.9 |
| 24 | Nonirrigated Crops | 111 | 160 | 70 | 66 | 0 | 0 | 2 | 34 | 34 | 3.7 | 2,124 | 62.6 | 23.0 | 2,124 | 62.6 | 23.0 |
| 25 | Nonirrigated Pasture | 245 | 354 | 155 | 146 | 0 | 0 | 2 | 72 | 72 | 3.5 | 4,296 | 59.4 | 21.8 | 4,298 | 59.4 | 21.8 |
| 26 | Irrigated Pasture | 15 | 22 | 8 | 24 | 18 | 0 | 0 | 7 | 7 | 5.3 | 444 | 66.9 | 24.6 | 437 | 66.9 | 24.6 |
| 27 | Cemetery | 19 | 28 | 12 | 25 | 18 | 0 | 0 | 9 | 9 | 5.9 | 492 | 52.5 | 19.3 | 490 | 52.5 | 19.3 |
| 28 | Irrigated Crops | 20 | 28 | 2 | 31 | 29 | 0 | 0 | 24 | 24 | 14.5 | 600 | 24.8 | 9.1 | 599 | 24.8 | 9.1 |
| 105 | Residential Med. Density | 12 | 17 | 11 | 8 | 4 | 3 | 7 | 15 | 4 | 4.4 | 504 | 34.4 | 12.7 | 156 | 35.7 | 13.1 |
| 106 | Undeveloped Grass/Shrub | 192 | 268 | 98 | 150 | 0 | 0 | 0 | 6 | 6 | 0.4 | 2,184 | undefined | undefined | 1,944 | 331.4 | 121.9 |
| 107 | Residential Low Density | 274 | 389 | 193 | 212 | 73 | 61 | 28 | 133 | 94 | 4.1 | 7,332 | 55.2 | 20.3 | 5,885 | 62.9 | 23.1 |
| 109 | High School | 8 | 12 | 6 | 9 | 6 | 0 | 8 | 13 | 3 | 4.4 | 552 | 42.8 | 15.7 | 134 | 44.0 | 16.2 |
| 110 | Uindeveloped Marsh/Trees | 10 | 14 | 1 | 9 | 0 | 21 | 0 | 2 | 1 | 1.7 | 48 | 20.9 | 7.7 | 28 | 20.2 | 7.4 |
| 114 | Undeveloped Shrubs | 10 | 14 | 1 | 8 | 0 | 0 | 0 | 4 | 2 | 3.0 | 60 | 14.9 | 5.5 | 50 | 20.4 | 7.5 |
| 115 | Commercial | 176 | 250 | 159 | 90 | 65 | 0 | 208 | 317 | 64 | 4.4 | 11,268 | 35.6 | 13.1 | 2,351 | 36.6 | 13.5 |
| 116 | Residential Med. Density | 319 | 446 | 242 | 265 | 200 | 69 | 272 | 560 | 116 | 4.4 | 17,112 | 30.6 | 11.2 | 3,759 | 32.3 | 11.9 |
| 117 | Bayview Heights | 166 | 247 | 113 | 155 | 104 | 35 | 66 | 212 | 61 | 4.4 | 5,124 | 24.2 | 8.9 | 1,610 | 26.6 | 9.8 |
| 118 | Mobile Homes | 45 | 67 | 55 | 19 | 17 | 0 | 42 | 63 | 16 | 4.4 | 2,400 | 38.3 | 14.1 | 643 | 39.3 | 14.4 |
| 119 | Undeveloped Trees | 121 | 180 | 17 | 112 | 0 | 205 | 0 | 36 | 20 | 2.0 | 600 | 16.7 | 6.1 | 579 | 28.8 | 10.6 |
| 128 | Irrigated Crops | 5 | 7 | 1 | 8 | 7 | 0 | 0 | 6 | 2 | 4.3 | 144 | 23.6 | 8.7 | 51 | 28.4 | 10.4 |
| 205 | Residential Med. Density | 44 | 64 | 35 | 38 | 28 | 9 | 28 | 75 | 112 | 30.4 | 1,848 | 24.8 | 9.1 | 3,039 | 27.2 | 10.0 |
| 206 | Undeveloped Grass/Shrub | 210 | 314 | 29 | 163 | 0 | 0 | 0 | 103 | 280 | 16.0 | 2,400 | 23.2 | 8.5 | 8,098 | 28.9 | 10.6 |
| 209 | High School | 22 | 30 | 11 | 31 | 28 | 0 | 13 | 35 | 53 | 29.4 | 1,008 | 29.0 | 10.7 | 1,597 | 30.1 | 11.1 |
| 210 | Uindeveloped Marsh/Trees | 18 | 25 | 2 | 17 | 0 | 39 | 0 | 4 | 19 | 13.0 | 96 | 22.5 | 8.3 | 579 | 29.8 | 11.0 |
| 214 | Undeveloped Shrubs | 18 | 26 | 2 | 15 | 0 | 0 | 0 | 7 | 22 | 15.1 | 120 | 16.2 | 6.0 | 593 | 26.7 | 9.8 |
| 216 | Residential Med. Density | 110 | 154 | 84 | 91 | 69 | 24 | 98 | 198 | 290 | 31.6 | 6,108 | 30.9 | 11.4 | 9,091 | 31.3 | 11.5 |
| 220 | Residential Low-Density | 23 | 33 | 12 | 20 | 7 | 5 | 8 | 20 | 38 | 20.4 | 744 | 38.2 | 14.0 | 1,109 | 28.8 | 10.6 |
| 221 | Irrigated Crops | 53 | 79 | 17 | 56 | 39 | 0 | 0 | 43 | 88 | 19.8 | 1,440 | 33.6 | 12.4 | 3,082 | 35.2 | 12.9 |
| 228 | Irrigated Crops | 7 | 9 | 1 | 10 | 10 | 0 | 0 | 8 | 13 | 24.9 | 192 | 23.7 | 8.7 | 371 | 27.6 | 10.1 |
| 229 | Horse Ranch | 3 | 4 | 1 | 3 | 2 | 0 | 1 | 3 | 5 | 23.5 | 1,032 | 344.0 | 126.5 | 1,109 | 226.4 | 83.2 |
| | Total | 4,658 | 6,606 | 2,073 | 3,652 | 1,368 | 1,031 | 1,267 | 4,075 | 3,525 | n.a. | 121,356 | n.a. | n.a. | 104,122 | n.a. | n.a. |
| | Average | | | | | | | | | | 9.1 | | 29.8 | 10.9 | | 29.5 | 10.9 |

Notes:
1) In zones where simulated recharge is zero, N concentration is undefined. 2) n.a. = not applicable

## Table 9. Simulated Average Annual Recharge and Nitrogen Loads with Proposed Sewer Project and 2000-2002 Hydrology

| Zone Number | Land Use | Zone Area (acres) | Rainfall (ac-ft/yr) | Runoff (ac-ft/yr) | Evapo-transpir-ation (ET) (ac-ft/yr) | Irrigation (ac-ft/yr) | Residual Potential ET (ac-ft/yr) | Septic System Leachate (ac-ft/yr) | WWTP Perco-lation (ac-ft/yr) | Groundwater Recharge: Before Perching Effects (ac-ft/yr) | Groundwater Recharge: After Perching Effects (ac-ft/yr) | Groundwater Recharge: After Perching Effects (in/yr) | Nitrogen Before Perching Effects: Load (lb/yr) | Nitrogen Before Perching Effects: Concentration (lb/ac-ft) | Nitrogen Before Perching Effects: Concentration (mg/l) | Nitrogen After Perching Effects: Load (lb/yr) | Nitrogen After Perching Effects: Concentration (lb/ac-ft) | Nitrogen After Perching Effects: Concentration (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Sandspit Shrubs | 202 | 274 | 22 | 165 | 0 | 0 | 0 | 0 | 64 | 64 | 3.8 | 1,008 | 15.9 | 5.8 | 1,007 | 15.9 | 5.8 |
| 3 | Sandspit Bare | 472 | 639 | 51 | 139 | 0 | 0 | 0 | 0 | 443 | 443 | 11.3 | 2,364 | 5.3 | 2.0 | 2,363 | 5.3 | 2.0 |
| 4 | Shoreline Shrubs/Trees | 47 | 66 | 6 | 41 | 0 | 61 | 0 | 0 | 13 | 13 | 3.3 | 228 | 17.5 | 6.4 | 229 | 17.5 | 6.4 |
| 5 | Residential Med. Density | 288 | 403 | 219 | 245 | 181 | 62 | 0 | 0 | 253 | 253 | 10.5 | 3,876 | 15.3 | 5.6 | 3,875 | 15.3 | 5.6 |
| 6 | Undeveloped Grass/Shrub | 441 | 617 | 52 | 334 | 0 | 0 | 0 | 0 | 193 | 193 | 5.2 | 5,028 | 26.1 | 9.6 | 5,027 | 26.1 | 9.6 |
| 7 | Residential Low Density | 12 | 17 | 5 | 10 | 3 | 2 | 0 | 0 | 8 | 8 | 7.5 | 600 | 75.9 | 27.9 | 585 | 75.9 | 27.9 |
| 8 | Residential Low Density | 34 | 47 | 13 | 30 | 9 | 51 | 0 | 0 | 17 | 17 | 6.2 | 732 | 42.1 | 15.5 | 732 | 42.1 | 15.5 |
| 9 | Monarch Elementary | 10 | 14 | 6 | 13 | 11 | 2 | 0 | 0 | 10 | 10 | 12.0 | 168 | 17.0 | 6.2 | 167 | 17.0 | 6.2 |
| 10 | Undeveloped Trees | 154 | 216 | 42 | 161 | 0 | 313 | 0 | 0 | 0 | 0 | 0.0 | 768 | undefined | undefined | undefined | undefined | undefined |
| 11 | Sea Pines Golf Course | 26 | 36 | 3 | 67 | 67 | 0 | 0 | 0 | 33 | 33 | 15.3 | 840 | 25.4 | 9.3 | 841 | 25.4 | 9.3 |
| 12 | Cabrillo Estates | 65 | 94 | 34 | 54 | 24 | 14 | 42 | 0 | 86 | 86 | 15.8 | 2,700 | 31.5 | 11.6 | 2,701 | 31.5 | 11.6 |
| 13 | Horse Ranch | 13 | 19 | 5 | 16 | 13 | 0 | 2 | 0 | 16 | 16 | 14.5 | 1,260 | 81.1 | 29.8 | 1,257 | 81.1 | 29.8 |
| 14 | Undeveloped Shrubs | 114 | 170 | 16 | 94 | 0 | 0 | 0 | 0 | 48 | 48 | 5.0 | 756 | 15.8 | 5.8 | 757 | 15.8 | 5.8 |
| 16 | Residential Med. Density | 209 | 292 | 158 | 174 | 131 | 45 | 0 | 0 | 218 | 218 | 12.5 | 3,192 | 14.7 | 5.4 | 3,191 | 14.7 | 5.4 |
| 20 | Residential Med. Density | 45 | 65 | 24 | 40 | 14 | 9 | 17 | 0 | 39 | 39 | 10.4 | 1,476 | 38.0 | 14.0 | 1,473 | 38.0 | 14.0 |
| 21 | Irrigated Crops | 259 | 375 | 76 | 277 | 191 | 0 | 0 | 0 | 200 | 200 | 9.3 | 7,020 | 35.1 | 12.9 | 7,024 | 35.1 | 12.9 |
| 24 | Nonirrigated Crops | 111 | 160 | 70 | 66 | 0 | 0 | 2 | 0 | 34 | 34 | 3.7 | 2,124 | 62.6 | 23.0 | 2,124 | 62.6 | 23.0 |
| 25 | Nonirrigated Pasture | 245 | 354 | 155 | 146 | 0 | 0 | 2 | 0 | 72 | 72 | 3.5 | 4,296 | 59.4 | 21.8 | 4,298 | 59.4 | 21.8 |
| 26 | Irrigated Pasture | 15 | 22 | 8 | 24 | 18 | 0 | 0 | 0 | 7 | 7 | 5.3 | 444 | 66.9 | 24.6 | 437 | 66.9 | 24.6 |
| 27 | Cemetery | 19 | 28 | 12 | 25 | 18 | 0 | 0 | 0 | 9 | 9 | 5.9 | 492 | 52.5 | 19.3 | 490 | 52.5 | 19.3 |
| 28 | Irrigated Crops | 20 | 28 | 2 | 31 | 29 | 0 | 0 | 0 | 24 | 24 | 14.5 | 600 | 24.8 | 9.1 | 599 | 24.8 | 9.1 |
| 105 | Residential Med. Density | 12 | 17 | 11 | 8 | 4 | 3 | 0 | 0 | 7 | 4 | 4.2 | 156 | 21.7 | 8.0 | 93 | 22.5 | 8.3 |
| 106 | Undeveloped Grass/Shrub | 190 | 266 | 98 | 149 | 0 | 0 | 0 | 0 | 6 | 6 | 0.4 | 2,172 | undefined | undefined | 1,933 | 331.4 | 121.9 |
| 107 | Residential Low Density | 274 | 389 | 193 | 212 | 73 | 61 | 0 | 0 | 105 | 79 | 3.4 | 6,096 | 57.8 | 21.3 | 4,983 | 63.4 | 23.3 |
| 109 | High School | 8 | 12 | 6 | 9 | 6 | 0 | 8 | 0 | 13 | 3 | 4.4 | 552 | 42.8 | 15.7 | 130 | 43.0 | 15.8 |
| 110 | Uindeveloped Marsh/Trees | 10 | 14 | 1 | 9 | 0 | 21 | 0 | 0 | 2 | 1 | 1.7 | 48 | 20.9 | 7.7 | 28 | 20.2 | 7.4 |
| 114 | Undeveloped Shrubs | 10 | 14 | 1 | 8 | 0 | 0 | 0 | 0 | 4 | 2 | 3.0 | 60 | 14.9 | 5.5 | 49 | 20.1 | 7.4 |
| 115 | Commercial | 176 | 250 | 159 | 90 | 65 | 0 | 0 | 0 | 109 | 61 | 4.2 | 1,920 | 17.6 | 6.5 | 1,379 | 22.5 | 8.3 |
| 116 | Residential Med. Density | 309 | 432 | 234 | 257 | 194 | 67 | 0 | 0 | 279 | 113 | 4.4 | 4,716 | 16.9 | 6.2 | 2,142 | 19.0 | 7.0 |
| 117 | Bayview Heights | 166 | 247 | 113 | 155 | 104 | 35 | 0 | 0 | 145 | 61 | 4.4 | 2,124 | 14.6 | 5.4 | 1,059 | 17.5 | 6.4 |
| 118 | Mobile Homes | 45 | 67 | 55 | 19 | 17 | 0 | 0 | 0 | 20 | 14 | 3.9 | 492 | 24.0 | 8.8 | 351 | 24.4 | 9.0 |
| 119 | Undeveloped Trees | 121 | 180 | 17 | 112 | 0 | 205 | 0 | 0 | 36 | 20 | 2.0 | 600 | 16.7 | 6.1 | 579 | 28.8 | 10.6 |
| 128 | Irrigated Crops | 5 | 7 | 1 | 8 | 7 | 0 | 0 | 0 | 6 | 2 | 4.3 | 144 | 23.6 | 8.7 | 51 | 28.4 | 10.4 |
| 205 | Residential Med. Density | 44 | 64 | 35 | 38 | 28 | 9 | 0 | 0 | 47 | 79 | 21.4 | 588 | 12.6 | 4.6 | 1,068 | 13.6 | 5.0 |
| 206 | Undeveloped Grass/Shrub | 209 | 312 | 29 | 162 | 0 | 0 | 0 | 0 | 103 | 254 | 14.6 | 2,376 | 23.1 | 8.5 | 5,096 | 20.0 | 7.4 |
| 209 | High School | 22 | 30 | 11 | 31 | 28 | 0 | 13 | 0 | 35 | 50 | 28.0 | 1,008 | 29.0 | 10.7 | 1,268 | 25.1 | 9.2 |
| 210 | Uindeveloped Marsh/Trees | 18 | 25 | 2 | 17 | 0 | 39 | 0 | 0 | 4 | 17 | 11.6 | 96 | 22.5 | 8.3 | 325 | 18.7 | 6.9 |
| 214 | Undeveloped Shrubs | 18 | 26 | 2 | 15 | 0 | 0 | 0 | 0 | 7 | 20 | 13.7 | 120 | 16.2 | 6.0 | 345 | 17.1 | 6.3 |
| 216 | Residential Med. Density | 110 | 154 | 84 | 91 | 69 | 24 | 0 | 0 | 99 | 179 | 19.5 | 1,680 | 16.9 | 6.2 | 2,607 | 14.5 | 5.3 |
| 220 | Residential Low-Density | 23 | 33 | 12 | 20 | 7 | 5 | 8 | 0 | 20 | 36 | 19.0 | 744 | 38.2 | 14.0 | 1,223 | 34.1 | 12.5 |
| 221 | Irrigated Crops | 53 | 79 | 17 | 56 | 39 | 0 | 0 | 0 | 43 | 81 | 18.4 | 1,440 | 33.6 | 12.4 | 2,131 | 26.2 | 9.6 |
| 228 | Irrigated Crops | 7 | 9 | 1 | 10 | 10 | 0 | 0 | 0 | 8 | 13 | 23.4 | 192 | 23.7 | 8.7 | 133 | 10.5 | 3.9 |
| 229 | Horse Ranch | 3 | 4 | 1 | 3 | 2 | 0 | 1 | 0 | 3 | 5 | 22.1 | 1,032 | 344.0 | 126.5 | 1,062 | 230.8 | 84.9 |
| 301 | WW Perc. Broderson | 12 | 16 | 1 | 9 | 0 | 0 | 0 | 908 | 913 | 913 | 952.7 | 17,388 | 19.0 | 7.0 | 17,380 | 19.0 | 7.0 |
| 302 | WW Perc. Monarch Grove | 1 | 2 | 1 | 2 | 2 | 0 | 0 | 78 | 80 | 80 | 684.9 | 1,512 | 18.9 | 6.9 | 1,517 | 19.0 | 7.0 |
| 303 | WW Perc. LOVR-Pine | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 56 | 57 | 57 | 487.7 | 1,080 | 18.9 | 7.0 | 1,542 | 27.1 | 10.0 |
| 304 | WW Perc. Pismo | 6 | 8 | 4 | 5 | 4 | 1 | 0 | 179 | 184 | 2 | 4.4 | 3,492 | 18.9 | 7.0 | 40 | 18.9 | 7.0 |
| 305 | WW Perc. Santa Maria | 4 | 6 | 3 | 4 | 3 | 1 | 0 | 179 | 183 | 2 | 4.4 | 3,468 | 18.9 | 7.0 | 30 | 18.9 | 7.0 |
| 306 | WW Perc. El Moro | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 56 | 57 | 58 | 495.1 | 1,080 | 19.0 | 7.0 | 1,100 | 19.0 | 7.0 |
| 307 | WW Perc. South Bay | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 90 | 90 | 1 | 4.6 | 1,716 | 19.1 | 7.0 | 10 | 19.2 | 7.0 |
| 308 | WW Perc. Vista de Oro | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 23 | 24 | 24 | 202.6 | 444 | 18.7 | 6.9 | 443 | 18.7 | 6.9 |
| | Total | 4,658 | 6,606 | 2,073 | 3,652 | 1,368 | 1,030 | 97 | 1,570 | 4,477 | 4,022 | n.a. | 98,508 | n.a. | n.a. | 89,275 | n.a. | n.a. |
| | Average | | | | | | | | | | | 10.4 | | 22.0 | 8.1 | | 22.2 | 8.2 |

Notes:
1) In zones where simulated recharge is zero, N concentration is undefined. 2) n.a. = not applicable

# APPENDIX D
# WATER QUALITY
# MASS BALANCE SUMMARY

## Table D1 - TDS Loading, Perched Aquifer (Current Conditions)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| PRECIPITATION | 558[2] | 0 | 0.0 |
| IRRIGATION | 178[2] | 868[4] | 210 |
| SEPTAGE | 631[1] | 620[3] | 531.9 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 742.0 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 1,367 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 399 |

[1] - CLEATH, 2008
[2] - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
[3] - FROM FINE SCREENING REPORT
[4] - ESTIMATION BASED ON IRRIGATION WATER AT 330 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION

## Table D2 - TDS Loading, Perched Aquifer (Post Project Conditions)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| PRECIPITATION | 558[2] | 0 | 0.0 |
| IRRIGATION | 178[2] | 868[4] | 210 |
| SEPTAGE | 36[1] | 620[3] | 30.3 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 240.4 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 772 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 229 |

[1] - CLEATH, 2008
[2] - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
[3] - FROM FINE SCREENING REPORT
[4] - ESTIMATION BASED ON IRRIGATION WATER AT 330 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION

## Table D3 - TDS Loading, Creek Compartment (Current Conditions)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| SEPTAGE | 30[1] | 620[3] | 25 |
| PRECIPITATION | 326[2] | 0 | 0 |
| IRRIGATION | 104[2] | 1,368[4] | 193 |
| LK/SCF[7] FROM PERCHED | 117[1] | 399[5] | 63 |
| LOS OSOS CREEK INFLOW | 665[1] | 540[6] | 488 |
| SUBSURFACE INFLOW | 167[1] | 470[6] | 107 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 877.2 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 1,409 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 458 |

1 - CLEATH, 2008
2 - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
3 - FINE SCREENING REPORT
4 - ESTIMATION BASED ON IRRIGATION WATER AT 520 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION
5 - ESTIMATION FROM TABLE 1
6 - CLEATH, 2005c
7 - LEAKANCE/SUBSURFACE CROSS FLOW

## Table D4 - TDS Loading, Creek Compartment (VPA2a)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| SEPTAGE | 30[1] | 620[3] | 25 |
| PRECIPITATION | 326[2] | 0 | 0 |
| IRRIGATION | 104[2] | 1,632[4] | 231 |
| LK/SCF[7] FROM PERCHED | 103[1] | 229[5] | 32 |
| LO CREEK INFLOW | 492[1] | 540[6] | 361 |
| SUBSURFACE INFLOW | 137[1] | 470[6] | 88 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 736.9 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 1,192 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 455 |

1 - CLEATH, 2008
2 - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
3 - FINE SCREENING REPORT
4 - ESTIMATION BASED ON IRRIGATION WATER AT 620 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION
5 - ESTIMATION FROM TABLE 2
6 - CLEATH, 2005c
7 - LEAKANCE/SUBSURFACE CROSS FLOW

## Table D5 - TDS Loading, Creek Compartment (VPA2b)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| SEPTAGE | 30 [1] | 620 [3] | 25 |
| PRECIPITATION | 326 [2] | 0 | 0 |
| IRRIGATION | 104 [2] | 1,368 [4] | 193 |
| LK/SCF[7] FROM PERCHED | 103 [1] | 229 [5] | 32 |
| LOS OSOS CREEK INFLOW | 665 [1] | 540 [6] | 488 |
| SUBSURFACE INFLOW | 166 [1] | 470 [6] | 106 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 845.1 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 1,394 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 446 |

[1] - CLEATH, 2008
[2] - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
[3] - FINE SCREENING REPORT
[4] - ESTIMATION BASED ON IRRIGATION WATER AT 520 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION
[5] - ESTIMATION FROM TABLE 2
[6] - CLEATH, 2005c
[7] - LEAKANCE/SUBSURFACE CROSS FLOW

## Table D6 - TDS Loading, UAS, Broderson (Current Conditions)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| SEPTAGE | 606[1] | 620[3] | 511 |
| PRECIPITATION | 1,129[2] | 0 | 0 |
| IRRIGATION | 360[2] | 868[4] | 425 |
| LK/SCF[7] FROM PERCHED | 698[1] | 399[5] | 379 |
| LK/SCF[7] FROM CC[8] | 90[1] | 520[6] | 64 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 1,378.0 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 2,883 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 352 |

[1] - CLEATH, 2008
[2] - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
[3] - FINE SCREENING REPORT
[4] - ESTIMATION BASED ON IRRIGATION WATER AT 330 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION
[5] - ESTIMATION FROM TABLE 1
[6] - CLEATH, 2005c
[7] - LEAKANCE/SUBSURFACE CROSS FLOW
[8] - CREEK COMPARTMENT

## Table D7 - TDS Loading, UAS, Broderson (VPA2a)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| SEPTAGE | 44[1] | 620[3] | 37.1 |
| PRECIPITATION | 1,129[2] | 0 | 0 |
| IRRIGATION | 360[2] | 868[4] | 424.9 |
| LK/SCF[7] FROM PERCHED | 634[1] | 229[5] | 197.4 |
| LK/SCF[7] FROM CC[8] | 51[1] | 520[6] | 36.1 |
| BRODERSON | 448[1] | 620[3] | 377.7 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 1,073.1 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 2,666 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 296 |

[1] - CLEATH, 2008
[2] - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
[3] - FINE SCREENING REPORT
[4] - ESTIMATION BASED ON IRRIGATION WATER AT 330 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION
[5] - ESTIMATION FROM TABLE 2
[6] - CLEATH, 2005c
[7] - LEAKANCE/SUBSURFACE CROSS FLOW
[8] - CREEK COMPARTMENT

# Table D8 - TDS Loading, UAS, Broderson (VPA2b)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| SEPTAGE | 44 [1] | 620 [3] | 37.1 |
| PRECIPITATION | 1,129 [2] | 0 | 0.0 |
| IRRIGATION | 360 [2] | 868 [4] | 424.9 |
| LK/SCF [7] FROM PERCHED | 634 [1] | 229 [5] | 197.4 |
| LK/SCF [7] FROM CC [8] | 85 [1] | 520 [6] | 60.1 |
| BRODERSON | 448 [1] | 620 [3] | 377.7 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 1,097.1 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 2,700 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 299 |

[1] - CLEATH, 2008
[2] - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
[3] - FINE SCREENING REPORT
[4] - ESTIMATION BASED ON IRRIGATION WATER AT 330 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION
[5] - ESTIMATION FROM TABLE 2
[6] - CLEATH, 2005c
[7] - LEAKANCE/SUBSURFACE CROSS FLOW
[8] - CREEK COMPARTMENT

## Table D9 - TDS Loading, UAS, Broderson (VPA2a)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| SEPTAGE | 44 [1] | 620 [3] | 37.1 |
| PRECIPITATION | 1,129 [2] | 0 | 0 |
| IRRIGATION | 360 [2] | 868 [4] | 424.9 |
| LK/SCF[7] FROM PERCHED | 634 [1] | 229 [5] | 197.4 |
| LK/SCF[7] FROM CC[8] | 51 [1] | 520 [6] | 36.1 |
| BRODERSON | 896 [9] | 620 [3] | 755.3 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 1,450.8 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 3,114 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 343 |

1 - CLEATH, 2008
2 - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
3 - FINE SCREENING REPORT
4 - ESTIMATION BASED ON IRRIGATION WATER AT 330 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION
5 - ESTIMATION FROM TABLE 2
6 - CLEATH, 2005c
7 - LEAKANCE/SUBSURFACE CROSS FLOW
8 - CREEK COMPARTMENT
9 - INITIAL PROPOSED DISPOSAL RATE, CLEATH, 2000

# Table D10 - TDS Loading, UAS, Broderson (VPA2b)

| WATER SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| SEPTAGE | 44 [1] | 620 [3] | 37.1 |
| PRECIPITATION | 1,129 [2] | 0 | 0.0 |
| IRRIGATION | 360 [2] | 868 [4] | 424.9 |
| LK/SCF [7] FROM PERCHED | 634 [1] | 229 [5] | 197.4 |
| LK/SCF [7] FROM CC [8] | 85 [1] | 520 [6] | 60.1 |
| BRODERSON | 896 [9] | 620 [3] | 755.3 |
| TOTAL ANNUAL LOAD TO SYSTEM (TONS) | | | 1,474.8 |
| TOTAL VOLUME OF DISCHARGE TO GROUNDWATER (AFY) | | | 3,148 |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 345 |

[1] - CLEATH, 2008
[2] - CALCULATED BASED ON TABLE 4 (YATES AND WILLIAMS, 2003)
[3] - FINE SCREENING REPORT
[4] - ESTIMATION BASED ON IRRIGATION WATER AT 330 MG/L TDS WITH 62 PERCENT ET AND 38 PERCENT PERCOLATION
[5] - ESTIMATION FROM TABLE 2
[6] - CLEATH, 2005c
[7] - LEAKANCE/SUBSURFACE CROSS FLOW
[8] - CREEK COMPARTMENT
[9] - INITIAL PROPOSED DISPOSAL RATE, CLEATH, 2000

## Table D11 - N03-N Loading Under Current Conditions

| SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| UPPER AQUIFER | 3,525[1] | 10.86[2] | 52.1 |
| TOTAL N03-N LOAD TO SYSTEM (POUNDS) | | | 104,120[2] |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 10.9[3] |

[1] - TOTAL BASED ON TABLE 4, COLUMN 11 (YATES AND WILLIAMS, 2003)
[2] - TOTAL BASED ON TABLE 4, COLUMN 16 (YATES AND WILLIAMS, 2003)
[3] - CONCENTRATION CALCULATED FROM TOTAL VOLUME OF WATER AND TOTAL N03-N LOAD TO SYSTEM (POUNDS)

## Table D12 - N03-N Loading With Broderson at 448 AFY

| SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| UPPER AQUIFER | 3,337[1] | 8.35[3] | 37.9 |
| TOTAL N03-N LOAD TO SYSTEM (POUNDS) | | | 75,740[2] |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 8.3[3] |

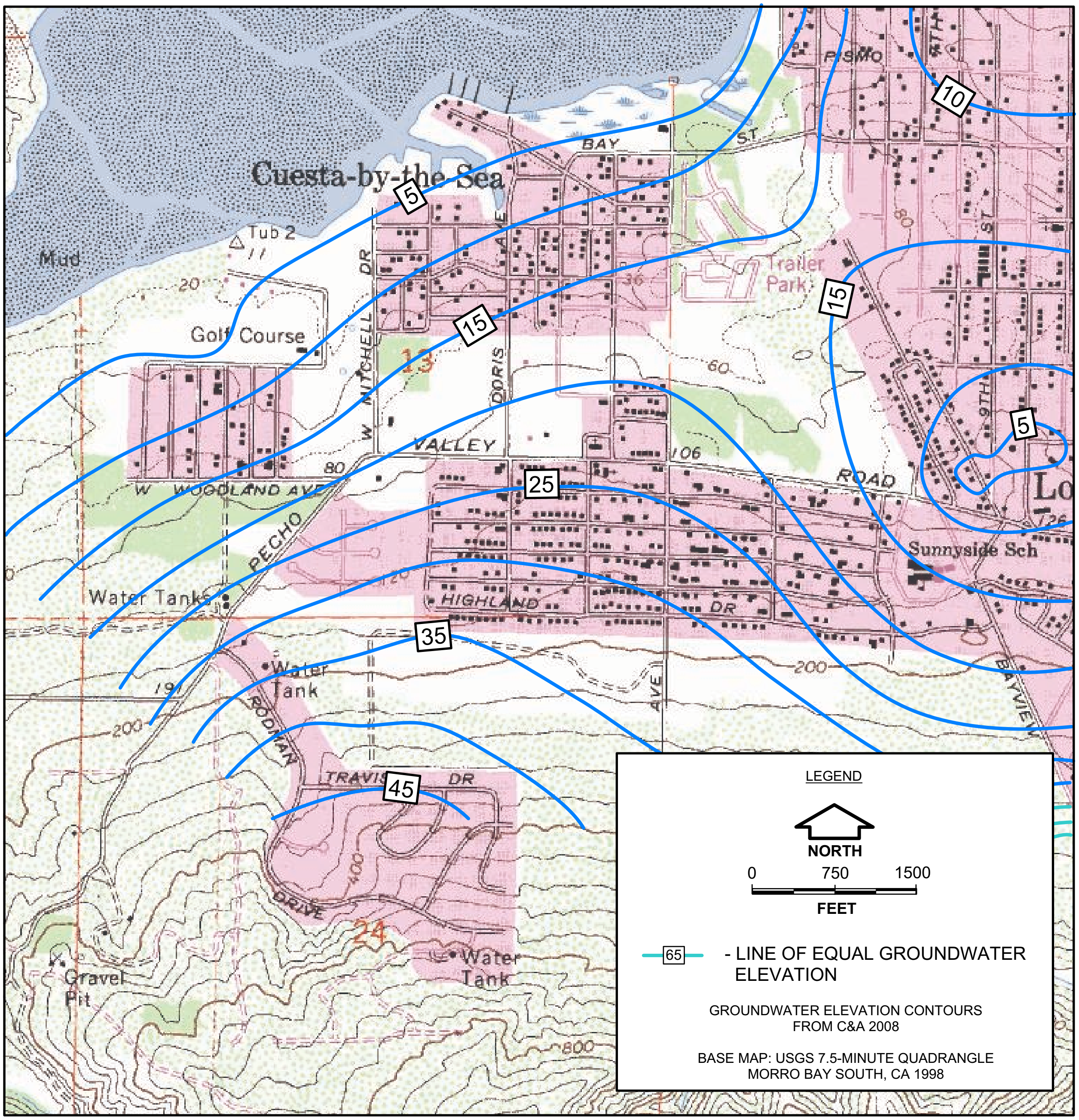
[1] - TOTAL BASED ON TABLE 9, COLUMN 13 (YATES AND WILLIAMS, 2003) WITH BRODERSON AS ONLY DISPOSAL SITE
[2] - TOTAL BASED ON TABLE 9, COLUMN 17 (YATES AND WILLIAMS, 2003)
[3] - CONCENTRATION CALCULATED FROM TOTAL VOLUME OF WATER AND TOTAL N03-N LOAD TO SYSTEM (POUNDS)

## Table D13 - N03-N Loading With Broderson at 896 AFY

| SOURCE | TOTAL VOLUME (AFY) | CONCENTRATION (MG/L) | TOTAL LOAD (TONS) |
|---|---|---|---|
| UPPER AQUIFER | 3,785[1] | 8.19[3] | 42.1 |
| TOTAL N03-N LOAD TO SYSTEM (POUNDS) | | | 84,268[2] |
| ESTIMATED CONCENTRATION OF DISCHARGE TO GROUNDWATER (MG/L) | | | 8.2[3] |

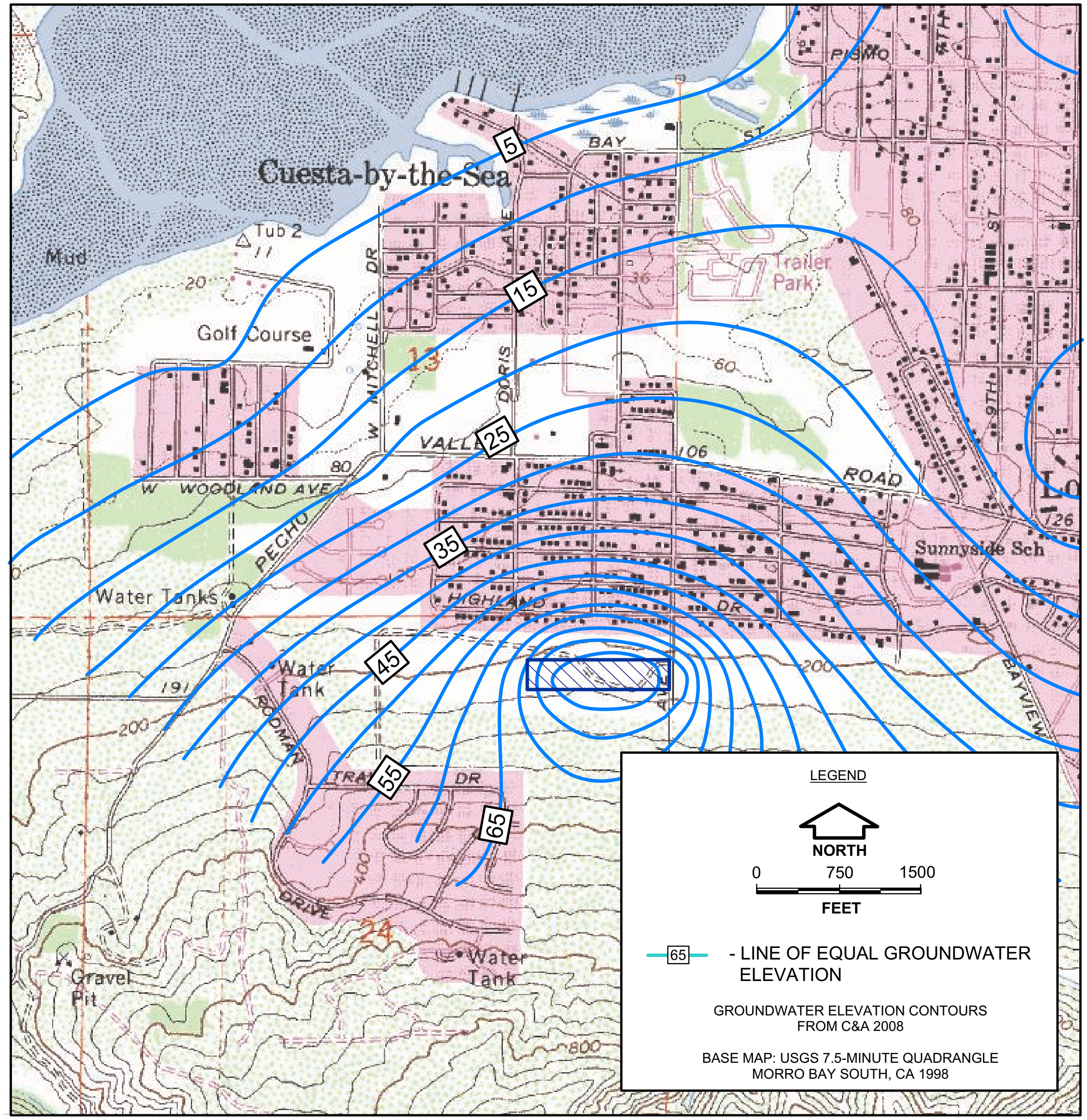
[1] - TOTAL BASED ON TABLE 9, COLUMN 13 (YATES AND WILLIAMS, 2003) WITH BRODERSON AS ONLY DISPOSAL SITE
[2] - TOTAL BASED ON TABLE 9, COLUMN 17 (YATES AND WILLIAMS, 2003)
[3] - CONCENTRATION CALCULATED FROM TOTAL VOLUME OF WATER AND TOTAL N03-N LOAD TO SYSTEM (POUNDS)

# APPENDIX E
# WATER LEVEL CONTOUR MAPS




**GROUNDWATER ELEVATION CONTOUR MAP**
**CURRENT CONDITIONS**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

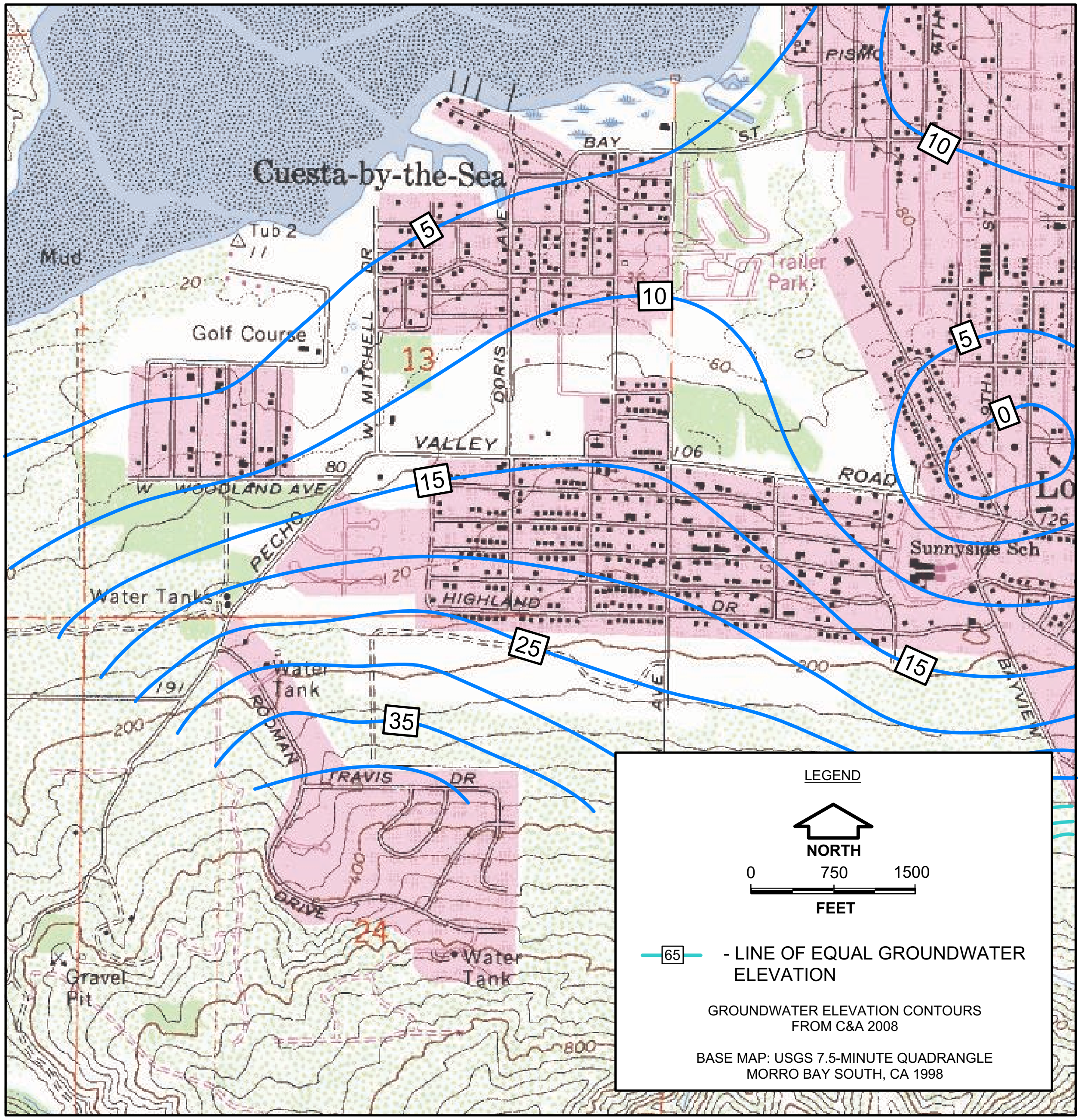
PLATE E1




**GROUNDWATER ELEVATION CONTOUR MAP**
**BRODERSON DISPOSAL SITE**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

PLATE E2

HOPKINS
GROUNDWATER
CONSULTANTS




**GROUNDWATER ELEVATION CONTOUR MAP**
**SPRAY FIELDS**
**Hydrogeological Impacts Analysis**
**LOWWP Draft EIR**
San Luis Obispo County
Los Osos, California

PLATE E3