TO: COMMITTEE MEMBERS

FROM: BRUCE BUEL BSB

DATE: JULY 20, 2007

AGENDA ITEM
2
JULY 23, 2007

FUGRO DISCHARGE GEO-HYDROLOGY STUDY

ITEM

Receive Fugro presentation re discharge geo-hydrology and consider Fugro recommendations re phase II [Forward Recommendations to Board].

BACKGROUND

Attached is Fugro's Phase I report entitled "Hydro-Geologic Characterization Southland Wastewater Treatment Facility". Paul Sorensen of Fugro is scheduled to present the findings set forth in this report at the Committee Meeting. Mr. Sorensen is also scheduled to detail the additional research recommended on Pages 9 and 10 of the report.

RECOMMENDATION

Staff recommends that the Committee receive Fugro's presentation, ask questions as appropriate, and forward recommendations to the Board regarding acceptance of the attached report and retention of Fugro to perform the recommended additional research.

ATTACHMENT

- July 2007 Fugro Report

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FUGRO WEST, INC.

HYDROGEOLOGIC CHARACTERIZATION
SOUTHLAND WASTEWATER TREATMENT FACILITY
NIPOMO, CALIFORNIA

Prepared for:
NIPOMO COMMUNITY SERVICES DISTRICT

Prepared by:
FUGRO WEST, INC.

July 2007

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July 17, 2007
Project No. 3596.001

Nipomo Community Services District
PO Box 326
148 S. Wilson Street
Nipomo, California 93444

Attention: *Mr. Bruce Buel*
General Manager

Hydrogeologic Characterization
Southland Wastewater Treatment Facility
Nipomo, California

Dear Mr. Buel:

Fugro West Inc. is pleased to submit this hydrogeologic characterization of Nipomo Community Services District's Southland Wastewater Treatment Facility. The objective of the study is to assess the current hydrogeologic conditions beneath the treatment facility and to develop a baseline understanding of groundwater conditions.

It is important to understand that this report is a compilation of our current understanding of the hydrogeology of the site and immediately surrounding area. Further field investigation will be required to more completely characterize the site. Recommendations for such fieldwork are outlined in this report. We look forward to meeting with you on July 23, 2007 to discuss this report and the next phase of work.

Sincerely,

FUGRO WEST, INC.

Paul A. Sorensen

Paul Sorensen, PG, CHg
Principal Hydrogeologist

Shawn Roberts

Shawn Roberts, PhD., PG
Project Hydrogeologist

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HYDROGEOLOGIC CHARACTERIZATION
SOUTHLAND WASTEWATER TREATMENT FACILITY
NIPOMO, CALIFORNIA

PURPOSE AND BACKGROUND

The Nipomo Community Services District (District) is in the process of planning for the expansion of the District's Southland Wastewater Treatment Facilities (WWTF), and has identified a need to assess the groundwater conditions beneath the site (Figure 1). The primary objectives of this assessment are to develop a baseline understanding of local groundwater conditions, characterize the aquifer(s) beneath the site, assess the fate of the discharged effluent, and evaluate the effectiveness of the existing monitoring network.

The current facility began discharging treated wastewater and disposing of effluent in 1985, at a plant capacity of 0.36 million gallons per day (MGD). Effluent disposal is accomplished through a series of percolation ponds (Figure 2). As required by the Regional Water Quality Control Board, Central Coast Region (RWQCB), monitoring of the groundwater quality at the WWTF was initially conducted using three shallow groundwater monitoring wells (wells MW-A, MW-B, and MW-C). After several years of monitoring and assessment, it was concluded that the monitoring wells were affected by a fault and were likely monitoring different geologic formations and/or aquifers (Cleath 1997a, 1997b; RWQCB 1997, 1999). Further evaluation suggested the presence of both a shallow aquifer and a deep aquifer. Review by the RWQCB concluded that the monitoring data were inconclusive in identifying the potential impacts of the effluent on the receiving groundwater.

In 1997, the RWQCB issued revised WDRs as part of plant expansion to an average daily discharge of 0.90 MGD. Three new monitoring wells (MW-1, MW-2 and MW-3) were installed to sample the shallow aquifer and monitor the effects of effluent discharge (Enloe, 2000). The expansion was completed in 2000.

As the District defined its objectives of its wastewater program and planned for plant expansion, it became apparent that the first step in evaluating the various disposal options available to the District required a more complete understanding of the groundwater conditions beneath and in the vicinity of the plant. This investigation, therefore, is the first step in the characterization of the geologic and hydrogeologic conditions of the site.

PROJECT ISSUES AND OBJECTIVES OF THE STUDY

Issues

- Based on borehole logs, a clay layer (aquitard) exists beneath the site, preventing vertical percolation of the discharged effluent and resulting in the formation of a shallow effluent mound beneath the site. To understand the effectiveness and capability of the plant requires an understanding of the shape, extent, depth, and gradient of the effluent mound;

- The hydraulic relationship of and between the shallow and deep aquifers is incompletely understood, as is the extent, thickness, hydraulic characteristics, and significance of the aquitard between the aquifers;
- The effluent mound is apparently growing, as indicated by several years of monitoring well water level recordings. Thus, there is a potential capacity issue of the shallow aquifer to effectively store and dispose of the effluent, particularly as the facility is expanded to 1.3 MGD, and particularly if hydraulic communication between the shallow and deep aquifers is limited;
- Water quality data indicate the water quality of the shallow aquifer is essentially equal to the effluent water quality; and
- It is not known if, and to what extent, the effluent is affecting the deep aquifer. The current monitoring plan and network monitors only the shallow aquifer.

Objectives

- Conduct a hydrogeologic investigation to characterize the two aquifers, and assess the fate of effluent in the shallow aquifer;
- Evaluate the potential impacts of the effluent on the deep aquifer;
- Evaluate the extent of the shallow effluent mound beneath the site;
- Assess the development of the mound over time;
- Identify the direction of flow and gradient of the effluent mound to Nipomo Creek;
- Develop an enhanced groundwater monitoring program;
- Assess the hydraulic communication of the deep aquifer and shallow effluent mound;
- Evaluate the potential for the effluent mound to reach the deep aquifer, and potential impacts, and;
- Investigate the water quality of and depth to water of the deep aquifer.

SCOPE OF THE STUDY

The hydrogeological assessment of the conditions beneath and in the vicinity of the Southland WWTF will likely require multiple phases of work. This document represents a first and preliminary phase of the assessment incorporating a data review and hydrogeological characterization of the site based upon geological maps, driller's logs, water quality data and previous reports. Work conducted as part of this study included:

- Attending a kickoff meeting with Bruce Buel, General Manager of the District, and representatives from Boyle Engineering, District engineers;
- Conducting an initial site visit;
- Compilation and review of previous reports and data collection efforts;
- Collection, compilation, review, and analysis of water level and water quality data from monitoring wells at the site;
- Installation of computerized transducers in two site monitoring wells (piezometer and MW-3) to identify and record real time responses of water levels, if any, of the effluent mound to pond loading;
- Conducting a traverse of Nipomo Creek from a point upstream of the WWTF to several hundred feet downstream of the plant to observe conditions of streamflow and creek vegetation;
- Sampling and preliminary characterization of surface water flow and quality in Nipomo Creek;
- Contact with and discussions of available data with representatives from SAIC, District geologists and Boyle Engineering;
- Preparation of several geologic and hydrogeologic cross sections across the site;
- Preparation of this summary report; and
- Development of conclusions and recommendation, as outlined herein.

REGIONAL GEOLOGY AND HYDROGEOLOGY

The Southland WWTF is located in the southeastern edge of the Nipomo Mesa. The sediments underlying the Nipomo Mesa typically consist of Pleistocene Older Dune Sand Deposits. The deposits form a triangular lobe approximately 4 miles wide that extends inland 12 miles to just beyond Highway 101. They are 150 to 250 feet in thickness and are typically highly permeable. Subsequently, minimal runoff occurs in areas covered by the Older Dune Sand Deposits (DWR, 2002). However, groundwater production from the sands is of relatively minor significance in terms of water supply (Papadopulos, 2004). Interlayered throughout the dune sand deposits are relatively fine-grained layers of variable thickness and continuity, upon which groundwater perches.

Throughout the Mesa, the Older Dune Sand deposits are typically underlain by the Paso Robles and Careaga Formations (DWR, 2002). The Paso Robles Formation was deposited under a variety of conditions from fluvial to shallow marine, composed typically of unconsolidated to poorly consolidated sediments. The Careaga Formation was deposited in a near shore marine environment and is composed of unconsolidated to well consolidated sediments.

The Paso Robles Formation thins from the west (500 feet in thickness) to the east (100 feet in thickness) and is generally absent east of the Wilmar Avenue Fault (DWR, 2002). In the vicinity of the site differing interpretations have been presented regarding the thickness of the Paso Robles Formation. The DWR (2002) study proposes approximately 200 feet thickness of Paso Robles Formation sediments, while Cleath (1996) interprets that the Paso Robles Formation pinched out to the west of the site, extending no further west than the Santa Maria River Fault. Cleath (1996) proposes that the Careaga Formation directly underlies the Older Dune Sands. Both Formations have similar characteristics that can make differentiation between them, and particularly the contact between them, difficult (DWR, 2002).

The basement rocks of the area consist of Franciscan Complex, Knoxville Formation and the Obispo Formation (DWR, 2002; Cleath, 1996). The basement rocks unconformably underlie younger Tertiary and Quaternary sediments. These basement rocks outcrop east of Nipomo Creek, approximately 0.5 miles from the site.

Structure and Faulting

The Nipomo Mesa is part of the Santa Maria Valley structural block. The block is bounded by the San Luis/Pismo block to the northeast and by the Hosgri fault zone to the west and the Casmalia block to the south. Within the Santa Maria structural block, convergence and crustal shortening have resulted in the deformation of the Quaternary and Tertiary deposits. The period of deformation has been recent, so that the current topography reflects the structure. Dominant features include the Santa Maria valley syncline and a series of faults.

Faults within the Nipomo Mesa typically strike west-northwest, and several have been defined by previous studies (Hall, 1978, 1981 and 1982), including the Santa Maria River, Wilmar Avenue and Oceano faults (Figure 1). The Santa Maria River Fault adopts the west-northwest trend and displays a vertical offset of about 180 to 250 feet. It has been constrained by differing water levels on either side of the fault. Water level variations of between 20 to 100 feet across the fault zone have been presented (DWR, 2002). The fault acts as a partial hydraulic barrier to groundwater flow in the area (Luhdorff and Scalmanini, 2000).

Nipomo Mesa Groundwater Levels and Flow

Groundwater levels in the shallow Older Dune Sand Formation show a high degree of variability due to the perched and localized nature of the aquifer(s), being dependent on the thickness and lateral extent of clay layers. Perched groundwater tends to migrate laterally along these low permeability layers. Locally the vertical restriction of flow can form a series of shallow aquifers. However, the clay layers are typically not laterally extensive so that a regional interpretation of a single unconfined aquifer in the western part of the Nipomo Mesa has been determined (DWR, 2002).

The deeper and primary aquifer of the Nipomo Mesa is the Paso Robles Formation. Within this aquifer groundwater flow is westward towards the Pacific Ocean. Typically groundwater elevations for this formation are less than 150 feet above sea level. Water levels above this typically represent wells screened within the dune sands and signify perched water. Some pumping depressions in the Paso Robles aquifer are present and have an overriding influence on localized groundwater flow.

Groundwater flow in the Nipomo Mesa is also affected by the presence of faults. Two faults are located in close proximity to the site (Figure 2), the Santa Maria River Fault to the west and the Wilmar Avenue Fault to the east. Groundwater levels across the Santa Maria Fault zone are discontinuous, the fault acting as a partial barrier to groundwater flow (Luhdorff and Scalmanini, 2000).

SITE GEOLOGY AND HYDROGEOLOGY

The site occupies approximately 47 acres of land on the eastern edge of the Nipomo Mesa (Figure 1). The topography in the area consists of low lying, rolling sand dunes. Northeast of the site is Nipomo Creek, which runs along the eastern edge of the Mesa and drains the Nipomo Valley southward to the Santa Maria River.

The WWTF site is shown on Figure 2, which also shows the location of the percolation ponds, shallow monitoring wells (MW-1, MW-2 and MW-3), test holes (TH1 through TH-6), previous monitoring wells (MW-A, MW-B and MW-C), as well as nearby private wells. Construction details for the wells and borings for which data exist are presented in Table 1.

The shallow stratigraphy in the vicinity of the Southland WWTF consists of Older Dune Sand deposits. Previous investigators have disagreed whether the sediments beneath the Older Dune Sand deposits at the site consist of the Careaga Formation (Cleath, 1997) or the Paso Robles Formation (DWR, 2002).

East of the site, the Wilmar Avenue Fault brings bedrock (Franciscan) to the surface east of the fault, thereby forming the boundary of the Santa Maria Groundwater Basin. The fault can act as a significant barrier to groundwater flow.

Shallow and Deep Aquifers

The Older Dune Sand deposits are 60- to 140-feet thick beneath the WWTF (Figures 3, 4, and 5). The Older Dune Sand deposits comprise the shallow aquifer at the site. The Older Dune Sand deposits consist of fine to medium-grained sand, with occasional thin, discontinuous stringers of clay-rich sediments. Beneath the Older Dune Sand deposits, a clay layer of at least 40-feet thickness has been encountered in borings drilled on or near the site.

The clay layer at the base of Older Dune Sand deposits appears to be sufficiently thick and impermeable to act as an effective aquitard, preventing the vertical migration of groundwater. The top of the clay layer dips at approximately 1.5 percent to the southwest (Figure 6). It apparently extends beneath the whole of the WWTF site; however, insufficient data exist to delineate its lateral extent (thickness and lithologic character) offsite.

Noted in some of the boring logs is the existence of a thin discontinuous clay lens within the Older Dune Sand deposits that appears to be 2 to 10 feet in thickness and, where present, within 25- to 45-feet below ground surface. This thin clay layer appears to have been noted as the first encountered clay in some borings (Cleath, 1996) and thus has previously been identified as the top of the aquitard.

Geologic data suggest that the WWTF is affected by a minor fault that offsets the top of the aquitard unit (Figures 3 and 4). Based on correlation of the clay layers in borings, it appears that the fault runs southeast to northwest between the piezometer and MW-1 or between MW-B and MW-C (Figures 3 and 4). The offset on the fault does not appear to significantly affect the aquitard unit.

Beneath the aquitard are interbedded sand and gravel layers that comprise the main or deep aquifer sediments of the Nipomo Mesa (DWR, 2002). The regional water level in the deep aquifer currently ranges from about 170- to 250-feet below ground surface (e.g. LM-1 and Walsh Windmill). The DWR (2002) report suggests that the deep aquifer in the western part of the Nipomo Mesa is generally unconfined (DWR, 2002). Localized clay layers undoubtedly exist and create perched aquifer zones, such as the conditions found at the WWTF.

Groundwater Flow Patterns and Water Levels

Prior to 2000, groundwater level data obtained from the monitoring wells at the WWTF were highly variable (Table 1) because the monitoring wells contained screened intervals within both the deep and shallow aquifers. The water level data reflected conditions that were not unique to either. This variability was identified in 2000 with the installation of monitoring wells MW-1, MW-2, MW-3 and the piezometer, in which the screened intervals for all the wells were placed solely within the shallow aquifer. Groundwater level data collected from these wells since 2000 are presented in Table 2.

Regional groundwater flow, as represented by water levels in the deep aquifer wells (Ioimo, Egg City, Walsh Windmill and LM-1), is toward the southwest at a hydraulic gradient of approximately 0.03 feet per foot. Groundwater levels in the shallow aquifer appear to be controlled on a local scale by the formation of an effluent mound. The piezometer in the center of the site, located between percolation ponds, consistently displays the highest groundwater elevation. Localized groundwater movement is likely away from the center of the percolation pond facility in all directions, at a measured gradient in the east-west direction of 0.01 to 0.02 feet per foot.

Based on a gradual rise in water levels in the monitoring wells and the piezometer, the effluent mound appears to be growing. Water levels in the monitoring wells are seven to 27-feet higher in 2007 than when they were installed in 2000 (Figure 7). With the exception of a single measurement in MW-3 in 2000 that appears to be an error, water level measurements in the monitoring wells indicate a relatively uniform rise in groundwater levels at the site of approximately one foot per year. No offsite shallow wells exist in the vicinity of the plant. The lateral extent of the mound and offsite migration of the effluent mound is unknown.

To assess whether the recorded water levels in the piezometer reflected actual depth to water in the shallow aquifer, or reflected the water level of the nearby percolation pond, transducers were installed in the piezometer and in MW-3. Water levels were recorded at 20-minute intervals over a seven-day period while the percolation pond immediately adjacent to the piezometer was filled. As shown in Figure 8, the water levels in both the piezometer and MW-3 declined at a steady rate throughout the time that the nearby pond was filled. Thus, it appears that the recorded water levels in the piezometer and monitoring wells reflect the water level of the shallow groundwater aquifer.

WATER QUALITY

Deep Aquifer Water Quality

Limited water quality data are available from wells in the deep aquifer in the vicinity of the site, and no consistent historical data exist to establish water quality trends over time. On the basis of a few water quality analyses in the 1980s and 1990s from the Egg City, Walsh Ranch and Ioimo wells, the total dissolved solids (TDS) levels in the deep aquifer ranged from 648 mg/l to 877 mg/l. Sodium concentrations increased from about 92 mg/l to 150 mg/l between the 1980s and the 1990's and chloride increased from approximately 115 mg/l in the 1980's to 175 mg/l in the 1990's.

Shallow Aquifer Water Quality

Water quality data for the three monitoring wells at the WWTF, particularly monitoring well MW-3, indicate groundwater quality in the shallow aquifer since 2000 has been affected by the discharge of effluent, particularly with respect to TDS, chloride, sodium, and boron (Table 3 and Figures 9a/b/c). The water quality of the shallow aquifer is now essentially that of the WWTF effluent.

OFFSITE MIGRATION OF THE EFFLUENT MOUND

To assess possible offsite migration of the effluent mound, particularly to the east towards Nipomo Creek, a limited field investigation was conducted. Electrical conductivity (EC) measurements were recorded from groundwater in the WWTF monitoring wells, and compared with surface water measurements taken along reaches of Nipomo Creek (Figure 10).

The EC of the shallow aquifer groundwater beneath the WWTF ranges from 1500 to 1600 microsiemens per centimeter (µS/cm), which is essentially equivalent to and represents the water quality of the effluent. Upstream of the WWTF, EC measurements of surface water in Nipomo Creek were approximately 1200 µS/cm. Downstream of the WWTF, EC measurements of surface water in the creek increased to about 1450 µS/cm (Figure 10).

It should be noted that increased EC in the surface water of the stream downstream of the WWTF is not necessarily conclusive evidence that effluent from the plant is daylighting into Nipomo Creek. However, there are additional inferences, as described below, that warrant a more detailed evaluation.

Inspection of the hydrogeologic cross sections shows that the gradient of the shallow aquifer effluent mound, if extended eastward to the creek, approximately intersects the base elevation of the creek (Figures 3 and 4). Also, an increase in riparian vegetation is observed along Nipomo Creek downstream of the WWTF, coupled with increased streamflow. No daylighting of seeps were observed in the slope from Highway 101 eastward to the creek.

It should again be noted that several factors could affect the conditions in the creek and the EC of the surface water. However, additional investigation is warranted to evaluate the potential migration of the shallow aquifer groundwater towards Nipomo Creek.

CONCLUSIONS

The primary objectives of the investigation to be addressed by this study are summarized below. As noted, not all the issues could be resolved because of limited available data or the need for additional field investigations. The primary conclusions of this study include:

- *Evaluation of the extent of the shallow groundwater mound beneath the WWTF, and assessment of trends and growth of the mound.* A dual aquifer system exists beneath the WWTF. The shallow aquifer, which ranges from 60- to 140-feet below ground surface, is separated from the deep aquifer by a thick, relatively impermeable aquitard (clay layer) that practically precludes vertical migration of groundwater from the surface to the deep aquifer. As a result, a perched effluent mound has formed beneath the WWTF that is growing vertically at the rate of approximately one foot per year. The mound appears to be centered beneath the central point of the site.
- *Evaluation of offsite flow of the mound.* Evidence exists that may suggest that the discharged effluent from the plant is, in part, flowing laterally towards Nipomo Creek. Increasing electrical conductivity measurements of surface water in the creek from a point upstream of the WWTF to a point downstream of the WWTF, as well as increased riparian vegetation in the creek bed downstream of the WWTF, support an influence of the effluent and observed conditions in Nipomo Creek. The distance from the point of discharge to Nipomo Creek (approximately 800 feet), the inferred hydraulic gradient along this distance (approximately 0.01 feet per foot), and the inferred horizontal hydraulic conductivity of the shallow aquifer or Older Dune Sand deposits (about 50 feet per day) implies that the effluent discharged in the percolation ponds would reach Nipomo Creek within a matter of months. Furthermore, a projection of the groundwater gradient from the plant eastward to the

creek intersects the thalweg of the streambed. Additional investigation is warranted to assess whether Nipomo Creek is influenced by discharged water from the plant.

- The water quality of the shallow aquifer appears to consist of WWTF effluent. Based on bi-annual water quality sampling of groundwater in the onsite monitoring wells and comparison of the results with water quality of the discharged effluent, the water quality of the shallow aquifer appears to consist of treatment plant effluent. The present monitoring network is ineffective for measuring up- and downgradient water quality impacts, as required by the Regional Water Quality Control Board. New monitoring wells need to be drilled, however identification of potential locations of those wells require additional field investigations to assess the lateral extent of the aquitard.
- *Investigation of the water quality of and depth to the deep aquifer.* Water levels in the deep aquifer are 170 to 250 feet deep in the vicinity of the site. Limited data exists of water quality of the deep aquifer in the vicinity of the plant, and insufficient historical data exists to establish trends to assess whether effluent disposal has had any impact on water quality of the deep aquifer.
- *Evaluation of the potential for the effluent mound to reach the deep aquifer.* Sufficient data do not exist to adequately address this question. Based on the available well log data, it appears that the aquitard separating the shallow and deep aquifers extends offsite and prevents the vertical migration of the WWTF effluent into the deep aquifer. However, the lateral extent and thickness of the aquitard is not fully known. Additional field studies to investigate the lateral extent, depth, and character of the aquitard are warranted. These additional investigations will allow for evaluation of the feasibility, and mechanics, of utilizing the deep aquifer for effluent disposal.

RECOMMENDATIONS

The current phase has identified several areas that require further investigation to form a better understanding of the hydrogeology of the area and to assess the percolation pond capacity of the WWTF:

- Additional sampling of Nipomo Creek for chemical indicators of effluent should be performed to evaluate the hydraulic connection between the WWTF and Nipomo Creek.
- A search of the DWR well log data base should be conducted to obtain copies of the off-site well logs in the vicinity of the WWTF, particularly to the west of the site. A well log request was given to the County Department of Public Works during this study, but the County indicated that they did not have any logs. Contact was made with SAIC, who indicated that they had initiated the data request from DWR. Such well logs, when they become available, will provide more information on the lateral

extent of the aquitards and locations where cone penetrometer tests (CPT) and test holes could be placed to fill data gaps.

- The hydraulic relationship between the shallow and deep aquifers remains poorly understood. A CPT survey and, where necessary, an auger boring test hole program should be conducted to delineate the lateral extent of the aquitard on and in the immediate vicinity of the WWTF. It is currently not known where the clay layers separating the shallow and deep aquifers end, and this survey would aid in the interpretation.

  An initial array of CPT soundings and/or auger borings (depending on depth to the aquitard) should be conducted at the site and within the public right-of-way along Range Place, Orchard Avenue, and further southwest from Orchard Avenue to Riverside Road. CPT soundings should also be placed to the northeast along South Oakglen Avenue and on the private property (if accessible) between the WWTF and Nipomo Creek. The CPT soundings will provide a network of lithologic profiles of the Older Dune Sand deposits to depths of 50 to 75 feet and should provide excellent definition of the top of the aquitards in the area. Due to the friction and tip resistance of the aquitard, the CPT soundings may not be able to penetrate significantly into the aquitards. Where the top of the aquitard is deeper than ±75 to 100 feet, auger borings may be necessary. All CPT and boring data should be placed in GIS to develop a three-dimensional profile of the shallow aquifer system. Approximately 30 CPT soundings or borings should be considered, spaced along traverses at 500 feet on center. Approximately 10 of the CPT soundings should be completed to micro wells to obtain water level and water quality data of the shallow aquifer system.

- To further assess the effluent mound and its apparent offsite migration, additional groundwater monitoring wells should be installed southwest of the WWTF. Locations for geologic test holes and groundwater monitoring wells should however await the results of the CPT soundings and micro well data. The monitoring wells will need to extend to depths greater than 100 feet to establish the thickness and hydraulic character of the aquitard to determine discrete water level data for the shallow and deep aquifer, and much needed, site-specific water quality data for the deep aquifer.

- Once the hydrogeologic conceptual model is refined and the extent of the clay aquitard is known, development of a local scale groundwater model may be an excellent tool to understand the fate and transport of the effluent beneath the site, the potential growth rates/patterns of the effluent mound at different disposal rates, and the ability of the site to adequately dispose of the effluent.

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TABLES

Table 1: Well and Test Hole Information for Southland WWTF

Well/ Test Hole	Installation	Surface Elev. (feet)	Seal Depth (feet)	Screen Depth Interval (feet)	Depth to Top of First Clay Layer (feet)	Elevation of Top of First Clay Layer (feet)	Depth to Top of Main Aquitard (Blue Clay) (feet)	Elevation of Top of Main Aquitard (Blue Clay) (feet)	Date Measurement	Depth to Water (feet)	Elevation of Water (feet)
PZ	Jan 2000	300	40	42-52	51	249	-	-	July 2007	30.2	271
MW-1	Jan 2000	298	-	35-75	27	271	80	218	July 2007	37.9	262
MW-2	Jan 2000	300	-	40-85	-	-	85	215	July 2007	40.9	260
MW-3	Jan 2000	302	-	50-130	-	-	135	167	July 2007	44.2	260
TH1	N/A	306	-	-	>100	<206	-	-	6/1/2000	59.0	247
TH2	N/A	307	-	-	66	241	-	-	7/1/2000	65.0	242
TH3	N/A	299	-	-	51	248	-	-	10/1/2000	41.0	258
TH4	N/A	307	-	-	>75	<232	-	-	11/1/2000	63.0	244
TH5	N/A	298	-	-	27	271	-	-	12/1/2000	45.0	253
Well A	-	300	50	140-240	10	-	99	201	6/18/1997	81.6	224
Well B	Abandoned	293	50	-	42	251	100	193	6/18/1997	66.9	227
Well C	Abandoned	303	50	-	-	-	80	223	6/18/1997	144.3	161
LM-1	-	300	50	250-500	40	260	-	-	6/18.97	173.2	127
Ioimo	-	~300	-	-	-	-	-	-	Aug-81	231.0	74
Egg City	3/20/1959	~300	-	-	-	-	-	-	Oct-96	245.1	70
Walsh Ranch	Unknown	~300	-	-	-	-	-	-	1984	57.6	230
Walsh Windmill	1/6/1957	303	219	-	58	245	-	-	-	-	-

NB: Depth to water for the TH boreholes is to "first water" while advancing during drilling□

Table 2: Shallow Groundwater Levels for Southland WWTF

Date	Piezometer		MW-1		MW-2		MW-3	
	GW Depth (feet) PZ	Elevation (feet) PZ	Depth (feet) MW-1	Elevation (feet) MW-1	Depth (feet) MW-2	Elevation (feet) MW-2	Depth (feet) MW-3	Elevation (feet) MW-3
Jan-00	38.8	262.9	44.6	255.3	49.6	251.6	70.8	232.9
Jul-00	37.0	264.7	-	-	-	-	-	-
Jan-01	39.0	262.7	-	-	-	-	-	-
Jul-01	36.0	265.7	-	-	-	-	-	-
Jan-00	32.0	269.7	-	-	-	-	-	-
Jul-02	32.0	269.7	-	-	-	-	-	-
Jul-04	-	-	40.0	259.9	44.0	257.2	47.0	256.7
Jan-05	27.0	274.7	43.0	256.9	45.0	256.2	46.0	257.7
May-05	31.0	270.7	37.0	262.9	39.0	262.2	45.0	258.7
Jul-05	30.0	271.7	40.0	259.9	41.0	260.2	44.0	259.7
Jul-07	30.2	271.5	37.9	262.0	40.9	260.4	44.2	259.5

Table 3: Groundwater and Effluent Quality Data for Southland WWTF

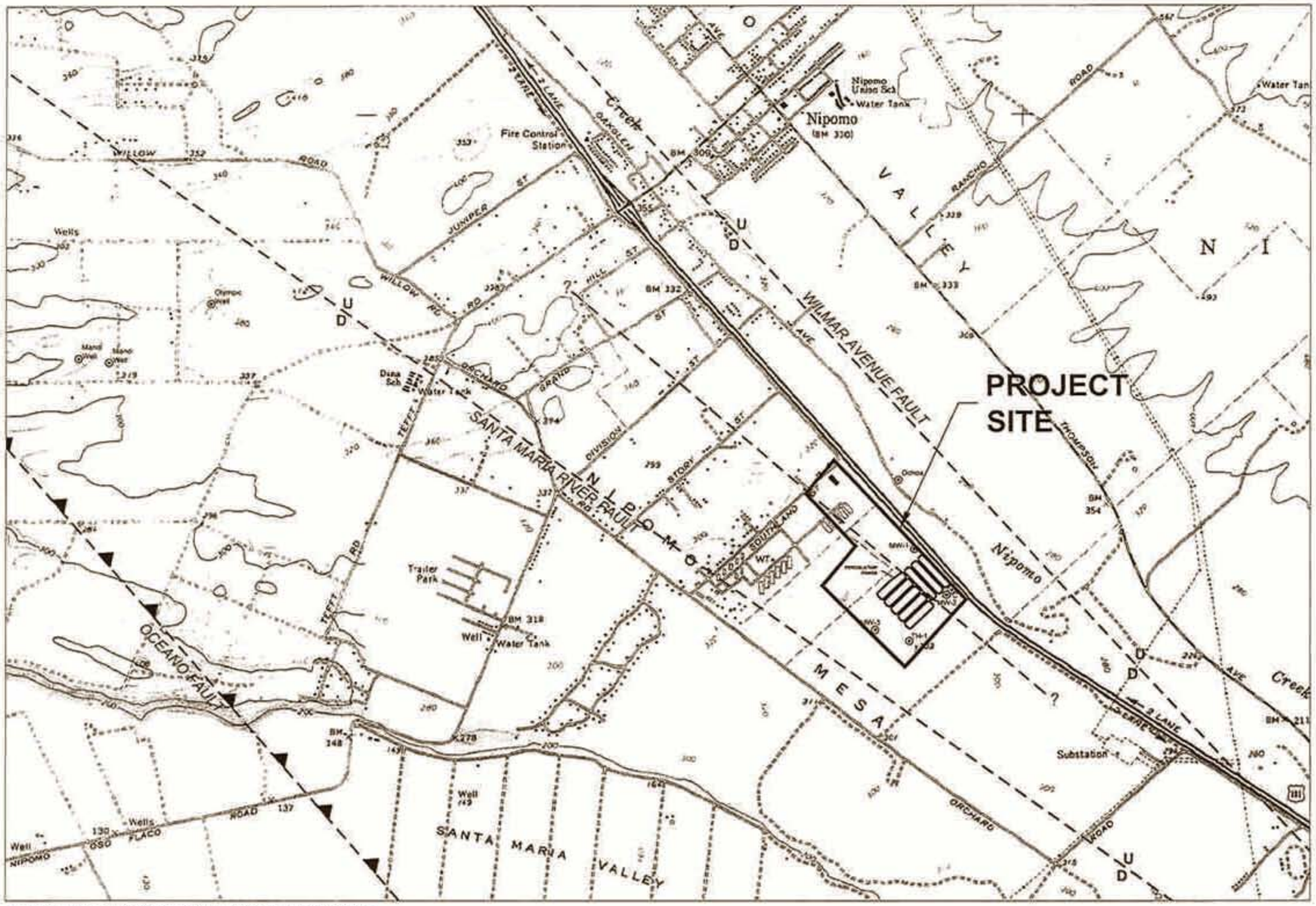
Well Name	Date	TDS mg/L	Na mg/L	Cl mg/L	Total N mg/L	SO4 mg/L	B mg/L	NO3 and NO2 as N mg/l
MW-1	Jan-00	920	140	110	1.7	350	0.13	-
	Jul-00	960	165	190	1.0	204	0.40	-
	Jan-01	970	200	222	6.3	199	0.30	-
	Jul-01	1240	213	238	17.5	337	0.40	-
	Jan-02	1080	182	203	14.7	308	0.72	-
	Jul-02	1110	176	232	15.6	292	0.42	-
	Jan-03	1100	188	238	16.5	288	0.47	-
	Jul-03	1110	190	245	17.0	302	0.50	-
	Feb-04	1080	201	244	14.6	300	0.50	-
	Jul-04	1100	199	194	19.0	243	0.40	-
	Jan-05	1130	205	145	1.4	302	0.40	-
	Aug-05	1240	204	225	35.4	270	0.50	34.1
	Jan-06	1220	211	241	30.4	299	0.40	29.1
	Jul-06	1230	160	226	25.4	281	0.30	24.6
	Jan-07	1100	210	226	24.4	250	0.33	23
MW-2	Jan-00	990	270	75	2.6	420	0.26	-
	Jul-00	110	220	196	1.4	292	0.30	-
	Jan-01	1190	192	245	6.4	385	0.40	-
	Jul-01	1100	188	216	17.0	308	0.50	-
	Jan-02	1070	189	233	10.6	306	0.88	-
	Jul-02	1340	216	250	52.0	330	0.46	-
	Jan-03	1120	202	249	16.0	313	0.44	-
	Jul-03	950	178	218	15.0	258	0.30	-
	Feb-04	1140	211	272	12.0	315	0.40	-
	Jul-04	1250	214	176	36.1	220	0.40	-
	Jan-05	1160	192	244	23.0	303	0.40	-
	Aug-05	1110	180	207	19.9	270	0.40	18.1
	Jan-06	1250	220	272	16.2	366	0.50	14.9
	Jul-06	1000	217	225	3.0	232	0.40	2.4
	Jan-07	1110	224	252	5.0	230	0.22	4.3
MW-3	Jan-00	440	75	96	19.0	80	0.05	-
	Jul-00	390	57	86	0.3	50	0.05	-
	Jan-01	760	134	171	15.1	192	0.10	-
	Jul-01	470	65	73	22.3	82	0.05	-
	Jan-02	750	96	128	51.0	135	0.07	-
	Jul-02	870	114	162	44.0	218	0.05	-
	Jan-03	1000	159	232	14.0	300	0.06	-
	Jul-03	990	168	243	16.3	292	0.10	-
	Feb-04	1030	197	244	17.3	303	0.10	-
	Jul-04	990	190	190	19.1	226	0.20	-
	Jan-05	1020	203	278	14.5	245	0.20	-
	Aug-05	1160	204	226	30.3	276	0.30	30.3
	Jan-06	1160	224	250	31.7	280	0.30	31.1
	Jul-06	1180	198	219	26.2	273	0.30	26.2
	Jan-07	1140	217	229	24.4	270	0.31	24.4

Table 3: Groundwater and Effluent Quality Data for Southland WWTF

Well Name	Date	TDS mg/L	Na mg/L	Cl mg/L	Total N mg/L	SO4 mg/L	B mg/L	NO3 and NO2 as N mg/l
Effluent	Jan-91	1000	200	160	-	200	0.50	-
	Jan-92	100	190	200	-	180	0.40	-
	Jul-92	1100	170	140	-	270	0.60	-
	Jan-93	980	140	180	-	170	0.40	-
	Jul-93	828	205	171	-	223	0.50	-
	Jul-94	1000	170	180	-	260	0.50	-
	Jan-95	850	160	170	-	160	0.40	-
	Jul-95	980	160	190	-	240	0.40	-
	Jan-96	-	170	230	-	280	0.30	-
	Jul-96	-	160	190	-	270	0.30	-
	Jan-97	-	150	170	-	230	0.30	-
	Jan-05	1050	183	239	44.0	-	-	1.5
	Aug-05	1130	190	234	40.0	-	-	0.9
	Jan-06	980	184	223	41.0	-	-	0.6
	Aug-06	1140	209	230	28.0	-	-	0.4
	Jan-07	-	-	-	-	-	-	0.6

FIGURES

FUGRO



Base map source: USGS Nipomo & Oceano Quadrangle Topographic Map

LEGEND

- Approximate Fault Line
- D U — Relative vertical movement of fault (U-upthrown side, D-downthrown side).
- Upper plate on low angle thrust fault.
- MW-1 — Approximate location of Exisiting Groundwater Monitoring Well

NORTH

0 2000 4000
FEET

SITE LOCATION MAP
Southland WWTF Discharge Study
Nipomo, California

Figure 1

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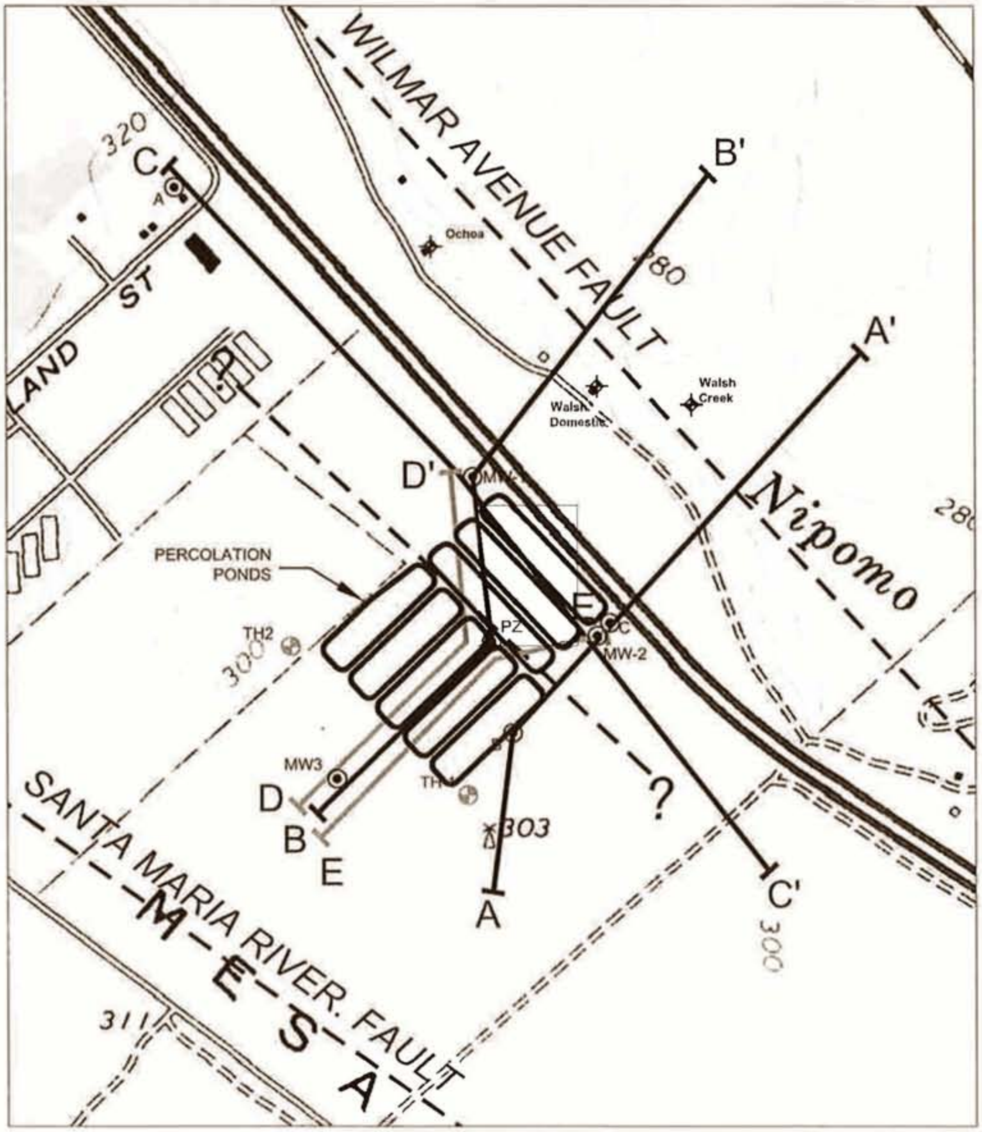
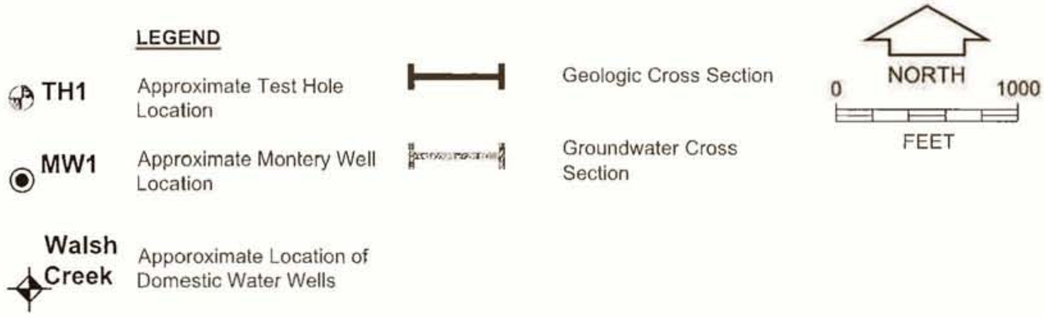


Base map source: USGS Nipomo & Oceano Quadrangle Topographic Map



CROSS SECTION REFERENCE AND WELL LOCATION MAP

Southland WWTF Discharge Study
Nipomo, California

Figure 2

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