LOS OSOS CSD

Memo

CENTRAL COAST REGIONAL
02 MAR 20 PM 1:50

To: Gerhardt Hubner, RWQCB

From: Bruce Buel

CC: File, Sorrel Marks

Date: 3/17/02

Re: Groundwater Monitoring Network Design Adoption

Attached is a copy of the Groundwater Monitoring Network Design adopted by the LOCSD Board on March 7, 2002. Please note that the final report was revised from the draft to include two wells in the "Creek Compartment" and to provide for rehabilitation of the 11 monitoring wells with incomplete seals.

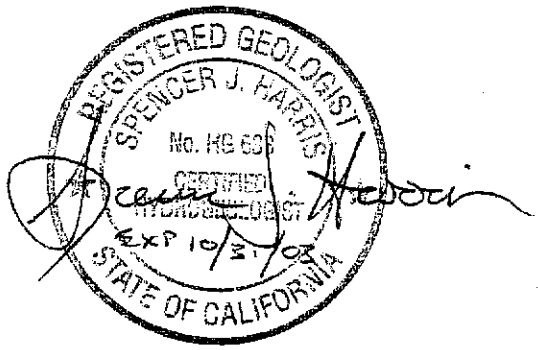
I have asked Cleath and Associates to submit a proposal for implementation by the end of March. As soon as I have this proposal, I will share it with you for your comments.

Feel free to call me at 805-528-9370 or e-mail me at bbuel@losososcsd.org.

NITRATE MONITORING PROGRAM DESIGN

Prepared for the

LOS OSOS COMMUNITY SERVICES DISTRICT



February 2002

CENTRAL COAST REGIONAL
02 MAR 29 PM 1:50

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

(805) 543-1413

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INTRODUCTION

The purpose of the Los Osos nitrate monitoring program is to evaluate upper aquifer salt loading in the Los Osos ground water basin. Salt loading is the accumulation of dissolved mineral salts (including nitrate) in ground water over time, typically due to anthropogenic factors. Excessive salt loading can lead to restrictions for both domestic and agricultural water uses. The monitoring program involves the periodic collection and analysis of water samples from a network of shallow wells, analysis for mineral salt concentration, and identification of changes in constituent concentrations over time.

The information obtained from the monitoring program will be useful to water purveyors and public agencies in assessing the status of water quality in the upper aquifer, and through the identification of water quality trends, in planning long-term basin management strategies. The program is also intended to satisfy monitoring requirements for future wastewater discharge associated with the community wastewater project, and will benefit studies on ground water recharge and movement.

There are three aspects to the monitoring program: data collection, sampling protocol, and data reporting. Data collection includes the type of water quality data collected, the frequency of collection, and the well locations recommended in the monitoring network. Sampling protocol covers sampling equipment and procedures. Data reporting includes presentation and interpretation of results.

BACKGROUND

Water quality monitoring in Los Osos has historically been performed by water purveyors, by permitted waste dischargers, and by various consultants and public agencies. In the early 1980's, Brown & Caldwell Consulting Engineers reviewed historical water quality data for the Los Osos ground water basin and determined that the existing data was inadequate for effective identification and documentation of water quality problems. A comprehensive ground water, surface water, and wastewater field sampling program was implemented, with the collection and analysis of 40 groundwater samples, two surface water samples, and six wastewater samples. Results of the basin-wide sampling event were interpreted and published in April 1983 (B&C, Phase I Water Quality Management Study).

Following the Brown & Caldwell study, the San Luis Obispo County Engineering Department began to monitor water quality at 18 ground water wells and four surface water locations. Sampling intervals were typically quarterly or semi-annual, although no samples were collected in1985 or 1986. Eleven of the 18 sampling locations were monitored by the County through the fourth quarter of 1998. Water quality analyses included general mineral and general physical parameters, including nitrate.

Nitrate has been the focus of water quality studies over the last decade. Basin-wide reviews of nitrate concentrations include the October 1994 Metcalf & Eddy Report (Los Osos Wastewater Study Report on Sanitary Survey and Nitrate Source Study) and the December 1995 Regional Water Quality Control

Board study (Assessment of Nitrate Contamination in Ground Water Basins of the Central Coast Region).

BASIN GEOMETRY

The outline of the Los Osos ground water basin is shown in Figure 1. The basin is bounded by non-water bearing rocks on the north, east, and south. On the west, the basin is bounded by the sea water/fresh water interface. The structure of the basin is roughly a synclinal trough, with an east west axis that is plunging to the west. Dip slopes at the edges of the basin reach approximately 4 degrees (7 percent). The basin is bisected by an inferred southeast-northwest trending fault splay associated with the Los Osos fault zone. Sediments forming the basin include dune sands, the Paso Robles Formation, and the Careaga Formation.

For the purpose of monitoring program design, the Los Osos ground water basin may been divided into three vertically discrete hydrogeologic zones; 1) first water (may include perched zone), 2) upper aquifer (shallow zone), and 3) lower aquifer (middle and deep zones). The basin also is comprised of three compartments; 1) West side, 2) East side, and 3) Los Osos Creek. A brief discussion of these zones and their relationship between compartments is presented below, and shown graphically in Figure 1 and in basin cross-section A-A' (Figure 2).

First water refers to the shallowest saturated horizon and corresponds to the water table. This zone is routinely monitored as part of a wastewater discharge permit, and was the primary focus of the historical 1982-1998 County monitoring program. First water is the interface where percolating waters, including precipitation and return flows from irrigation and wastewater, mix with basin waters. First water extends across all three basin compartments, and may be present in dune sands, Paso Robles Formation deposits, or Los Osos Creek alluvium. In downtown Los Osos, first water is perched above shallow clay horizons (AT1 Clay).

The upper aquifer, or shallow zone, refers herein to non-perched, water-bearing zones above the regional aquitard (AT2 Clay). On the West side (west of the inferred Sweet Springs splay of the Los Osos fault), the upper aquifer extends from first water to the AT2 Clay. In downtown Los Osos (East side compartment), the upper aquifer consists of Paso Robles Formation deposits beneath the perching clay. As the basin structure rises to the north along the limb of the regional syncline, the perching clay subcrops beneath relatively flat-lying dune sands and the upper aquifer becomes a water table aquifer (in Baywood Park), saturating both dunes sands and Paso Robles Formation deposits.

The lower aquifer refers to water bearing zones below the regional aquitard (AT2 Clay). There are both Paso Robles Formation and Careaga Formation deposits in the lower aquifer. The base of the lower aquifer is claystone and sandstone bedrock of the Pismo and Franciscan Formations, although the effective base of fresh water lies above bedrock at the western edge of the basin. The rising axis of the regional syncline is interpreted to cause the regional aquitard to crop out along the west banks of Los

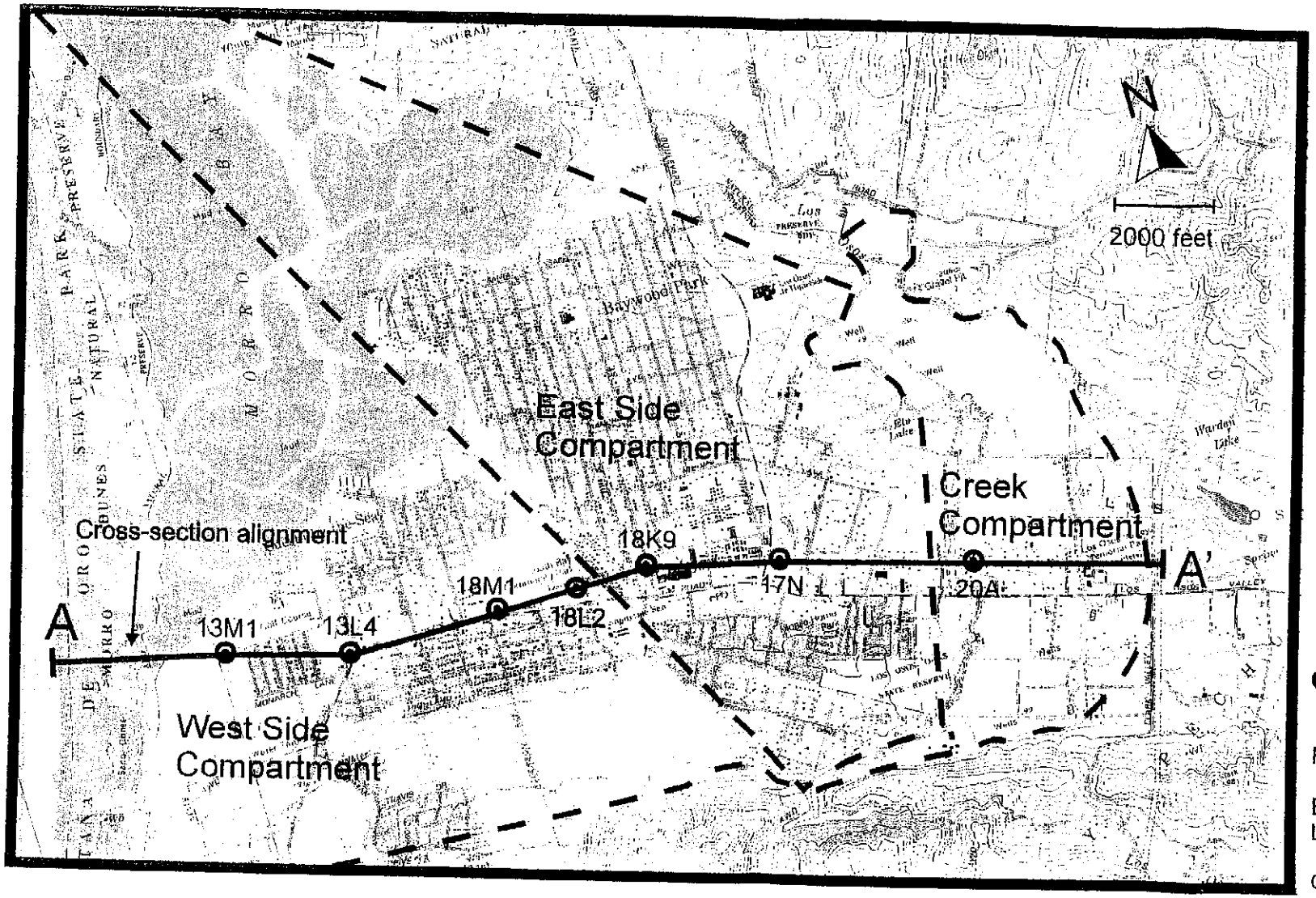


Figure 1

Basin Compartments
Los Osos CSD

Cleath & Associates

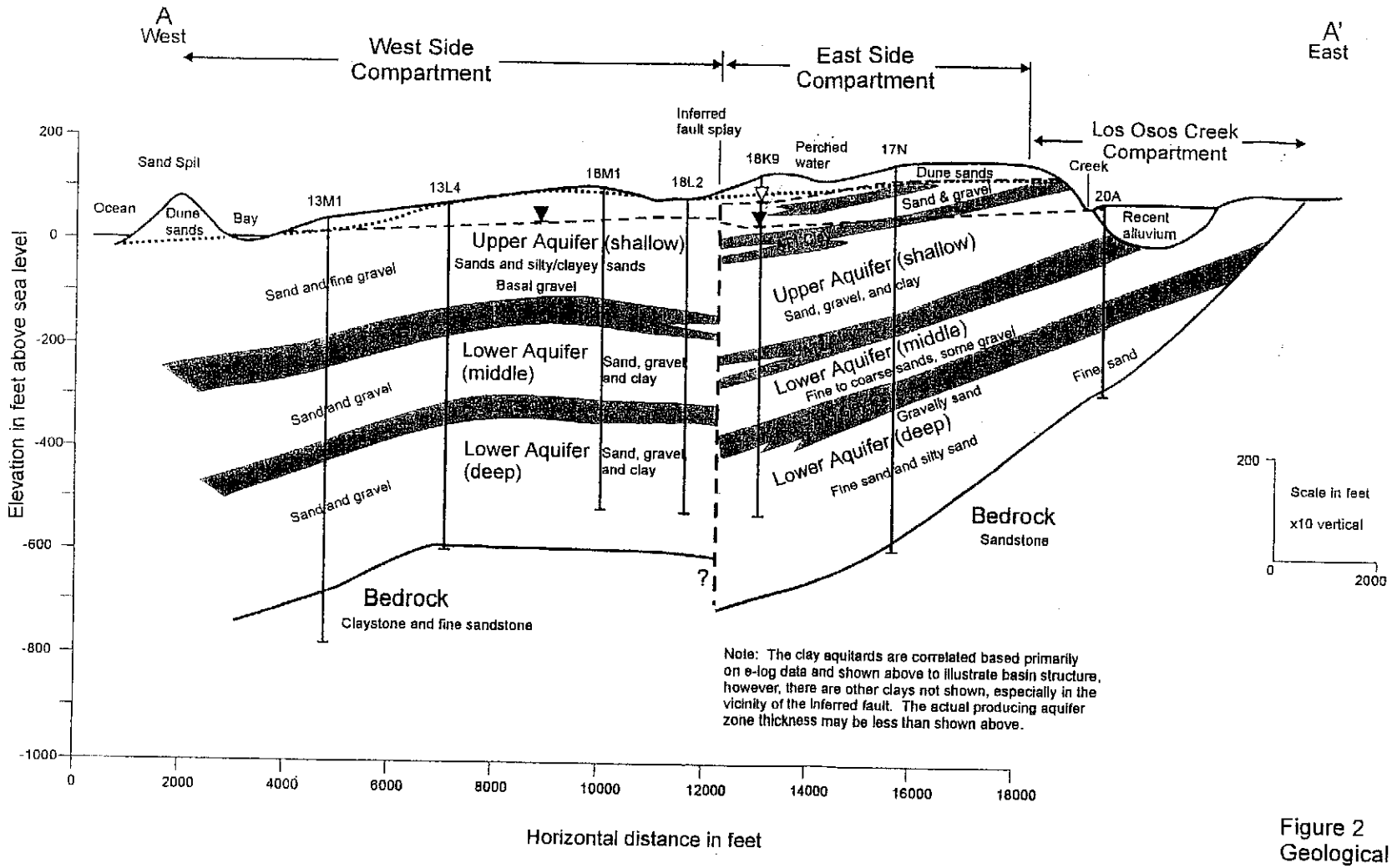


Figure 2
Geological Cross-Section A-A'
Generalized Basin Structure

Cleath & Associates

Osos Creek, and brings the lower aquifer in contact with the Los Osos Creek alluvium. There are two generalized aquifer zones within the lower aquifer. The middle zone lies between the AT2 and the AT3 Clays. The deep zone is below the AT3 clay (Figure 2).

DATA COLLECTION

Constituents

The proposed program will monitor salt loading in the upper aquifer of the Los Osos ground water basin. The optimal constituents list for salt loading monitoring is given below. The underlined constituents are the minimum recommended for the monitoring program by the Regional Water Quality Control Board.

Mineral salt constituents:

- Calcium
- Magnesium
- Sodium
- Potassium
- Alkalinity (Carbonate and Bicarbonate)
- Sulfate
- Chloride
- Boron
- Total Nitrogen (all forms identified)

Other:

- Total dissolved solids (TDS)
- Electrical Conductance (EC)
- pH
- Temperature

TDS and EC are standard measures for ground water mineralization and salinity. Temperature and pH are parameters that are routinely measured during sampling to verify that the ground water samples represent the actual aquifer conditions. Depth to water will also be measured prior to sampling.

Monitoring Frequency

Monitoring frequency is the time interval between sampling events. Seasonal fluctuations relating to ground water are typically semi-annual. The dry and wet periods of the year influence recharge, water levels, well production, and water quality. A semi-annual monitoring frequency would provide a measure

of major seasonal cycles, which would then be distinguishable from long-term trends. The preferred sampling times would coincide with the seasonal water level fluctuations, typically late fall (low) and late spring (high).

It is not necessary to analyze all the above-listed constituents during every semi-annual sampling event. At a minimum, the bolded constituents required for wastewater discharge monitoring should be analyzed each time, along with the three field analyses (EC, pH, and temperature). The full general mineral suite may be performed once every two to five years, depending on the variation seen in the continuously monitored constituents. If little to no changes are seen in the continuously monitored constituents, then there is no reason to repeat the general minerals more than once every five years. If water quality is changing significantly over time, however, it is important to understand as much as possible about the process, and a complete general mineral analysis may be helpful in tracking ground water movement and estimating percentages of mixing between different waters.

Monitoring Locations

The Los Osos nitrate monitoring program will evaluate both first water and upper aquifer ground water quality. A distinction between monitoring first water quality and monitoring the upper aquifer quality in Los Osos is necessary. For practical purposes, it is the overall upper aquifer quality, rather than the quality of first water, that is most relevant to community water supply purveyors and to ground water basin management issues. On the other hand, historical water quality monitoring in Los Osos by the County has been mostly limited to wells in the shallowest portion of the upper aquifer. In order to continue evaluating historical water quality trends, these shallow (first water) wells must be used. Ground water sampling at lower aquifer wells is not part of this monitoring program. Water quality in the lower aquifer is already being monitored by community water supply purveyors. Available water purveyor data on lower aquifer water quality will be incorporated into the nitrate monitoring program reports.

First water, as mentioned previously, is routinely monitored as part of a wastewater discharge permit, and was the primary focus of the historical 1982-1998 County monitoring program. First water is the interface where percolating waters, including precipitation and return flows from irrigation and wastewater, mix with basin waters.

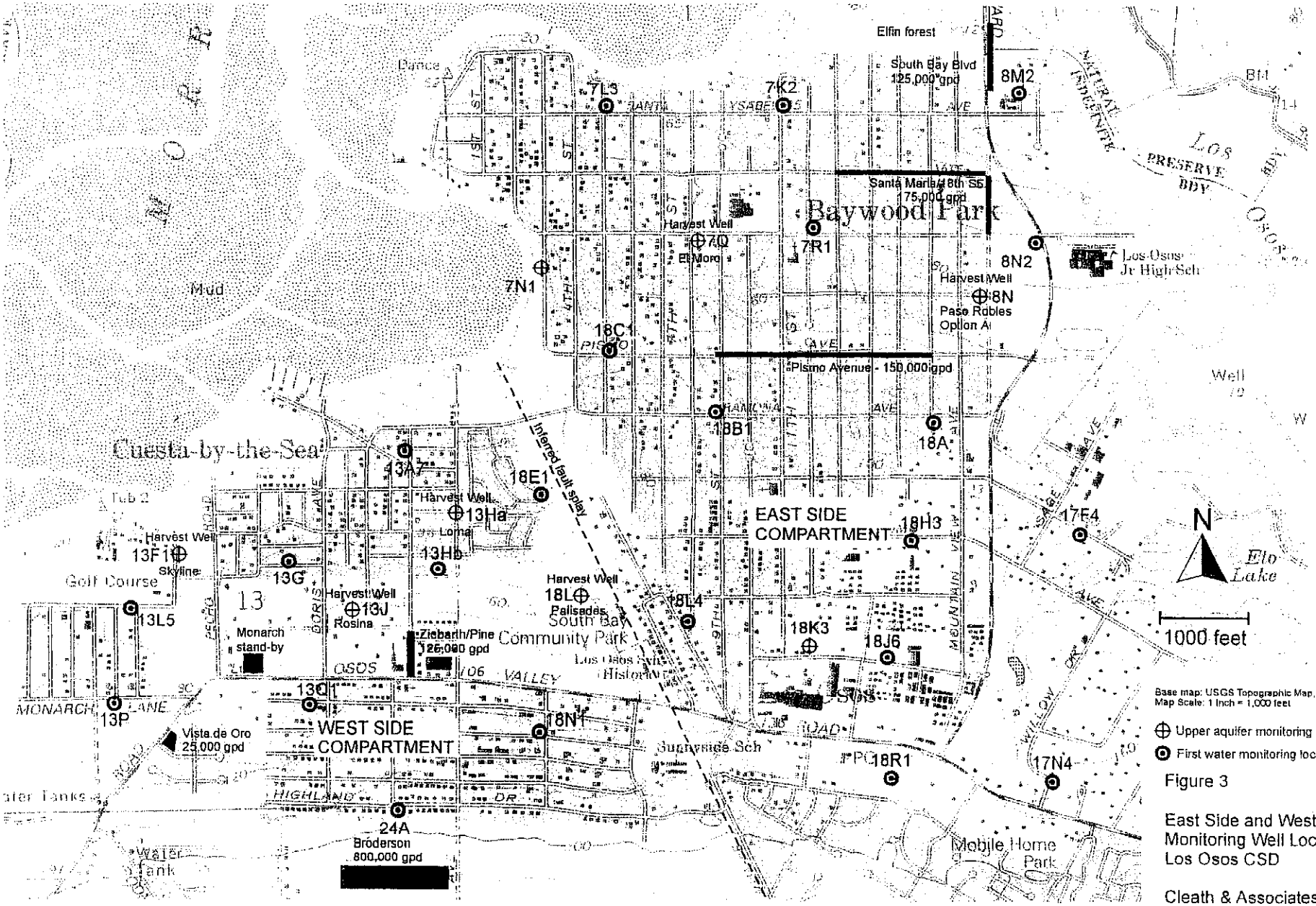
To provide continuity with prior water quality monitoring efforts, most of the wells in the 1982-1998 County program should be retained. Sample location continuity is an important aspect of monitoring, because it allows monitoring changes in water quality over time. Concerns with the wellhead seals must be addressed, however. At least 11 of the monitoring locations will require wellhead reconditioning, including installation of water-tight, traffic-rated well boxes with locking caps, a surface sanitary seal which is in contact with the well casing, and a cement apron to hold the well box that is tapered to drain away from the well. Prior to any such work, an application for well reconditioning should be submitted to the County Environmental Health Division for continued use as monitoring wells.

A total of 33 sampling locations are recommended across basin, including the East side, West side, and Creek compartments. All sampling location tap either first water or the upper aquifer. A summary of the locations are presented below in Table 1, and shown in Figures 3 and 4.

Table 1
Monitoring Well Locations - Nitrate Monitoring Program

Well ID	Location	Type	Depth (ft)	Perforated interval (ft)	Well diam. (in)	GSE (ft)	DTW approx. (ft)	Data history (years)
30S/10E								
13A7	Pine St.	Private	40	30-40	8	11.6	5	1982-1998
13F1	Solano/ Skyline	CCW	195	90-195	14	16*	10	1991-2001
13G	South Court	CSD mon	52	47-52	2	55*	40	none
13Ha	**Loma St.**	**CSD**	**190**	**90-190**	**10**	**50***	**20**	**none**
13Hb	Broderson/Skyline	CSD mon	34	29-34	2	55*	20	none
13J	**Rosina Ave.**	**CCW**	**190**	**90-190**	**10**	**85***	**55**	**none**
13L5	Howard/ Del Norte	CSD mon	35	32-35	1.5	29.98	20	1982-1998
13P	Monarch Lane	CSD mon	69	64-69	2	70*	60	none
13Q1	Woodland Dr.	CSD mon	100	97-100	1.5	98.61	80	1982-1998
24A	Highland/ Alexander	CSD mon	164	154-164	2	185*	150	none
30S/11E								
7K2	Santa Ysabel/ 12th	CSD mon	65	62-65	1.5	92.8	50	1982
7L3	Santa Ysabel/ 5th	CSD mon	45	43-45	1.5	43.32	35	1982-1998
7N1	3rd St.	CSD prod	83	61-71, 73-83	8	9.13	5	1982-2001
7Q	**El Moro/ 8th St.**	**CSD**	**125**	**75-125**	**10**	**25***	**5**	**none**
7R1	El Moro/ 12th St.	CSD mon	30	27-30	1.5	58.75	20	1982-1987
8N	**Paso Robles/ 18th**	**CSD**	**120**	**60-120**	**8**	**75***	**5**	**none**
8M2	SantaYsabel east	Private	90	70-90	6	100*	50	none
8N2	El Moro/ 12th St.	CSD mon	45	42-45	1.5	97.75	30	1982
17F4	Hollister Ln.	Private	72	48-72	8	76.2	40	1983-1998
17N4	Willow Dr.	Private	60	40-60	6	160.2	10	1983-1987
18A	Ramona Ave./16th St.	Private	tbd	tbd	tbd	100*	40	tbd
18B1	Ramona Ave./10th St.	CSD mon	32	29-32	1.5	76.97	15	1982-1987
18C1	Pismo Ave./ 5th St.	CSD mon	30	27-30	1.5	30.6	20	1982
18E1	Morro Shores	CSD mon	60	40-60	6	37.5	25	1982
18H3	Nipomo Ave.	Private	110	50-100	6	107.56	60	1982
18J6	Los Olivos/ Fairchild	CSD mon	25	22-25	1.5	122.65	15	1982-1998
18K3	Los Olivos/11th St.	CCW prod	232	148-202/222-232	8	121.2	115	1982-2001
18L	**Palisades Ave.**	**CSD**	**190**	**90-190**	**10**	**85***	**30**	**none**
18L4	Ferrell Ave.	CSD mon	25	22-25	1.5	101.13	15	1982
18N1	Manzanita/ Ravenna	CSD mon	90	87-90	1.5	106.82	80	1982-1987
18R1	Los Osos Valley Rd.	Private	50	40-50	8	168.64	10	1982-1999
20B	Palomino Drive	Private	tbd	tbd	tbd	100*	60	tbd
21D13	Tapidero Street	Private	100	35-100	tbd	70*	35	1984, 1987

Notes: Wells in bold are not yet constructed (future harvest wells)
DTW = depth to water (approximate - various dates)
Data history = years with available water quality data
* Estimated elevations (survey needed)
GSE = ground surface elevation
CCW = California Cities Water
CSD = Los Osos CSD
tbd = to be determined



Base map: USGS Topographic Map, Morro Bay South
Map Scale: 1 Inch = 1,000 feet

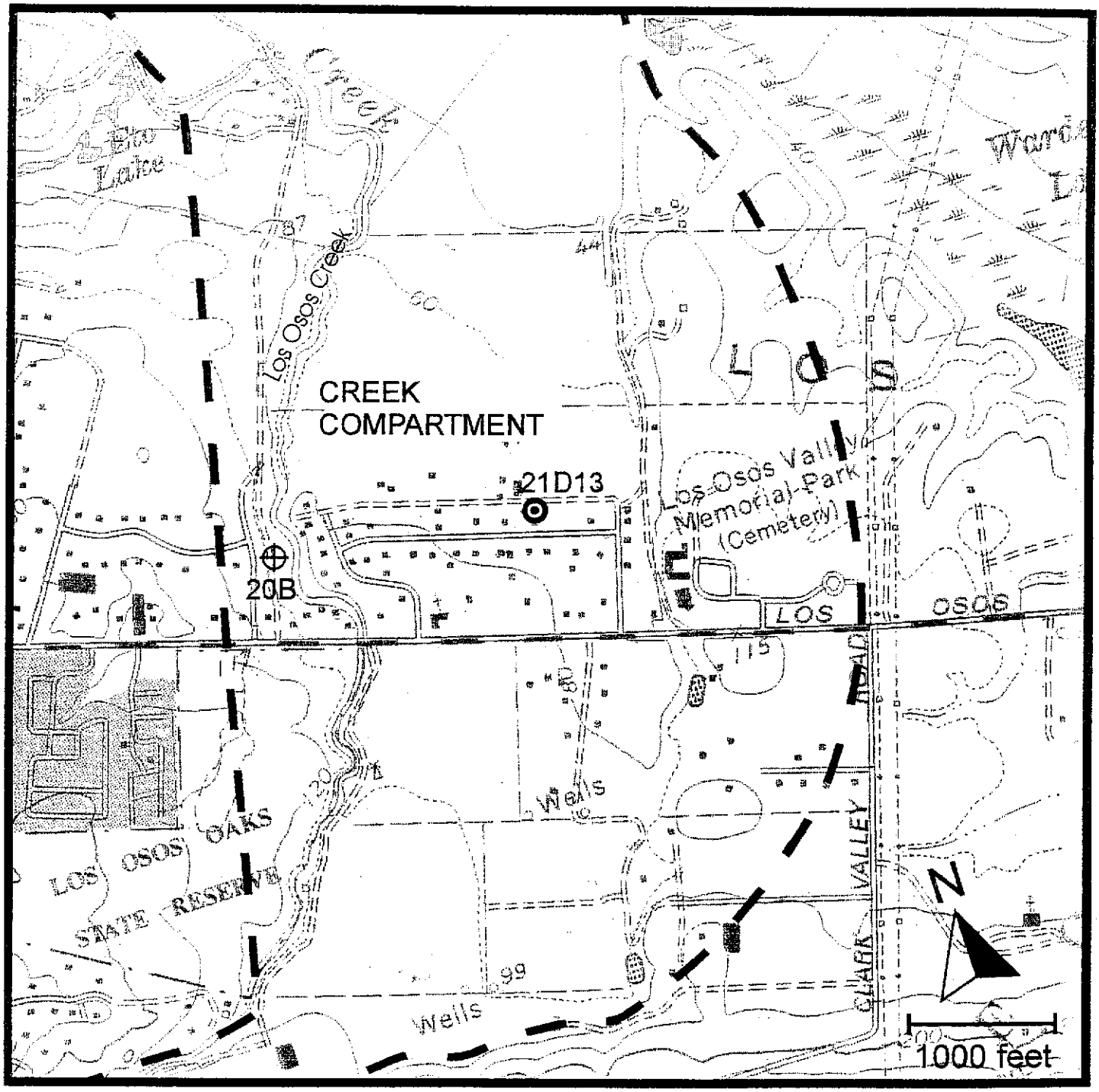
⊕ Upper aquifer monitoring location

⊙ First water monitoring location

Figure 3

East Side and West Side
Monitoring Well Locations
Los Osos CSD

Cleath & Associates



Base map: USGS Topographic Map, Morro Bay South, 1994

Map Scale: 1 inch = 1,000 feet

⊕ Upper aquifer monitoring location

◎ First water monitoring location

— — — Compartment boundary

Figure 4

Creek Compartment
Monitoring Well Locations
Los Osos CSD

Wells recommended for inclusion in the new monitoring program are discussed individually below. The rationale for including wells in the monitoring program may include continuity with historical monitoring locations, improved lateral coverage of the basin, and assisting basin management operations (identifying water quality trends at harvest wells and for solute transport model calibration).

30S/10E-13A7

Pine Street. Private well; equipped. NO3-N concentrations ranges from 6.5 to 17.2 mg/l, average 11 mg/l (1982-1998). Mostly in excess of drinking water standards since 1989. This is a shallow residential well (first water). Recommended to provide continuity with historical nitrate monitoring program data.

30S/10E-13F1

Solano Street near Skyline. California Cities Water (CCW) production well; equipped. Well is presently inactive, but has been selected for harvest well service. NO3-N concentration measured 18 mg/l in January 2001. This is an upper aquifer well. Recommended due to harvest well status and for solute transport model calibration.

30S/10E-13G

South Court. Former Metcalf & Eddy monitoring well. Well taps first water. No history of water quality. Recommended due to location, which will assist in coverage of west side. Also allows comparison of first water quality to upper aquifer quality in the vicinity of harvest wells.

30S/10E-13Ha

Loma Street (east end). Future Los Osos CSD harvest well site; will be equipped. Will be an upper aquifer well. Recommended due to harvest well status and for solute transport model calibration.

30S/10E-13Hb

Broderson Avenue at Skyline Drive. Former Metcalf & Eddy monitoring well. Well taps first water. No history of water quality. Recommended due to location, which will assist in coverage of west side. Also allows comparison of first water quality to upper aquifer quality in the vicinity of harvest wells.

30S/10E-13J

Rosina Ave. Future CCW harvest well site; will be equipped. Will be an upper aquifer well. Recommended due to harvest well status and for solute transport model calibration.

30S/10E-13L5

Howard / Del Norte. Former Brown & Caldwell monitoring well. NO3-N concentrations ranges from 5.8 to 40 mg/l, average 19 mg/l (1982-1998). Mostly in excess of drinking water standards since 1984. This is a first water monitoring well. Recommended to provide continuity with historical nitrate monitoring program data. Wellhead improvements needed.

30S/10E-13P

Monarch Lane at El Dorado. Former Metcalf & Eddy monitoring well. Well taps first water. No history of water quality. Recommended due to location, which will assist in coverage of west side.

30S/10E-13Q1

Woodland Dr. Former Brown & Caldwell monitoring well. NO3-N concentrations ranges from 10.6 to 32 mg/l, with an average of 22 mg/l (1982-1998). Consistently in excess of drinking water standards since 1982. Trend of deteriorating water quality. This is a first water monitoring well. Recommended to provide continuity with historical nitrate monitoring program data. Wellhead improvements needed.

30S/10E-24A

Highland Ave. / Alexander (located on Broderson wastewater disposal site). Former Metcalf & Eddy monitoring well. Well taps first water. No history of water quality. Recommended due to location, which will assist in coverage of west side.

30S/11E-7K2

Santa Ysabel Ave. / 12th Street. Former Brown & Caldwell monitoring well. NO3-N concentration of 14.6 mg/l in June 1982 (in excess of drinking water standards). This is a first water monitoring well. Recommended due to location, which will assist in coverage of east side. Wellhead improvements needed.

30S/11E-7L3

Santa Ysabel / 5th Street. Former Brown & Caldwell monitoring well. NO3-N concentrations ranges from 4.3 to 20.5 mg/l, with an average of 14 mg/l (1982-1998). Consistently in excess of drinking water standards since 1987. This is a first water monitoring well. Recommended to provide continuity with historical nitrate monitoring program data. Wellhead improvements needed.

30S/11E-7N1

3rd Street. Los Osos CSD production well. NO3-N concentrations ranges from 1.5 to 5 mg/l, with an average of 2.7 mg/l (1982-1998). Consistently below drinking water standards. This is a partially-penetrating upper aquifer water supply well. Clay aquitard present from 30-56 feet depth. This locally confining clay is not laterally extensive, based on information at 8th Street and El Moro Avenue. Recommended to provide continuity with historical nitrate monitoring program data.

30S/11E-7Q

8th Street / El Moro (east end). Future Los Osos CSD harvest well site; will be equipped. Will be an upper aquifer well and will replace the old 8th Street Well (7Q1). NO3-N concentrations at 7Q1 ranged from 3.1 to 19 mg/l, with an average of 14 mg/l (1982-1998). Consistently in excess of drinking water standards since 1982. Recommended due to harvest well status, for solute transport model calibration, and to provide continuity for historical nitrate monitoring program data.

30S/11E-7R1
El Moro / 12th Street. Former Brown & Caldwell monitoring well. NO3-N concentration 19.7 mg/l in June 1982 (in excess of drinking water standards). This is a first water monitoring well. Recommended due to location, which will assist in coverage of east side. Wellhead improvements needed.

30S/11E-8M2
Santa Ysabel east of South Bay Boulevard. Private well. No water quality history. This is a first water well. Recommended due to location, which will assist in coverage of east side.

30S/11E-8N2
El Moro / South Bay Boulevard. Former Brown & Caldwell monitoring well. NO3-N concentration of 2.61 mg/l in June 1982 (below drinking water standards). This is a first water monitoring well. Recommended due to location, which will assist in coverage of east side. Wellhead improvements needed.

30S/11E-8N
Paso Robles / 18th Street (Option A). Future Los Osos CSD harvest well site; will be equipped. Will be an upper aquifer well. Recommended due to harvest well status and for solute transport model calibration.

30S/11E-17F4
Hollister Lane. Private well; equipped. NO3-N concentrations ranged from not detected to 4.4 mg/l, with an average of 1.3 mg/l (1982-1998). Consistently below drinking water standards. This is a first water monitoring well. Recommended to provide continuity for historical nitrate monitoring program data.

30S/11E-17N4
Willow Drive. Private well; equipped. NO3-N concentrations ranged from 3.6 to 4.4 mg/l (1983-1987). Consistently below drinking water standards. This is a first water monitoring well. Recommended to provide continuity for historical nitrate monitoring program data.

30S/11E-18A
Ramona Ave. / 16th Street vicinity. Any private well in area (specific location not yet identified). Unknown water quality history. Will probably be a first water monitoring well. Recommended due to location, which will assist in coverage of east side.

30S/11E-18B1
Ramona Ave. / 10th Street. Former Brown & Caldwell monitoring well. NO3-N concentration ranged from 2.1 mg/l to 12.9 mg/l (last measured at 2.1 mg/l in 1987; below drinking water standards). This is a first water monitoring well. Recommended due to location, which will assist in coverage of east side. Wellhead improvements needed.

30S/11E-18C1

Pismo Ave. / 5th Street. Former Brown & Caldwell monitoring well. NO3-N concentration of 9.53 mg/l in June 1982; below drinking water standards. This is a first water monitoring well. Recommended due to location, which will assist in coverage of east side. Wellhead improvements needed.

30S/11E-18E1

Morro Shores mobile home park. Private well; equipped. NO3-N concentration of 3.47 mg/l in 1982 (below drinking water standards). This is a first water monitoring location. Recommended due to location, which will assist in coverage of east side.

30S/11E-18H3

Nipomo Avenue. Private well; equipped. NO3-N concentration of 15.9 mg/l in June 1982 (in excess of drinking water standards). This is a first water monitoring location. Recommended due to location, which will assist in coverage of east side.

30S/11E-18J6

Los Olivos / Fairchild. Former Brown & Caldwell monitoring well. NO3-N concentrations ranges from not detected to 21 mg/l, with an average of 3.4 mg/l (1982-1998). Mostly below drinking water standards (one exception). This well monitors a lense within the perched aquifer in downtown Los Osos. There is a separate perched water zone above the zone being monitored. Trend of water quality deterioration suggested by chloride concentrations over time. Recommended to provide continuity for historical nitrate monitoring program data. Wellhead improvements needed.

30S/11E-18K3

Los Olivos Ave near 11th Street. California Cities Water (CCW) production well; equipped. NO3-N concentrations consistently below drinking water standards. This is an upper aquifer well (beneath perched aquifer in downtown Los Osos). Recommended due to location for basin management operations (nitrate solute transport model calibration).

30S/11E-18L

Palisades Avenue (north end). Future Los Osos CSD harvest well site; will be equipped. Will be an upper aquifer well. Recommended due to harvest well status and for solute transport model calibration.

30S/11E-18L4

Ferrell Avenue. Former Brown & Caldwell monitoring well. NO3-N concentration of 10.5 mg/l in June 1982 (above drinking water standard). Recommended due to location, which will assist in coverage of east side. Wellhead improvements needed.

30S/11E-18N1

Manzanita / Ravenna. Former Brown & Caldwell monitoring well. NO3-N concentration 21.8 mg/l in June 1982 (above drinking water standard). Recommended due to location, which will assist in coverage of east side. Wellhead improvements needed.

30S/11E-18R1

Los Osos Valley Road (Bender - Garage). NO3-N concentrations ranges from 8.4 to 21 mg/l, average 16 mg/l (1982-1998). Mostly in excess of drinking water standards. Trend of deteriorating water quality through 1990. This is a first water monitoring well. Recommended to provide continuity for historical nitrate monitoring program data.

30S/11E-20B

Palomino Drive. Any private well in area that taps the upper aquifer (specific location not yet identified). Unknown water quality history. Recommended due to location, which will allow assessment of the upper aquifer flow between the East side and Creek compartments.

30S/11E-21D13

Tapidero Avenue. Private well. NO3-N concentrations ranged from 11.2 to 23 mg/l, average 17 mg/l (three samples in 1984 and two in 1987). Consistently in excess of drinking water standards. This is a first water monitoring well. Recommended to provide continuity for historical nitrate monitoring program data and due to location in Creek compartment.

SAMPLING PROTOCOL

The recommended sampling protocol, including the selection of equipment, is designed to allow one technician the ability to sample all the wells in the program. The sampling protocol is divided into two sections, sampling procedures and sampling equipment. An example field log sheet is attached.

Sampling Procedures

Sampling procedures for general mineral and nitrate sampling are presented below. The purpose of the procedures are to ensure that communication is established with the aquifer prior to sample collection.

Non-equipped monitoring wells (15 wells total):

1) Calibrate field monitoring instruments each day prior to sampling.
2) Inspect wellhead condition and note any maintenance required (perform at earliest convenience).
3) Measure depth to static water (record to 0.01 inches) from surveyed reference point.
4) Install temporary purge pump to at least three feet below the water surface (deeper setting may be needed if water level draw down is too great).
5) Begin well purge, record flow rate.
6) Measure discharge water EC (measured to 10 µmhos/cm), pH (measured to 0.01 units), and temperature (measured to 0.1 degrees F) twice during each casing volume purge. Record time and gallons purged. Allow sufficient time for any discharge water trapped in hose from prior well sampling event to be displaced before taking first measurement. Also note discharge water color, odor, and turbidity (visual).

7) A minimum of three casing volumes of water should be removed during purging. In addition, a set of at least three consecutive field monitoring measurements with stable values should be recorded. For EC, stability within 10 percent of the first value in the set is sufficient (typically within 50-100 µmhos/cm). For pH, stability within 5 percent of the first value is sufficient (typically within 0.3-0.4 units). For temperature, stability within 1 percent of the first value is sufficient (typically within 0.5-0.7 degrees).
8) Collect sample directly from discharge tube, note sample color, odor, turbidity (visual). Use only laboratory-provided containers.
9) Place samples on-ice for transport to the laboratory.
10) Remove temporary pump, dry off pump and wet portion of hose with clean towel (rinse first with clean water if sediment or foreign matter observed).
11) Close well and secure well box lid.

Equipped wells (18 wells total):

The sampling port for an equipped well must be upstream of any water filtration or chemical feeds. Sample from the discharge line as close to the wellhead as possible. Sampling procedures for equipped wells will vary, based on whether the well is active or inactive. For active wells (i.e. wells used daily), the need for purging three casing volumes is unnecessary. The well should be turned on for a nominal 5 minutes, and one set of EC, pH, and temperature readings collected prior to sampling. For inactive wells, a field monitoring procedure similar to that described above would be appropriate. Static water level measurements should also be taken before sampling. Water samples should always be transported on-ice to the laboratory.

Sampling Equipment

The recommended sampling equipment for non-equipped wells is a portable, reel-mounted downhole pump which would be transported from well to well. The main constraint for downhole pump choices is well diameter. There are 1.5-inch diameter and 2-inch diameter unequipped wells. A suitable pump choice would be the Bennett submersible piston pump, Model 140 (1.4-inches outside diameter). This pump is air-compressor powered, although air does not contact the discharged water. Purge rates of 1 gpm can be expected, which translates to purge times of less than 20 minutes for the unequipped wells. A compressor with minimum 80 psi pressure capacity and 3 cfm air flow capacity would be sufficient to drive the pump. The portable unit includes a manual, chain-driven reel with swivel head and hand-brake, built in water-level indicator, flow meter, and air pressure regulator and gage. Discharge tubing choices are polypropylene or teflon (polypropylene is acceptable for program application).

For sampling events conducted by Cleath & Associates, water level sounding and field water quality monitoring equipment are provided at no additional charge. Should a trained water purveyor technician perform the sampling program, however, these items would need to be purchased.

Accurate water level measurements are an important part of the sampling procedure. The water level indicator on the sampling pump reel should only be used for pump depth setting, not for reporting depth to water. For depth to water measurements, a calibrated well sounder is needed. Various brands are available. One suitable product is the Powers Well Sounder, with flexible 3/8-inch diameter brass weights at the probe and a 20 AWG size cable. The construction of this sounder is durable, and the flexible probe end minimizes the potential for getting hung up on other downhole equipment.

There are many field water quality monitoring meters available. Some offer EC, pH, and temperature in one meter, such as the Hydac tester. Any meter(s) capable of the resolutions recommended in the sampling procedures would be acceptable for the program.

DATA REPORTING

The data reporting should meet regulatory requirements and facilitate interpretation of trends. The following figures are recommended:

- A base map with sample locations.
- A water level contour map for estimating hydraulic gradients and flow directions.
- A nitrate concentration contour map for data from wells tapping first water, with upper aquifer well concentrations shown but not contoured. This will allow a comparison of the difference in quality between first water and the upper aquifer.
- A total dissolved solids concentration contour map for data from wells tapping first water, with upper aquifer well concentrations shown but not contoured (similar to nitrate map).
- A water level hydrograph and chemical hydrographs of nitrate and TDS at each well. A minimum of three historical data points should be available before a hydrograph is introduced.
- If the general mineral package is performed (first sampling event and every 5 years minimum), a trilinear diagram showing milliequivalent percentages for the major ions should be prepared.

In addition to the figures, the following tables are recommended:

- A table with well construction details and current water level information.
- A table summarizing water quality data for the latest sampling event.
- A table summarizing water quality from deep aquifer wells during the period (from water purveyors).

The report text should include the following items:

- A brief conduct of work and any unusual field observations or procedures during the sampling event.

- Discussion and interpretation of the results, including comparisons of the difference in quality between wells tapping first water and upper aquifer wells and identification of trends in water quality.
- Recommendations for any additions or modification to the nitrate monitoring program.

Laboratory results for the latest sampling event should be included as an appendix to each semi-annual report. All historical water quality data should be made available electronically for interested parties.

GROUND WATER MONITORING FIELD LOG
LOS OSOS NITRATE MONITORING PROGRAM

Date:_____
Operator:_____
Well number and location:_____
Site and wellhead conditions:_____
_____
_____

Static water depth (feet): _____
Well depth (feet): _____
Water column (feet): _____
Casing diameter (inches): _____
Three casing volumes (gal): _____
Pump rate (gpm): _____
Pump setting (feet): _____
Minimum purge time (min): _____
Time begin purge: _____

Time	Gallons	EC	pH	Temp.	Comments*

* turbidity, color, odor, sheen, debris, etc.