Nitrate Study

Metcalf & Eddy
An Air & Water Technologies Company

March 2, 1995

Honorable Board of Supervisors
San Luis Obispo County
County Government Center
San Luis Obispo, CA 93408

Subject: Los Osos Wastewater Study

Dear Board Members:

Metcalf & Eddy (M&E) is pleased to submit this final report on Task F - Sanitary Survey and Nitrate Source Study. This completes the first phase of the work in the amendment dated October 1, 1993 to the original agreement dated October 10, 1989.

This report was prepared from two earlier drafts with extensive input from the Los Osos Technical Advisory Committee (TAC), appointed by the Board in September 1993 to assist, review, and advise M&E during the study. The assistance of TAC, as well as County staff, is greatly appreciated.

The report consists of five chapters plus appendixes which present results of work on the following tasks.

- Documentation of problems with onsite wastewater systems in Los Osos. This consisted of analysis of data from a sanitary survey performed by volunteers from the community under the direction of the Los Osos Blue Ribbon Committee. Also included was an analysis of onsite system permit/repair data.

- Discussion and documentation of nitrate sources. This included analysis of nitrate concentration data in shallow wells and estimates of relative contribution of potential sources of nitrate in shallow groundwater.

The conclusion of the study is that, for most of the community, existing onsite wastewater systems cannot be justified. It is recommended that Task G - Evaluation of Alternative Technologies be completed to develop the best available methods of managing wastewater in Los Osos.

The TAC has prepared its own comments on the report which are identified in the report text with a number enclosed in braces { } and summarized at the end of each chapter. The full text of these comments is presented in Appendix A. TAC has reached different conclusions than M&E and developed its own recommendations for future management of wastewater in Los Osos.

1804 Embarcadero Road, Suite 100, Palo Alto, CA 94303-3308
TEL: 415-494-9300 FAX: 415-494-2434

We are looking forward to continuing our efforts to deal with wastewater problems in the Los Osos community during completion of Task G - Evaluation of Alternative Technologies.

Yours truly,

METCALF & EDDY, INC.

Charles E. Pound, P.E.
Senior Vice President

Howard L. Selznick, P.E.
Project Manager

Rec'd from County of SLO

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

APPENDIXES

FIGURES

TABLES

ACKNOWLEDGMENTS

Metcalf & Eddy appreciates the assistance of the following organizations and individuals in the preparation of this report.

SAN LUIS OBISPO COUNTY BOARD OF SUPERVISORS

David Blakely
Ruth Brackett
Evelyn Delany
Laurence Laurent
Harry Ovitt

LOS OSOS/BAYWOOD PARK ALTERNATIVE TECHNOLOGIES REVIEW AND TECHNICAL ADVISORY COMMITTEE

<u>Blue Ribbon Committee</u>:

Mark Markwort: *Grade 5 Wastewater Treatment Operator*
Tom Ruehr, Ph.D.: *Professor of Soil Science, California Polytechnic State University*
Stan Stein, Alternate: *California Licensed Architect, A.I.A.*

<u>Chamber of Commerce</u>:

John T. Burnham, *Esq.*
Jerry Gregory, *C.A.R., N.A.R.*
Glen Ross, Alternate: *California State Licensed Contractor, Sanitation-Specialty*

<u>Citizens of Affordable Wastewater Systems</u>:

Wade Brim: *P.E. Civil Engineering*
Roger Shields: *P.E. Mechanical Engineering*
Jennifer McCallum, Alternate: *B.S. Microbiology*

<u>CSA 9 Advisory Group</u>:

Frank Freiler: *B.S. Industrial Technology, California State Licensed General Contractor*
Henry Hammer, Ph.D.: *California State Licensed General Contractor, Energy Consultant*
Paul Reynolds, Alternate

SAN LUIS OBISPO COUNTY ENGINEERING DEPARTMENT

Clint Milne, P.E., County Engineer
Glen Priddy, P.E., L.S., Deputy County Engineer
George Gibson, P.E., Project Engineer
Percy Garcia, Environmental Chemist
John Beaton, Water Systems Chemist

SAN LUIS OBISPO COUNTY PLANNING DEPARTMENT

John Hand
John Hofschroer

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, CENTRAL COAST REGION

Jay Cano, P.E. Senior Engineer

U.S. ENVIRONMENTAL PROTECTION AGENCY, CENTER FOR ENVIRONMENTAL RESEARCH INFORMATION

James Kreissl, Environmental Engineer

CALIFORNIA CITIES WATER COMPANY

Henric Szopinski

OTHER

Bob Semonsen (provided graphics for base maps)

METCALF & EDDY PROJECT STAFF

Charles Pound, P.E., Senior Vice President and Principal-in-Charge
Howard Selznick, P.E., Project Manager
Dr. James Wells
Elizabeth Hirschhorn, P.E.
Peter Miller
James Graydon, P.E.
Lloyd Pound
Marina Dee
June B. Miller

EXECUTIVE SUMMARY

INTRODUCTION

Los Osos is an unincorporated, suburban residential community that has grown from a population of 600 in 1950 to over 14,000 today. The method of wastewater disposal is onsite systems, primarily septic tanks and leachfields or seepage pits. In the late 1970s, the California Regional Water Quality Control Board, Central Coast Region (RWQCB) observed high nitrate levels in shallow monitoring wells and concluded that these nitrate levels appeared to increase with population and time. The RWQCB also concluded that most of the nitrates were the result of increasing numbers of onsite wastewater systems. Furthermore, some nitrate levels were above the Maximum Contaminant Limit (MCL) of 45 mg/L (as nitrate). As a result of these high nitrate levels and other factors such as bacterial levels exceeding Basin Plan limits, small lot sizes, and documented health concerns and problems from the County Environmental Health Department and State Health Department, the RWQCB imposed a prohibition (Resolution 83-13) against individual wastewater discharges that became effective in 1988.

There is no direct evidence to indicate that existing domestic water supplies, which draw from deeper wells, are being contaminated by nitrates. The concern is that nitrate in shallow groundwater will eventually reach this deeper groundwater. The concern does not appear imminent because of the good quality of domestic water supply, i.e., nitrate levels are well below the MCL. However, there appears to be an increasing trend of nitrate concentration in four of the 13 water supply production wells in the community.

As early as 1985, the RWQCB issued probable waste discharge requirements based on the beneficial uses of surface water and groundwater in the Los Osos area. A facilities plan, preliminary design, and Environmental Impact Report were prepared in 1985-87. The proposed project in these documents was a conventional gravity and pressure sewer collection system; a 1.6-million-gallon/day advanced wastewater treatment plant; and discharge of treated effluent into the groundwater basin via Los Osos Creek or a percolation basin at the south end of Broderson Avenue. The cost of these facilities, including design, construction, and financing costs, was estimated to be $71.5 million (1993 dollars), which represented a bonded assessment of over $11,500/single family dwelling. This cost has caused officials and citizens to search for less expensive alternatives and a better definition of wastewater problems in Los Osos.

Most data and information previously used to show that nitrate levels are primarily the result of onsite wastewater system effluent did not consider possible denitrification in the soil. Furthermore, there have been no definitive studies on data collected on wastewater problems or specific onsite wastewater system performance in the Los Osos area.

Consequently, the objectives of this study are to:

- Evaluate the relative importance and magnitude of potential sources of the observed nitrate concentrations in shallow groundwater and determine the relative contributions of nitrate from these sources.
- Analyze the available data to determine whether there are problems and potential problems with existing onsite wastewater systems.

NITRATE SOURCES

To investigate the hypothesis that onsite wastewater system effluent is major contributor to nitrate in shallow groundwater, the following tasks were accomplished.

- Evaluate historical trends in nitrate concentrations to determine if there is a correlation between nitrate concentrations and time or population.

- Identify and quantify sources of nitrogen that could contribute to nitrates in shallow groundwater.

The relationship between nitrate concentration and time and population growth is based on an analysis of historical nitrate data in shallow monitoring wells. Based on 445 observations in 29 wells from 1954 to 1994, average annual nitrate concentration in shallow groundwater appears to be increasing over time and in proportion to the population of the community. Of these 29 wells, 7 have increasing trends in nitrate concentrations, 3 have decreasing trends and 3 have no discernable trends. The remaining 16 wells did not have sufficient data for trend analysis. Such data alone do not establish cause-effect relationship between nitrates and time or population, but when analyzed statistically, do suggest a correlation between these data.

The relative amount of nitrates in vadose zone soil moisture from various sources is estimated with a mass loading calculation. The following sources are considered.

- Onsite wastewater system effluent
- Natural sources (soil organic matter, vegetation, inflowing groundwater)
- Agricultural fertilizers
- Animal wastes - horses
- Animal wastes - dogs and cats
- Horticultural fertilizers
- Soil disturbance from construction
- Weed abatement activities

Although the mass loading calculation is for vadose zone soil moisture, the results can be used for estimating relative contributions of nitrates to shallow groundwater, assuming the above list represents all significant sources of nitrate in the study area. Based on a mass loading of these nitrogen sources with appropriate factors for losses such as volatilization and denitrification, over 60% of the nitrate in shallow groundwater appears to be coming from onsite wastewater system effluent. Other sources such as soil (natural and disturbed), fertilizers, animal wastes, and weed abatement activities contribute lesser amounts of nitrates to shallow groundwater. This mass loading calculation and the apparent increase in nitrates over time suggest that onsite wastewater systems are a major contributor to vadose zone soil moisture and groundwater nitrate.

ONSITE WASTEWATER SYSTEMS

The problems and potential problems associated with conventional onsite wastewater systems are based on the results of a sanitary survey, repair and complaint records, depth to groundwater, and land use data.

The sanitary survey was performed by the Blue Ribbon Committee (BRC) and other volunteers and reached approximately 2,000 Los Osos households, or about 44% of the total. Specific documented problems with onsite wastewater systems included persistent wet spots, plumbing problems after heavy rains or visitors, backups, and odors. The relative incidence of these problems throughout the community showed no specific pattern of occurrence, i.e., there was no specific area with a higher or lower relative incidence of problems.

Repair and complaint data are also indicators of onsite system problems such as poor drainage and plumbing backups that may have resulted from improper design, construction, and/or maintenance. There were approximately 900 permits for onsite system repairs and 17 recorded complaints for the period 1985-1994; this is an average of 2% of the systems/year needing repairs. Residents in Cuesta-by-the-Sea and the Martin Tract have a lower relative incidence of repairs and complaints than the rest of the community. However, there are no specific clusters having a relatively high incidence of repairs and complaints.

An onsite system needs a certain minimum area to effectively treat wastewater. Based on County guidelines and other criteria on application rates and setback distances for a three-bedroom house, this minimum area is approximately 1,200 to 2,100 sq ft for a septic tank and leachfield and 1,100 to 1,900 sq ft for a septic tank and leach pit. This area should be clear of trees and woody shrubs and structures such as patios, decks, and driveways. It is possible to fit an onsite system on a lot as small as 5,500 sq ft, but the fit is tight and may constrain the property owner from fully developing the lot. In general, lots over 10,000 to 15,000 sq ft have few such constraints, while lots smaller than 5,500 sq ft, such as in Cuesta-by-the-Sea and along Ferrell Avenue, have severe constraints. Since most residential lots in the community are less than 6,250 sq ft, there are area constraints to leachfield system location throughout the community. Since these systems are already in place, this means that residents may have planted trees or shrubs or constructed other structures over their leachfields, possibly adversely affecting system performance.

Furthermore, housing density in Los Osos affects groundwater quality. If, for example, there were half as many people living in Los Osos in the same area--i.e., lot sizes would be twice as large, typically 12,000 to 20,000 sq ft--onsite systems would account for less than 50% of the nitrate contribution to groundwater instead of over 60%.

Depth to groundwater is a critical factor in onsite wastewater system performance. Based on available monitoring data on leach pits in the community, it appears that the minimum distance below the effluent subsurface discharge point is at least 10 to 15 ft for the maximum amount of denitrification to occur. This amount is 67% of the effluent nitrate, i.e., 33% of the effluent nitrate is reaching the groundwater. In areas where groundwater is less than about 30 ft deep, more than 33% of effluent nitrate is entering the groundwater. About one-third of the community (within the Prohibition Area) overlies groundwater less than 30 ft deep. In this area, use of conventional onsite wastewater systems could pose water quality problems from higher nitrate discharges.

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Findings

1. Average annual nitrate concentrations in shallow groundwater have increased since 1954. Population has also increased in the same time period. There is a statistically significant correlation between nitrate concentrations and population or time, suggesting a relationship between these variables. However, such correlation does not establish a causal relationship between increasing nitrate and increasing population.

2. Because nitrate concentrations in shallow groundwater differ widely within the community, the impact of onsite wastewater systems and other potential nitrate sources does not appear to be evenly distributed over the community.

3. Individual onsite wastewater systems appear to be a major contributor of nitrate to shallow groundwater. Over 60% of the nitrate currently in shallow groundwater may be derived from onsite wastewater system effluent. The data and calculations presented above provide strong evidence of a relationship between onsite wastewater system effluent and groundwater nitrate.

4. Natural sources, such as soil organic matter, native vegetation, and inflowing groundwater, contribute approximately 18% of the nitrate in shallow groundwater. Contributions from other non-natural sources--agricultural fertilizers, horticultural fertilizers, and horse wastes--are smaller and less significant. The magnitudes of other non-natural sources--soil disturbance from construction, weed abatement, and dog and cat wastes--are less certain but probably minor.

5. Problems revealed by the results of the sanitary survey include wet spots, odors, plumbing backups. Of the approximately 2,000 residences surveyed, 16% reported at least one of these problems. These data indicated that such problems occur throughout the community but there are no clusters with a relatively high incidence of problems.

6. A building permit for a leachfield or pit repair may be an indicator of a potential onsite wastewater system problem. Based on data from 1980 to 1994, the rate of repairs in Los Osos is approximately 2% of the systems/year. As with the sanitary survey data, repairs occur throughout the community but there are no clusters with relatively high incidence of repairs.

7. In most of Los Osos, lots are large enough to fit an onsite system according to County guidelines. The onsite system should be in an open expanse without trees and other structures such as patios, decks, or driveways. On lots less than 10,000 to 15,000 square feet, the fit is tight and there are constraints to developing the lot with trees and other structures.

8. As indicated by the limited data from the Los Osos Nitrogen Study, nitrogen transformation occurs beneath onsite systems but appears to reach a maximum at 10 to 15 feet below the effluent discharge point. This transformation is most likely to be nitrification and dentrification. Depending on the type of onsite system, this is equivalent to 20 to 30 feet below the ground surface. Thus, in areas where groundwater depth is 30 feet or more, denitrification is maximized and nitrates entering the groundwater are minimized. Where groundwater is less than 30 feet deep, effluent is probably entering the groundwater at higher nitrate concentrations. About one-third of the community within the Prohibition Area overlies groundwater less than 30 feet deep.

Conclusion

Based on these findings, continued use of existing conventional onsite wastewater systems is not justified in portions of the community having small lots (high density of onsite systems) and depths to groundwater less than 30 ft. This includes most of the community except Bayview Heights, the Martin Tract, and vacant areas.

Recommendations

Consequently, it is recommended that Task G - Alternative Technologies for Wastewater Collection, Treatment, and Disposal be completed as follows.

- For all of the community except Bayview Heights, the Martin Tract, and vacant areas with zoning for small lots (generally less than 10,000 square feet), evaluate variations to existing conventional onsite systems that increase nitrate removal as well as clustered or centrally located collection, treatment, and disposal technologies.

- For Bayview Heights, the Martin Tract, and vacant areas with zoning for large lots and groundwater greater than 30 feet, evaluate continued use of conventional onsite, soil-based wastewater systems but with appropriate design, maintenance, and operating criteria, standards, and regulations as part of a maintenance district.

ROLE OF THE TECHNICAL ADVISORY COMMITTEE

Throughout the preparation of this report, Metcalf & Eddy (M&E) worked closely with the Los Osos Technical Advisory Committee (TAC). TAC members were appointed by the Board of Supervisors to represent the community of Los Osos and to include concerned and interested citizens having a wide range of professional backgrounds. The members included a variety of expertise, technical and nontechnical, and represented the community in defining the problems and addressing issues with the full interest of the community in mind.

The TAC reviewed draft versions of this report and in some cases had differences of opinion as to interpretation of data and resulting conclusions. To provide a report that reflects both M&E's efforts and the position of the TAC, it was mutually agreed to categorize areas of difference in this Executive Summary, place a reference in the main report text at points where these differences are found, and provide a summary of TAC's comments at the end of each chapter. The complete text of TAC comments is in Appendix A.

The principal differences in opinion between M&E and TAC are categorized below.

- Proposed nitrogen limitation of 5 mg/L for wastewater discharges.
- Correlation of nitrate concentration with population and time.
- Lot size and density as an indicator of onsite wastewater system problems.
- Incidence of problems revealed by sanitary survey results and by permit and complaint data.

- Nitrogen mass loading calculation.

- Relation between nitrate transformations in soil moisture and groundwater depth.

LOS OSOS WASTEWATER STUDY
TASK F - REPORT ON SANITARY SURVEY AND NITRATE SOURCE STUDY
March 1995

ERRATUM

Pages Ex-8 to Ex-9, replace the bulleted items with the following tabulation.

M&E	TAC
1. In general, nitrate concentrations in shallow monitoring wells appear to be increasing in proportion to population of the community and over time.	1. While a correlation of population growth and increasing nitrate concentration may be in evidence in some parts of the community, there is no statistically significant correlation of population growth and increasing nitrate concentration for the community as a whole.
2. On lot sizes smaller than 10,000 to 15,000 sq ft, there are constraints to developing the property with trees and other structures because of space and setback requirements for onsite wastewater systems.	2. Lot sizes as small as 5,500 sq ft can adequately support the operation of conventional onsite wastewater systems.
3. There are no specific areas or clusters with relatively high incidence of problems as revealed by the sanitary survey and permits.	3. While all areas are subject to a certain random amount of repairs and complaints, there are certain specific areas of the community where the number of adverse conditions indicate particular problems (e.g., poor drainage) that can and should be dealt with.
4. Over 60% of nitrate in shallow groundwater may be derived from onsite wastewater systems.	4. The analysis and calculations in the report are inadequate to support this conclusion, and in fact less than 25% of the nitrate in the groundwater comes from onsite wastewater system effluent.
5. Regional Water Quality Control Board staff has issued a probable total nitrogen limitation of 5 mg/L for effluent discharged from a treatment facility.	5. No nitrogen standard has been issued for Los Osos.
6. In areas of the community where groundwater is less than about 30 ft deep, more that 33% of nitrogen in wastewater effluent is reaching the groundwater.	6. The amount of nitrate entering the groundwater has not been established, and is probably appreciably less than 33%.

LOS OSOS WASTEWATER STUDY
TASK F - REPORT ON SANITARY SURVEY AND NITRATE SOURCE STUDY
March 1995

ERRATUM

Page 3-35, bottom, add the following: "...ground surface and as over 24 mg/L in soil moisture at depths of 21 feet at well 13L5. The tables and analysis are included in Table A-4 of Appendix A."

Rec'd from County of SLO
BH

Los Osos

BOARD OF SUPERVISORS

COUNTY GOVERNMENT CENTER • SAN LUIS OBISPO, CALIFORNIA 93408 • 805-781-5450

FACSIMILE COVER SHEET

May 3 1995

PLEASE DELIVER THE FOLLOWING TO:

NAME/AGENCY Sorrel Marks, State Regional Water Quality Control Board

PHONE

FAX 543-1377

CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD
RECEIVED
5 1995

Total pages transmitted including cover sheet 6

SENT FROM:

Supervisor Bud Laurent

Comments This item was passed at yesterday's Board of Supervisors meeting

Contact Person: **Sondra Reiner, Administrative Secretary**
Phone 805-781-5450 FAX 805-781-5023

BOARD OF SUPERVISORS

COUNTY GOVERNMENT CENTER • SAN LUIS OBISPO, CALIFORNIA 93408 • 805-781-5450

LAURENCE L. LAURENT
DISTRICT TWO

TO: BOARD OF SUPERVISORS

FROM: LAURENCE LAURENT, SUPERVISOR, DISTRICT 2

DATE: MAY 2, 1995

SUBJECT: CONCURRENCE ON ITEMS IN DISPUTE ON THE TASK F REPORT ON A SANITARY SURVEY AND NITRATE SOURCE STUDY

Summary

The attached letter of concurrence, or agreement, follows up a meeting held on April 8, 1995 to attempt to resolve areas of dispute between members of the Los Osos Technical Advisory Committee and representatives of the Consultant contracted to perform an Alternative Technologies Study related to the Los Osos Waste Water Project.

Recommendation

It is recommended that your Board approve the addition of the attached letter on areas of concurrence (agreement) to the Task F Report of the Los Osos Waste Water Project Alternative Technologies Study.

Discussion

The consulting firm of Metcalf and Eddy Engineering (M&E) was contracted by the County of San Luis Obispo to perform a study of alternative technologies as part of the development of the Los Osos Waste Water Project. In order to maximize community participation in the study, the Los Osos Technical Advisory Committee (TAC) was formed to advise M&E, County Engineering staff, and the Board of Supervisors on the elements of the Study as it progressed. Some differences between Consulting Firm representatives and TAC members had surfaced which we attempted to resolve in a meeting held on April 8, 1995.

The attached letter memorializes areas of concurrence reached between M&E Representatives and members of the Technical Advisory Committee.

Other Agency Involvement

Engineering Department staff participated in the meeting to resolve areas of dispute.

Financial Considerations

None.

B-11
5-2-95

BOARD OF SUPERVISORS

COUNTY GOVERNMENT CENTER • SAN LUIS OBISPO, CALIFORNIA 93408 • 805-781-5450

LAURENCE L. LAURENT
DISTRICT TWO

MEMORANDUM

TO: LOS OSOS TECHNICAL ADVISORY COMMITTEE ON ALTERNATIVE TECHNOLOGIES, METCALF AND EDDY, INCORPORATED

FROM: LAURENCE L. LAURENT, SUPERVISOR, DISTRICT TWO

DATE: APRIL 11, 1995

SUBJECT: AGREEMENT ON ITEMS IN DISPUTE ON TASK F REPORT ON SANITARY SURVEY AND NITRATE SOURCE STUDY

On April 8, 1995, members of the Los Osos Technical Advisory Committee (TAC), representatives of Metcalf and Eddy Engineering (M&E), County Engineering, and I met in a workshop to resolve six areas of disagreement remaining in the "Task F" Report submitted to the Board of Supervisors in March, 1995. Those areas were: 1) the statistical significance of the historical database of nitrate concentration in groundwater; 2) the significance of lot size regarding constraints for onsite septic systems; 3) whether there are "clusters" of specific areas with relatively high incidences of onsite septic system problems; 4) the extent to which onsite septic systems contribute nitrate to groundwater compared to other possible sources; 5) what standard for nitrate nitrogen limitation should be applied; 6) how much credit should be given for denitrification of effluent reaching groundwater.

The following memorializes the agreements reached on the above points. If this record is deemed to be accurate by both the TAC and M&E, I ask that both Frank Freiler, Chairman of the TAC, and Charles Pound, Senior Vice-President of M&E, indicate such by their signatures where indicated. When I receive said signatures, I will submit this memorandum to the Board of Supervisors with a recommendation to the Board that this memorandum be added to the Task F Report and that said report be accepted by the Board.

STATISTICAL SIGNIFICANCE OF NITRATE DATABASE

A consensus was reached that the nitrate in groundwater database shows high variability from which <u>no</u> specific conclusions can be drawn with respect to time, population, and nitrate concentrations. However, data from certain wells do show excessive levels of nitrate. [This repudiates the representation made by Regional Water Quality Control Board staff in a recent report that analysis of the database indicates a "99.99" correlation between nitrates and population growth or time, when no such conclusion has been made by any competent statistician.]

Agreement on Items in Dispute
Task F Report on Sanitary Survey and Nitrate Source Study
Page Two

SIGNIFICANCE OF LOT SIZE RELATIVE TO ONSITE SEPTIC SYSTEMS

A consensus was reached that onsite system problems are not related to lot size; that nitrate contribution potential is related to population/unit area (density); and that onsite systems may be appropriate if specific conditions can be met.

CLUSTERING OF AREAS WITH HIGH INCIDENCE OF SEPTIC PROBLEMS

A consensus was reached that a finer analysis of the Sanitary Survey data for "problem areas", which was conducted by John Burnham, does show clustering. Burnham's analysis showed that slightly over 50% of described problems occur in about 10% of the community. Specifically, it was agreed to accept TAC's statement, "While all areas are subject to a certain random amount of repairs and complaints, there are certain specific areas of the community where the number of adverse conditions indicate particular problems (e.g., poor drainage) that can and should be dealt with," as representing the consensus on this point.

THE AMOUNT OF NITRATE IN THE GROUNDWATER DERIVING FROM ONSITE SEPTIC SYSTEMS ("MASS LOADING")

A consensus was reached that the issue of Mass Loading is extremely complicated and that insufficient data exist to accurately characterize the amount of nitrate in the groundwater deriving from onsite septic systems. However, in order to complete Task G (the examination and recommendation of possible alternatives to the proposed sewer collection and treatment system), in conformance with the State's Basin Plan, it was agreed that a figure of 13.0 grams of nitrogen/person/day for residential units would be utilized to calculate loading from future wastewater treatment processes including conventional onsite septic systems, alternative wastewater treatment solutions and sewered collection and treatment.

STANDARD FOR NITRATE NITROGEN LIMITATION

A consensus was reached that the following statement will apply as a standard for Task G, relative to nitrate nitrogen limitation: "The basis for the Los Osos 'remedy' will be that each residence will contribute, on average, no more than 10.0 mg/liter of nitrate nitrogen to the upper aquifer. For levels of controllable nitrate nitrogen in the groundwater exceeding 10.0 mg/liter, Los Osos (or the County) will institute management practices to lower these levels to 10.0 mg./liter over a 20 year period."

[Interpretative note by L. L. Laurent: In order to distinguish natural sources of nitrogen from nitrogen derived from human activities, a monitoring program will be established to scientifically determine natural "background" nitrogen concentrations in groundwater. Since RWQCB has not established a discharge concentration requirement for the vadose zone, further discussion and clarification on this are needed.]

RATES OF NATURAL DENITRIFICATION

While both the TAC and M&E acknowledge that the recent Nitrate Study completed by the County indicates that natural denitrification occurs in onsite systems studied, and that the averaged denitrification rates observed was approximately 67%, the parties agreed to set

Agreement on Items in Dispute
Task F Report on Sanitary Survey and Nitrate Source Study
Page Three

aside their differing opinions as "moot" concerning the significance of this. However, it was also agreed that the onsite system studied at the "14th Street" site, which showed average denitrification rates of 85%, may represent "typical" onsite systems under ideal conditions (depth to groundwater, etc.).

In addition to agreement reached on the six points, above, the group also came to consensus on "Evaluation Criteria for Nitrate Loading" and for the timetable for completion of Task G, as follows:

EVALUATION CRITERIA FOR NITRATE LOADING

1. Since total human population will effect nitrate loading calculations, the current "build-out" population of approximately 28,000 in the current general plan within the Urban Reserve Line should be used as an upper figure. [However, the general plan is being updated and this figure may be lowered by as much as 10-20%]

2. Individual onsite "units" will not be used in nitrate loading calculations, rather the loading by "regions" will be used.

3. Rather than constraining analysis of future options to the current "prohibition" area, it will be assumed that a "sanitation district" can be expanded to include outlying septic areas in adjacent residentially zoned development.

4. The exclusion or inclusion of Cabrillo Estates in Task G strategies will be evaluated when RWQCB staff (Howard Kolb) provides the criteria originally used to exclude this area of Los Osos from the current prohibition zone.

TIMETABLE FOR COMPLETION OF TASK G

Event	Timeline
1. "Fatal Flaw Analysis" submitted by M&E to TAC	4/14/95
2. "Fatal Flaw Analysis" completed	5/1/95
3. Task G Draft submitted to TAC	5/15/95
4. TAC comments returned to M&E	6/1/95
5. Task G Final to TAC	6/15/95
6. TAC completes Task G	6/30/95
7. Task G sent to CSA9 members	7/6/95
8. CSA9 Hearing on Task G	7/13/95
9. Task G scheduled for Board of Supervisors hearing	7/25/95

Agreement on Items in Dispute
Task F Report on Sanitary Survey and Nitrate Source Study
Page Four

By our signatures do we attest to the accuracy of the above account of the agreements reached between the TAC and M&E:

Frank Freiler, Chairman, TAC	Charles E. Pound, Vice-President, M&E

I would like to express my deep appreciation to all members of the Los Osos Technical Advisory Committee, Metcalf and Eddy, and County Engineering for their dedicated efforts and willingness to labor together in the cause of finding new answers to an old problem. What you have accomplished to date is remarkable and I am certain that your commendable contributions will be long remembered by a grateful community. Good luck with the final leg of your long journey.

Chapter 1
INTRODUCTION

HISTORICAL BACKGROUND

Los Osos is an unincorporated, primarily residential community with a typical suburban density of development with the usual residential lot size ranging from 5,000 to 10,000 square feet. From a population of 600 in 1950, the community has grown to over 14,000 residents. Based on the current general plan for the area [1],[a] the buildout population could be as high as 28,700. The Community is served by onsite wastewater treatment and disposal systems at individual homes and businesses. Most are individual septic tanks connected to leachfields or seepage pits but there are community systems serving Bayridge Estates (234 homes), Vista de Oro (63 homes), and four mobile home parks (455 units).

The Community is served by three water companies--County Service Area No. 9 (CSA 9), California Cities Water Company (Cal Cities), and S&T Mutual Water Company (S&T)--which have a total of 13 production wells for public water supply. These wells draw water from depths down to 530 feet and the water currently meets all quality and health standards.

However, in the late 1970s, high nitrate levels were observed in shallow groundwater monitoring wells in the Los Osos/Baywood Park community. Nitrate levels in many samples from these shallow wells were above the Maximum Contaminant Limit (MCL) for drinking water of 45 mg/L as nitrate (10 mg/L as nitrogen [2]). Nitrate concentration is of concern because high nitrate levels have been linked to methemoglobinemia, a blood disorder. This disorder results when ingested nitrates are reduced to nitrites in the stomach. Nitrites interfere with the absorption of oxygen by blood. Infants under 3 months of age are most susceptible to methemoglobinemia. Adults generally do not contract the disorder [3, 4].

---

a. A new general plan for the community is being prepared and may be completed by late 1995.

In 1971, the California Regional Water Quality Control Board, Central Coast Region (RWQCB) imposed a prohibition against individual waste discharges effective July 1, 1974. This prohibition was lifted in April 1975 once a program of groundwater monitoring was begun by San Luis Obispo County. The RWQCB used the results of this program and data collected by its staff to conclude that most of this nitrate contamination appeared to be from onsite wastewater systems, i.e., septic tanks and leachfields or seepage pits [5, 6, 7].

Although there appeared to be contamination in shallow groundwater[b], nitrate in production wells met and continues to meet the MCL for nitrate ([8] and Appendix B-2). In general, nitrate in all CSA 9 wells is less than 15 mg/L (as nitrate) and has been at this level since 1985. The only exception is the 12th Street well, which reached as high 40 mg/L (as nitrate) in the mid-1980s and has since been shut down. No other CSA 9 well shows any observable trend in nitrate concentrations over time (Appendix B-2).

Of the six Cal Cities wells, Highland and Los Olivos show a general upward trend in nitrate concentration since the 1970s and Skyline well has an upward trend since 1991. These are the shallowest wells, having perforations less than 200 feet deep. Furthermore, the Highland well is located near a horse corral. The three remaining wells, Cabrillo, Pecho, and Rosina, each have perforations below 200 feet and none has any observable trends in nitrate levels over time (Appendix B-2).

S&T has three wells, ranging in depth from 80 to 300 feet, but nitrate concentrations are not available for each individual well. However, based on available data, there seems to be an general upward trend in nitrate concentrations since the 1970s (Appendix B-2).

Although nitrate levels in water from deep production wells is less than the MCL of 45 mg/L (as nitrate), County and RWQCB staff believe that there remains a long-term threat to the

b. Nitrates in shallow groundwater are discussed in Chapter 3. The complete database for shallow groundwater is in Appendix B-1.

public water supply. The RWQCB subsequently reimposed the individual wastewater discharge prohibition in 1983 by its Resolution 88-13, which became effective November 1, 1988. The reasons for the prohibition were not only high nitrate levels in shallow groundwater but other factors such as bacterial levels exceeding Basin Plan limits, small lot sizes, and documented health concerns and problems from the County Environmental Health Department and State Health Department.[c] The area covered by the prohibition and the general community boundary, as defined by the Urban Reserve Line, are shown in Figure 1-1.

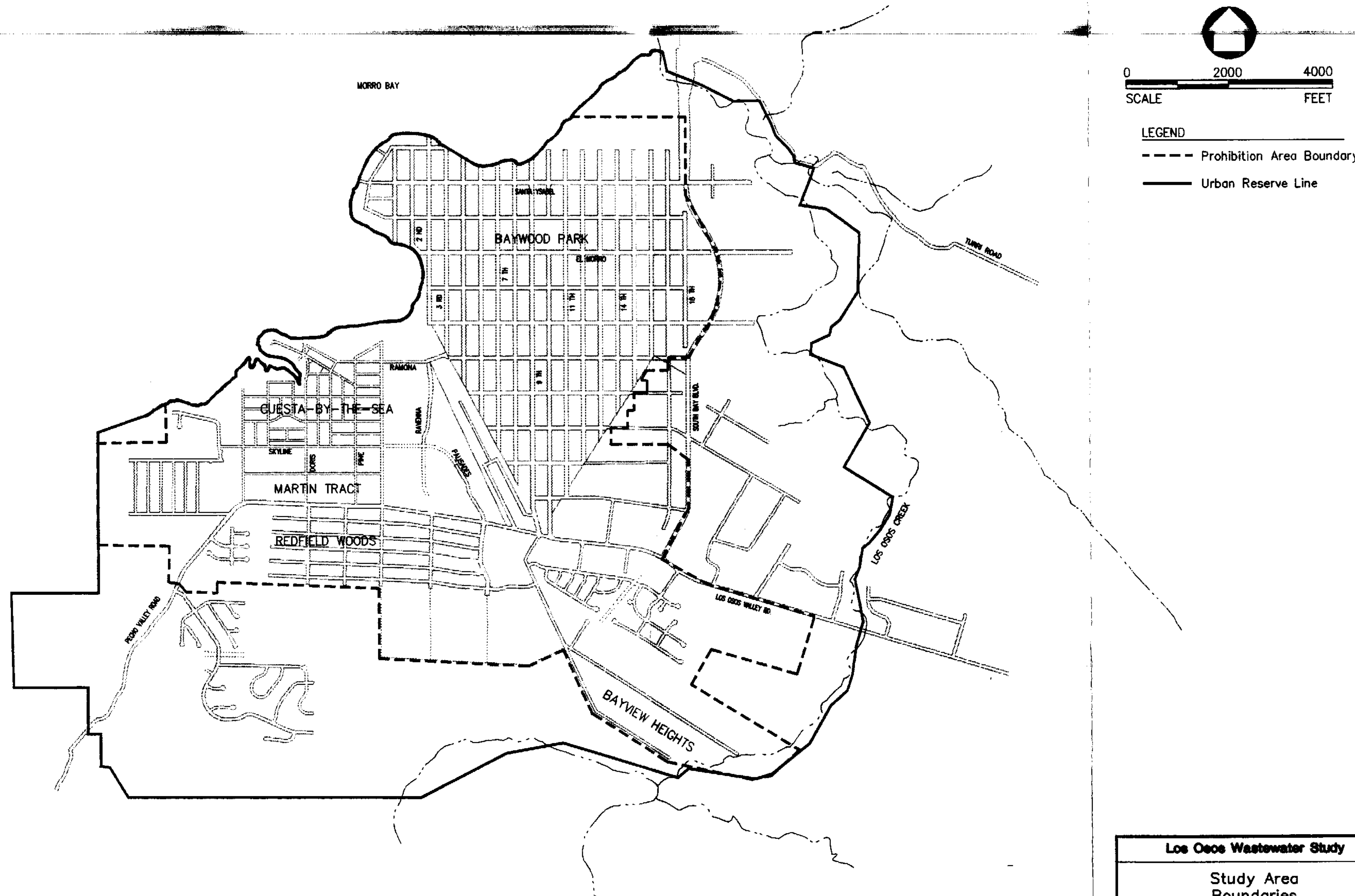
In response to the County's proposed wastewater treatment and disposal system, the RWQCB staff issued probable waste discharge requirements as early as 1985 [9]. Recognizing the critical nature of nitrate levels in a potential drinking water source, the RWQCB staff has recommended a total nitrogen limitation of 5.0 mg/L (as nitrogen) for effluent discharged from a treatment facility. {A1.1} The nitrogen and other effluent discharge limits (e.g., BOD, suspended solids, minerals, chlorine residual, pH, etc.) were based on the following conditions.

- Effluent discharge to Los Osos Creek when there is no hydraulic continuity with Morro Bay.
- Effluent discharge to another site when the Los Osos Creek-Morro Bay hydraulic continuity exists.

Additionally, the effluent discharge limits were based on the following beneficial uses for surface water, i.e., Los Osos Creek, and for groundwater as established in the Basin Plan [10]:

- Municipal
- Domestic
- Agricultural and industrial

c. These reasons are stated in the "whereas" clauses of RWQCB Resolution 83-13.



Los Osos Wastewater Study

Study Area Boundaries

Figure 1-1

Metcalf & Eddy

Date: January 1995

- Groundwater recharge (surface water only)
- Water contact and non-water contact recreation (surface water only)
- Habitats (surface water only)
- Fish migration and spawning (surface water only)

The probable nitrogen limit, which is half of the MCL of 10 mg/L (as nitrogen), could be changed subject to engineering justification for credit for further treatment in the soil column. {A1.1}

Facilities Plans were completed in 1984 and 1986 and the conclusion of each was that centralized wastewater collection and treatment systems were preferred over continued use of onsite treatment/disposal or other non-conventional methods [11, 12]. Many specific alternative projects were evaluated, but the one selected in 1986-87 consisted of the following components [1].

- Conventional gravity (192,000 ft) and pressure sewers (33,000 ft)
- Seven pumping stations
- 1.6-mgd tertiary treatment plant
- Percolation basin for recharging effluent to the shallower aquifer in winter (when there is hydraulic continuity between Los Osos Creek and Morro Bay)
- Outfall for discharge to Los Osos Creek in summer to recharge the deeper aquifer (when there is no hydraulic continuity between Los Osos Creek and Morro Bay)

An Environmental Impact Report on these facilities was completed in August 1987 and subsequently certified [13].

In 1989, Metcalf & Eddy, Inc. (M&E) was selected by the County to perform design and construction services to implement this project. An Assessment District was formed to fund the project in 1990. No design and construction work has been undertaken since the formation of the Assessment District because of litigation and other issues on the nature of the nitrate problem, performance of existing onsite wastewater systems, and the overall costs of the project.

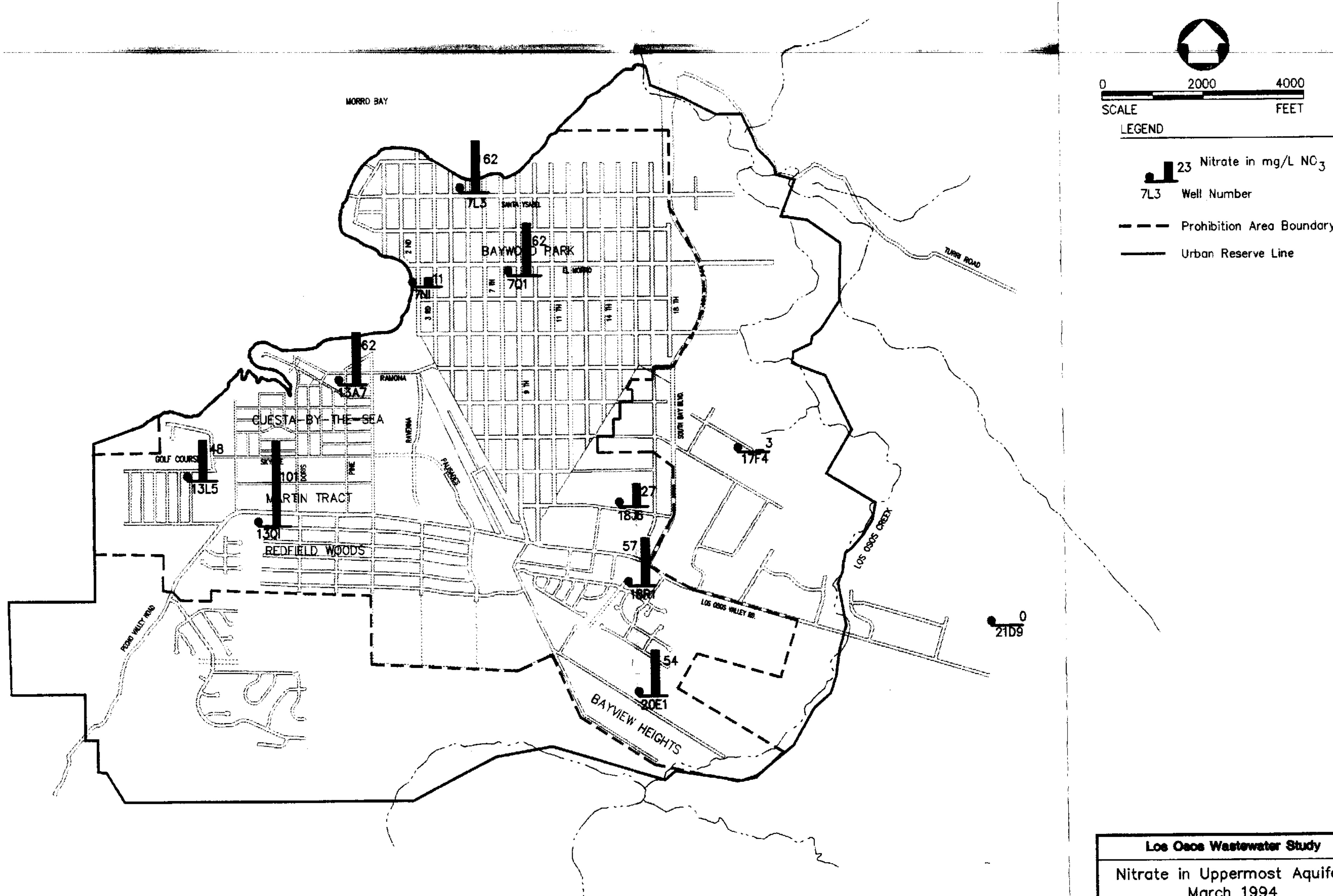
RECENT ISSUES

Nitrates in Groundwater

Based on ongoing sampling of shallow wells, the RWQCB concluded that nitrate levels in shallow wells have generally increased from the 1960s to the present and that many wells showed nitrate concentrations exceeding the MCL of 45 mg/L (as nitrate). However, not all data showed this trend and some data were erratic [5, 14]. Furthermore, most data and information previously used to show that nitrate levels are primarily the result of onsite wastewater system effluent did not consider possible denitrification of wastewater and other sources of nitrate in the soil [6, 19]. Also, recent (March 1994) data on nitrate concentrations shown in Figure 1-2 seem to indicate that in some areas of the community, nitrate levels are close to or above the MCL but in other areas, concentrations are well below the MCL. Furthermore, the highest concentrations were in only two or three locations. This suggests that onsite wastewater treatment in some areas of the community may be more effective than in other areas; and/or that there may be sources of nitrate other than onsite wastewater systems.

Status of Existing Onsite Wastewater Systems

There are no available data on the performance and operation of existing onsite wastewater systems throughout the community. By identifying and documenting the extent of existing septic tank and leachfield or seepage pit problems--including type and location--specific solutions could then be designed for the community.



Los Osos Wastewater Study	Figure
Nitrate in Uppermost Aquifer, March 1994	1-2
Metcalf & Eddy	Date: January 1995

Costs

The total estimated design and construction cost for the project was updated in 1989 to be \$58.0 million (in 1993 dollars [16][d]) which represents an assessment of \$9,120/single family dwelling unit [17][e]. Total project implementation cost--including design, construction, real property acquisition, financing, bond reserves, permits, EIR supplements, surveying, and mapping--is \$71.5 million or over \$11,500/single family dwelling. This cost does not include construction on private property, i.e. installation of house laterals and abandonment of the existing septic tank and leach field or leach pit. Because of this cost, many Los Osos residents believed that less expensive alternatives should be investigated.

Furthermore, since completion of the most recent facilities plan in 1986, no substantive engineering work has been done. In the years since then, there have been new developments in wastewater collection and treatment technology and construction techniques which may result in lower construction and operation and maintenance costs.

REPORT FORMAT

The Los Osos Technical Advisory Committee (TAC) has reviewed previous drafts of this report and prepared comments which are included in this report in the following format.

- Points of agreement are incorporated directly into the text.

---

d. Based on Engineering News-Record Construction Cost Index (ENR CCI) of 7,252. This value was developed based on a 6%/year inflation from 1989 to 1993 [16]. The current (first quarter 1994) ENR CCI for Los Angeles is approximately 6,500, so that the actual inflation rate has been 3%/yr.

e. Mobile homes and multiple family units had a smaller assessment. Nonresidential property was assessed on the same basis as single family residences with each 10,000 sq ft being the equivalent of a single family residence.

- Points of disagreement are:

  - Categorically highlighted in the Executive Summary
  - Identified by braces { } at appropriate points in the report text
  - Summarized at the end of each chapter

- The text of actual comments by TAC is included in Appendix A.

Further details of this format are in Chapter 2.

SUMMARY OF TAC COMMENTS

A1.1, Page 1-3, 1-5. Establishing the required concentration limit of nitrate and the amount of denitrification is essential in solving the Los Osos waste water problem. The TAC believes that M&E's inclusion of a standard for limits on nitrate of 5mg/L and 10mg/L is misleading. The TAC has requested M&E to remove all references to these unestablished nitrate limits or to provide proof of the establishment of any nitrate limit during the TAC's review of this study. M&E has refused to do either.

Chapter 2

STUDY OBJECTIVES AND SCOPE OF THE WORK

In 1991, a Blue Ribbon Committee (BRC) was formed to advise the County on finding the best alternative solution to the wastewater problem and to consider flooding, recharge, and water supply sources for Los Osos. The BRC, County, and M&E worked together to develop a scope of work to perform a new, updated study of alternative wastewater management systems. In September 1993, a Technical Advisory Committee (TAC) was formed to further define that scope of work and to assist, advise, monitor, and confer with M&E during the study.

OBJECTIVES

The study has the following objectives.

1. Determine the causes and sources of the observed high nitrate concentrations in shallow groundwater.

2. Determine the problems and potential problems of existing onsite wastewater systems.

3. Find ways to reduce the $58 million construction cost and/or operation and maintenance cost.

SCOPE OF WORK

To achieve these objectives, M&E's 1989 agreement was amended to add the following three work elements.

1. **Nitrate Sources.** Estimate the relative contributions of various sources of nitrates in groundwater, i.e., wastewater, fertilizer and irrigation, natural vegetation, atmospheric sources, etc.

2. **Sanitary Survey.** Obtain information on factors that affect performance of onsite wastewater systems. Citizen volunteers would develop and administer a questionnaire to Los Osos residents and businesses and deliver the results to M&E. The San Luis Obispo County Engineering and Planning Departments would also provide data on nitrate concentrations, groundwater levels, building permits issued for onsite wastewater system repairs, land use, and septage pumper records.

3. **Alternative Technologies Evaluation.** Evaluate alternative technologies for wastewater collection, treatment, and disposal. The evaluation is based on the results of the above work elements and specific criteria such as cost, technical feasibility, regulatory conformance, environmental impacts, and ability to implement.

The first two work elements constitute Task F of M&E's amended agreement and are the subject of this report. The third work element will be covered in a separate report (Task G).

STUDY METHODS AND REPORT FORMAT

During the course of the study, M&E used many data sources, including a library of reports and data assembled by Los Osos TAC. The files at the RWQCB office were also reviewed. Every document was reviewed but only material specifically relevant to the scope and purpose of the work was actually used and referenced in preparing this report.

Additional data were obtained from the San Luis Obispo County Engineering Department (well elevations, water consumption, and water quality) and the San Luis Obispo County Planning Department (building permits for onsite wastewater system repairs and population and land use). California Cities Water Company and S&T Mutual Water Company were also consulted for water consumption and water quality data.

TAC reviewed M&E's progress and work at biweekly telephone conference calls or meetings throughout the course of the study.

A draft report was submitted to TAC and County Engineering Department in May 1994. TAC and County Engineering submitted written comments on this draft. M&E prepared formal responses to these comments and attended two TAC meetings for further discussion of the comments and responses. M&E submitted a revised draft in October 1994 based on these written comments and discussions at the meetings.

Following review of the revised draft, TAC then prepared additional comments, which are included in this report in the following format.

- Points of agreement are incorporated directly into the text.
- Points of disagreement are:
  - Categorically highlighted in the Executive Summary.
  - Identified by braces { } at appropriate points in the report text.
  - Summarized at the end of each chapter
- The text of actual comments by TAC is included in Appendix A.

TAC wrote Appendix A and the end-of-chapter summary comments. These are reproduced as received from TAC except that in some cases explanatory notes have been added in *italics* to present revisions to the text made after TAC's review of the November 1994 Revised Draft.

Chapter 3
NITRATE SOURCES

INTRODUCTION

The purpose of this chapter is to investigate the hypothesis that onsite wastewater system effluent is a major contributor of nitrate to the shallow groundwater underlying the community. Specifically, the objectives are to:

- Evaluate historical trends in nitrate concentrations, i.e., determine if there is a correlation between nitrate concentrations and time or population. {A3.1}
- Identify and quantify specific sources of nitrogen that could contribute to nitrates in the shallow groundwater. {A3.1}

This issue has been addressed in previous studies of the Los Osos area [5, 6, 15, 18, 19]. These studies have concluded that onsite septic systems are responsible for nitrate contamination in the shallow groundwater at Los Osos. {A3.2} Conclusions from these studies were based on professional judgments of the authors, observations of water quality in shallow wells, and/or results of modeling. {A3.3, A3.4} Some of these studies used a mass loading approach for nitrogen but did not account for denitrification in the soil and other nitrogen losses such as plant uptake and volatization. The studies cited do not provide definitive evidence of the magnitude of the impact of onsite wastewater effluent on shallow groundwater at Los Osos.

Other research has also demonstrated that onsite wastewater systems may result in adverse impacts on groundwater when development density exceeds a certain threshold, or in areas with unsuitable subsurface conditions such as shallow groundwater or very permeable soils [3, 4, 20, 21, 22, 23]. {A3.5} A local study [34, 35] concluded that there is "strong evidence that nitrate [from leach pits or leach fields] is not actually reaching the groundwater."

Because subsurface processes cannot be directly observed as they occur, it is difficult to prove or disprove the onsite wastewater system effluent-groundwater nitrate connection. {A3.6} It is possible, however, to analyze the existing data, address potential nitrate sources, and seek to minimize the uncertainty regarding this question. The basic approach is to:

- Compare current and historical population to groundwater nitrate levels and to assess any correlation between these two time series.
- Conduct basin-wide mass loading calculations to assess the relative importance of potential nitrate sources.

HISTORICAL TRENDS

Population

The Los Osos community has grown significantly since the 1950s. This growth is documented in Table 3-1.

Table 3-1. LOS OSOS POPULATION HISTORY

Year	Population
1950	600
1960	1,480
1965	2,670
1970	3,487
1975	7,600

Table 3-1. LOS OSOS POPULATION HISTORY	
Year	Population
1980	10,933
1990	14,377
Sources: [7, 24], 1990 US Census	

Nitrate Concentrations - Overall

Population data can be compared with an average value for nitrate in shallow groundwater in the Los Osos basin. The database for developing this average value is nitrate sampling and analyses reported in a variety of sources as listed below.

- From 1982 to present as part of San Luis Obispo County Engineering Department ongoing monitoring program [14].
- From the 1950s to the early 1980s as reported in references [25, 26, 27, 28].

To obtain the most representative picture of nitrate in shallow groundwater over time, all available data were screened for inclusion in the database using three criteria:

1. Wells designed to sample the shallow groundwater, defined as less than 100 ft below ground surface.
2. Wells within the Urban Reserve Line (Figure 1-1).
3. Wells believed to be structurally intact and not subject to direct contamination from the surface, as reported in [14]. {A3.7}

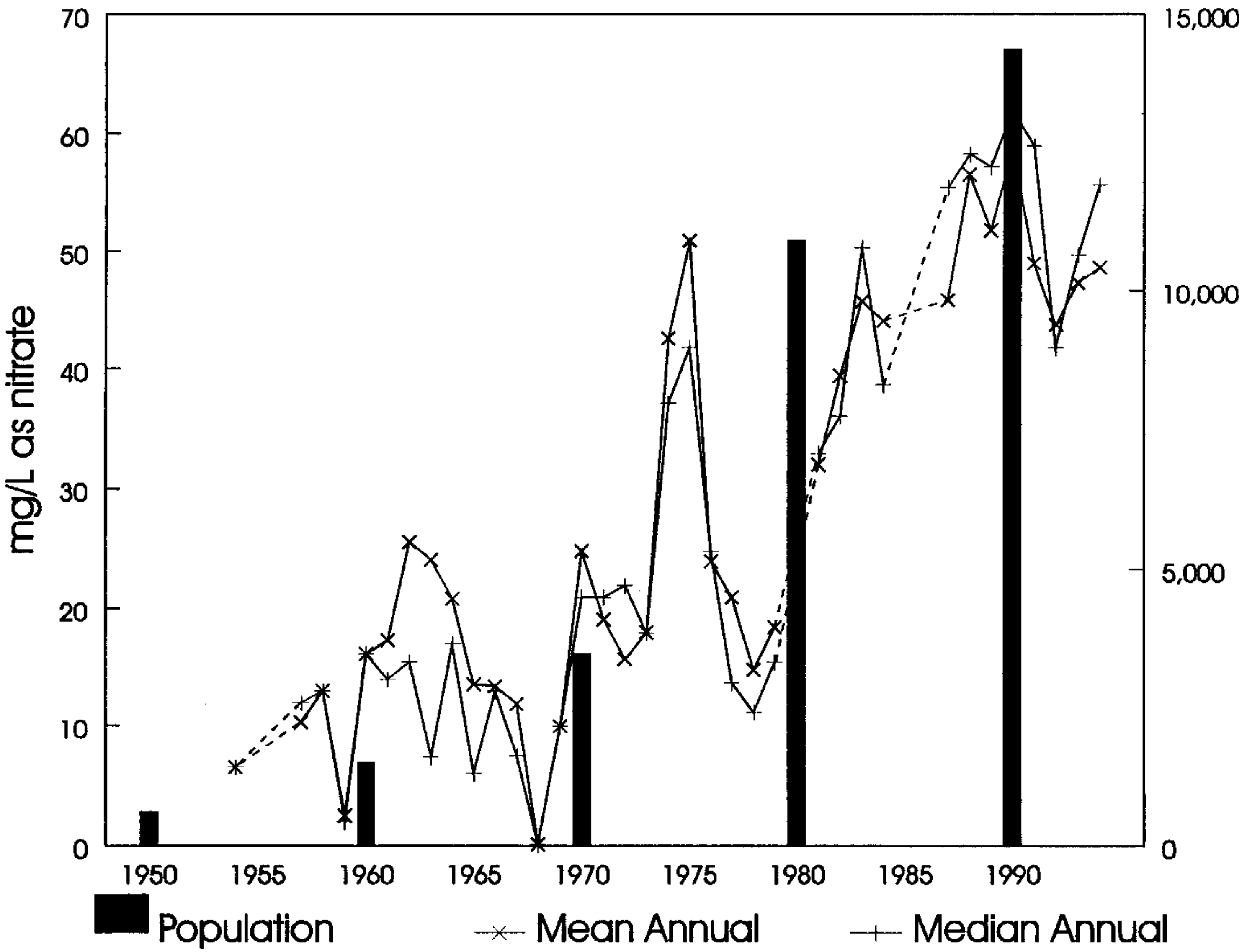
The usable data, totaling 445 individual analyses, are presented in Appendix B-1, Tables B-1 and B-3. The data from the County Engineering Department collected since 1982 [14] are based on standard protocols for sampling and analyses [29], such as set forth in references [30, 31]. For the 1950s-1980s data, there is no information on the sampling or analytical procedures used. {A3.8} In the absence of a viable alternative, M&E has used the older data, but makes no claims as to their quality.

The data from these shallow wells should not be considered representative of the entire aquifer. {A3.9} However, the data can be used to show estimated historical trends in the quality of shallow groundwater.

Data from wells surviving the above screening were sorted by date and mean and median values were calculated for each year (Appendix B-1, Table B-2). The advantage of this method is that it utilizes the available data to provide a measure of nitrate conditions over time. The disadvantage is that this method utilizes data from different places and different times that may have been collected with different degrees of quality control. In particular, quantitative comparisons between pre-1982 and post-1982 data may be subject to uncertainty.

Figure 3-1 shows the mean and median annual nitrate concentrations in shallow groundwater from 1954 through 1993 and population growth of Los Osos from 1950 to 1990 (Table 3-1). In this study, mean annual nitrate concentration refers to the arithmetic mean of nitrate analyses in the database in Appendix B-1 for a given year. Although this database is not ideal for statistical analysis purposes because of the difference in number of data points in each year, it can be useful for evaluating correlations between nitrates and time or population. {A3.10} For example, in some years over 30 points are available (1984, 1987, 1989-92) while for other years only one or two points are available (1954, 1960, 1968, 1979). To address the problem of variable data, both mean and median annual figures were plotted.

An alternative to the mean annual nitrate concentration is the <u>median</u> annual concentration. The median is the midpoint of the distribution in each year, so that there are an equal



Los Osos Wastewater Study	Figure 3-1
Average Annual Nitrate Concentrations and Population {A 3.11}	
Metcalf & Eddy	Date: March 1995

number of higher and lower values. This tends to give less weight to very high and very low values. As shown in Figure 3-1, both the mean and median annual values follow the same general trend with respect to time and population. {A3.12}

A linear regression analysis was conducted on the mean annual nitrate concentration and time (measured as years from 1954) and for population (also since 1954). Population in years other than those shown in Table 3-1 was derived by linear interpolation, except that for 1989 to 1994, population is assumed to be equal to the 1990 census figure because of the wastewater discharge prohibition (Chapter 1). {A3.12} The correlation coefficient, r, for mean annual nitrate concentration and time is +0.80 and for mean annual nitrate concentration and population, +0.81. {A3.13}

The r value for any two variables is a measures of how well they correlate, i.e., how closely a change in one variable is to the change in the other variable. An r = +1.0 indicates perfect positive correlation, e.g., when one variable increases by (say) 10%, the other variable also increases by 10%. Similarly, if r = -1.0, the variables are perfectly correlated negatively, e.g., if one variable increases by (say) 10%, the other variable decreases by 10%. r = 0 represents no correlation, so that changes in one variable have no relation to the changes in the other. An r value between +1.0 and 0 (or between -1.0 and 0) represents some degree of correlation less than perfect and suggests that there may be a trend between the variables. However, correlations do not imply a cause and effect relation between the variables. {A3.14}

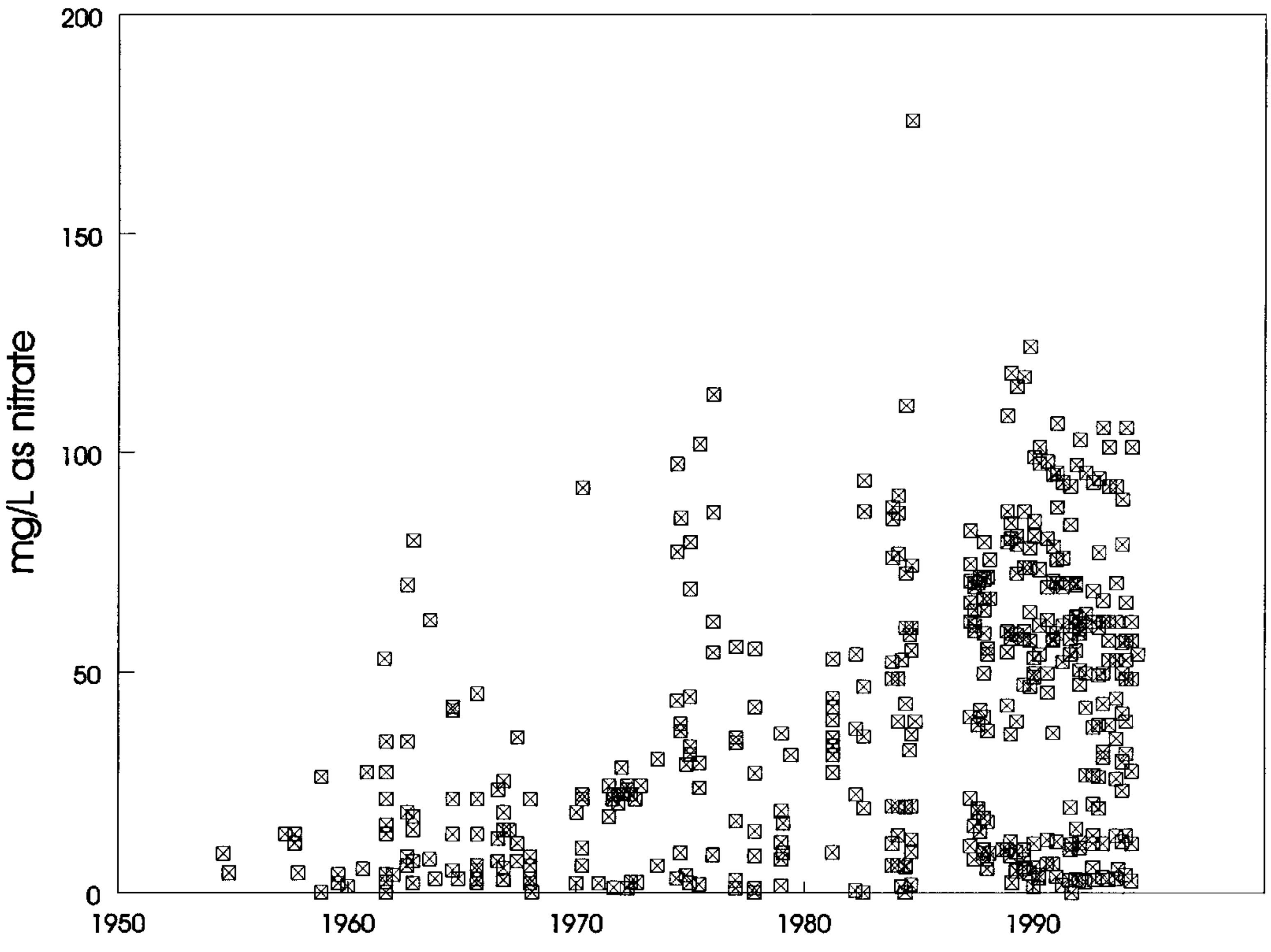
In this case, the r = 0.80 and 0.81 values indicate a moderately strong correlation between mean annual nitrate concentration and time or population. In other words, this linear regression analysis suggests that nitrate concentrations are increasing with time or population but that the data exhibit much scatter. {A3.15} Both of these correlations are significant to the 99% confidence level. This means the probability that the result was <u>not</u> a random occurrence is 99%. Overall, the linear regression analysis demonstrates that the mean annual nitrate concentration exhibits a high degree of scatter or "noise" but that there is a statistically significant trend of rising nitrate concentrations from 1954 to 1994.

A plot of all nitrate data is provided in Figure 3-2. This plot shows the scatter in the available data. The scatter is the result of the geographical variation of sampling locations, different sampling and analytical techniques, and the overall complexity of the groundwater basin. The correlation coefficient, r, is +0.40. However, the envelope of all datapoints shows an increasing trend over time, again suggesting a generally upward trend in nitrate concentrations in shallow groundwater.

Other statistical analyses have found a similar positive correlation between nitrate concentration and time and between nitrate concentrations and time or population [32, 33]. Reference [32] is a statistical evaluation of 217 samples of monitoring wells from 1954 to 1987. The statistical analysis consisted of determining correlation between pairs of the following variables:

- Year
- Month
- Nitrate concentration
- Depth to groundwater
- Elevation of groundwater
- Population

The r value for year and population was 0.978 indicating almost perfect correlation. This is not surprising given the growth of Los Osos since the 1950s. However, the report then states that "no other correlations are apparent in the data set." The r value for nitrate concentrations and population was found to be +0.47 and for nitrate and year, +0.44. These are obviously not perfect correlations, but indicate that some trend is present. {A3.18} Furthermore, the correlations are statistically significant at the 0.001 level, which means that the probability that the correlation was a random, chance occurrence is less than 0.1%. {A3.19}



Los Osos Wastewater Study

Nitrate Data
1954-1994 {A 3.16, 3.17}

Figure
3-2

M&E Metcalf & Eddy

Date:
March 1995

Reference [33] is based on the 299 data points in the May 1994 draft of this report. The authors of [33] present three hypotheses of why nitrates are observed to increase in shallow groundwater.

	Hypothesized mechanism for nitrate increase	Specific change predicted in nitrate concentrations
1.	Leaching from onsite wastewater disposal systems	Continual increase over time and with increasing population
2.	Release of stored nitrates from soil disturbed by new construction	After delay, increase after the soil disturbance; then a decrease as construction activity drops off
3.	Release of stored nitrates from soil disturbed by fire abatement measures (disking of soil)	Increase as abatement activity increases, level when construction ceases

The basic premise of these hypothesized mechanisms is that releases of stored nitrates from construction and fire abatement measures are significant sources of nitrates in shallow groundwater in Los Osos. As will be demonstrated later in this report, these are not major sources of nitrate. {A3.20} However, it is possible that all three mechanisms are at work and have some influence on observed nitrate levels in shallow groundwater.

The existence of any positive, statistically significant correlation in these data--even though they are "noisy"--leads to the conclusion that there is a trend of generally increasing nitrate concentrations in shallow groundwater underlying Los Osos. {A3.21} This analysis applies only to the study area as a whole; some local areas do not experience rises in nitrate concentrations but the overall trend in shallow groundwater is one of rising concentrations over time and as population increases. This observation does not establish a causal link between rising nitrate concentrations and time or population. {A3.22} It does, however, suggest that these parameters may be related.

Nitrate Concentrations - Individual Wells

Although overall nitrate levels appear to be increasing, not every well in the area shows an increasing trend in nitrate concentrations. {A3.23} The 445 individual data points are from 29 specific shallow wells. However, only 13 of these wells had enough data, 10 or more data points, for analysis of trends. The remaining 16 wells had fewer than 10 data points and are not included in the trend analysis in this section. {A3.24} Only three wells (7N1, 7Q1, and 18R1) have data more or less continuously from the 1950s to 1994, with some gaps in the 1970s. One well (17F4) has data from 1974 to 1994. Several wells have been monitored continuously since 1982 (7L3, 13A7, 13L1, 13L5, 13Q1, and 18H6). The remaining wells have data only from before 1981.

Of the nine wells that have been monitored quarterly for chemical constituents since 1982, five have an upward trend in nitrate concentrations, two show a downward trend, and two exhibit no discernable trend (Table 3-2 and Appendix B-1). {A3.26} For three of the wells (7Q1, 7N1 and 18J6), correlations in Table 3-2 are based on the exclusion of apparently anomalous values, i.e., values that appear to be far from the main trend line as shown in the figures in Appendix B-1. {A3.25} The correlation coefficients with these values are presented in the footnotes of Table 3-2.

Of the wells that were sampled only in the 1950s through 1981, there are about an equal number of wells with upward, downward, and no trends (Table 3-2 and Appendix B-1). In either time period, the wells with upward trends are primarily in Baywood Park and Cuesta-By-The-Sea, as shown in Figure 3-3. {A3.27}

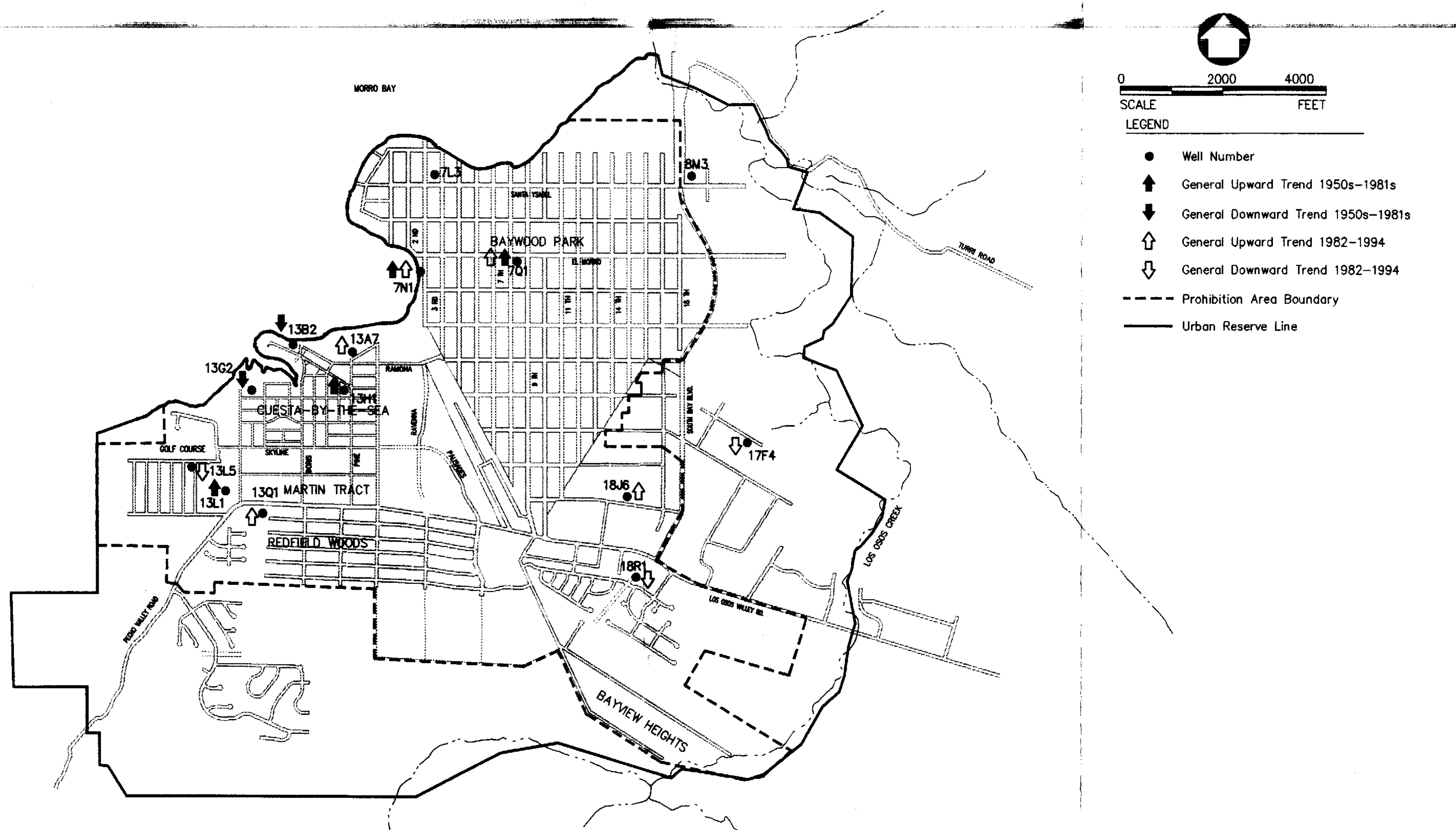
Well	Location (Figure 3-3)	General trends[a] (correlation coefficient)			Comments
		1950s-1981	1982-1994	1950s-1994	
7L3	5th north of Santa Ysabel	--[c]	None[b] (+0.16)	--	--
7Q1	8th and El Morro	Up (+0.61)[e]	Up (+0.55)[e,f]	Up (+0.82)[e]	Some apparently anomalous values excluded.[f]
7N1	3rd south of El Morro	Up (+0.62)[e,g]	Up (+0.47)[d,h]	Up (+0.69)[e]	Some apparently anomalous values excluded.[g,h]
8M3	Santa Ysabel east of South Bay Blvd	None[b] (+0.25)	--[c]	--	--
13A7	Ramona near Pine	--[c]	Up (+0.49)[e]	--	--
13B2	End of Mitchell	Down (−0.64)[d]	--[c]	--	--
13G2	Binscarth near Pecho	Down (−0.68)[e]	--[c]	--	--
13L1	Southeast of golf course	Up (+0.86)[e]	--[c]	--	One data point in 1987.
13L5	South of golf course	--[c]	Down (−0.51)[e]	--	Appears to be up 1982-84 and down since 1984.
13Q1	Woodland west of Rieger	--[c]	Up (+0.75)[e]	--	--
17F4	East of So. Bay Blvd	None[b] (−0.32)	Down (−0.25)	None[b] (+0.08)	Data from 1974 to 1993.
18J6	Los Olivos and Fairchild	--[c]	Up (+0.70)[e]	--	One apparently anomalous value excluded.[i]
18R1	Bay Oaks Dr south of Los Osos Valley Road	None[b] (+0.11)	See comments (+0.01)	Up (+0.74)[e]	No data from 1965 to 1977; appears to be up 1977-90 and down since 1990.

Table 3-2. GENERAL TRENDS IN NITRATE CONCENTRATIONS {A3.26}

Table 3-2. GENERAL TRENDS IN NITRATE CONCENTRATIONS {A3.26}

a. Based on data and graphs in Appendix B.
b. No trend observed.
c. No data.
d. Statistically significant at the 95% level.
e. Statistically significant at the 99% level or greater.
f. Excluding three apparently anomalous values at October 1990, March 1992, and July 1992. If these values are included, r = +0.05 and is not statistically significant.
g. Excluding one apparently anomalous value at August 1957. If this value is included, r = +0.30 and is not statistically significant.
h. Excluding one apparently anomalous value at March 1982. If this value is included, r = −0.11 and is not statistically significant.
i. Excluding one apparently anomalous value at March 1993. If this value is included, r = +0.55 and is statistically significant at the 99% level.

NOTE: Wells 7F1, 7G3, 7J1, 7R1, 8M2, 13A1, 13A2, 13A6, 17L1, 17N4, 18A2, 18D2, 18H2, 18K5, 18N1, 20D1, are not shown because of insufficient data for trend analysis (fewer than 10 data points).



Los Osos Wastewater Study

Trends in Nitrate Concentrations for Selected Shallow Wells

Figure 3-3

Metcalf & Eddy

Date: January 1995

NITRATE MASS LOADING

The analytical method used to identify and quantify nitrate sources on a basin-wide scale is mass loading. {A3.28} This approach consists of two steps: (1) estimate total nitrogen contributions from each source and (2) account for nitrification and denitrification in the vadose zone and other nitrogen losses to compute the contributions of nitrates from the sources which have the potential to migrate to groundwater. The first step has been performed in previous studies [6, 15]. However, in these studies no credits were taken for denitrification in the soils or other losses of nitrogen, i.e., it was assumed that all nitrogen generated reached the groundwater in nitrate form. In this study, the second step includes adjusting the total nitrogen amounts for each source by specific denitrification factors as well as accounting for other nitrogen "losses" such as plant uptake and volatilization. {A3.29}

This mass loading calculation provides a spatially-averaged estimate of nitrate impact from each potential source. Because of this spatial averaging, the calculation does not simulate or predict local variations in groundwater nitrate concentration. {A3.30} It is, however, a useful tool to account for overall nitrate contributions on the scale of the study area. Although the mass loading calculation is primarily for vadose zone soil moisture, the results can be used for estimating relative contributions of nitrates to shallow groundwater. The calculations presented below are based on limited site-sampling information and values from other studies, and represent M&E's best professional judgment of the relative contribution of each potential source to the overall flux of nitrate to shallow groundwater.

This calculation does not simulate effects of groundwater flow and cumulative mixing within the aquifer, thus does not predict actual groundwater concentrations. Groundwater concentrations depend on such factors as groundwater flow velocity, dispersion, dilution and the composition of groundwater upgradient of a particular location.

The calculation includes the following potential nitrate sources within the Urban Reserve Line (approximately 3,500 acres). {A3.31}

- Onsite wastewater system effluent
- Natural sources such as soil organic matter, vegetation, and inflowing groundwater
- Geological sources
- Agricultural fertilizers
- Horticultural fertilizers
- Animal wastes - horses
- Animal wastes - household pets (dogs and cats)
- Soil disturbance from construction and weed abatement

Onsite Wastewater System Effluent

The contribution of nitrate to groundwater from onsite wastewater system effluent is based on the following data on number of dwelling unit equivalents (DUE), unit wastewater flows, and nitrogen content of effluent.

- 6,199 DUE. A DUE contains the wastewater flow and nitrogen content of one single family residence. While a single family residence is equal to one DUE, commercial establishments such as retail stores, offices, restaurants, and laundromats have flow and nitrogen content different than a single family unit. These establishments are counted as DUEs based on estimated flows and nitrogen content of their wastewater effluent. Limited available local data [15,34] suggests that in terms of effluent nitrogen concentration, each commercial establishment is one DUE. An estimate of DUEs is in Appendix D, Table D-1. {A3.32, A3.33}

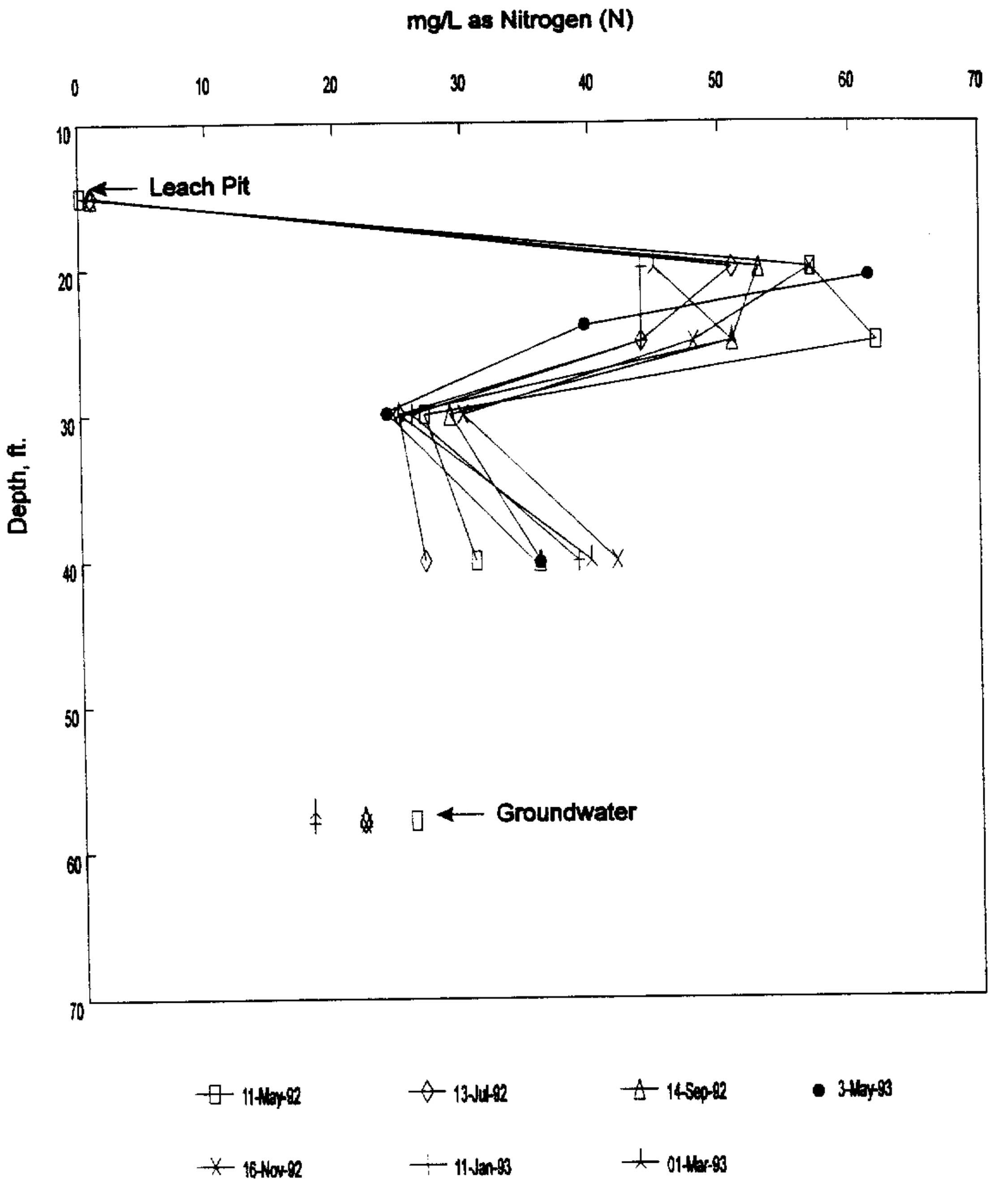
- 189 gpd/DUE wastewater flow (or 75 gpd/person based on 2.5 persons/DUE). This figure is based on actual metered water consumption for customers served by California Cities Water and CSA 9 for winter 1993 and 1994. During the winter months, most water use is indoors and is eventually reaches the onsite wastewater system. However, an allowance has been made for some outdoor water use during this period, as shown in Appendix D, Table D-2. This wastewater flow compares favorably with other areas in California (Appendix D, Table D-3). {A3.33}

- Effluent nitrogen concentration (all forms) of 50 mg/L, based on local residential and commercial data [15, 34].

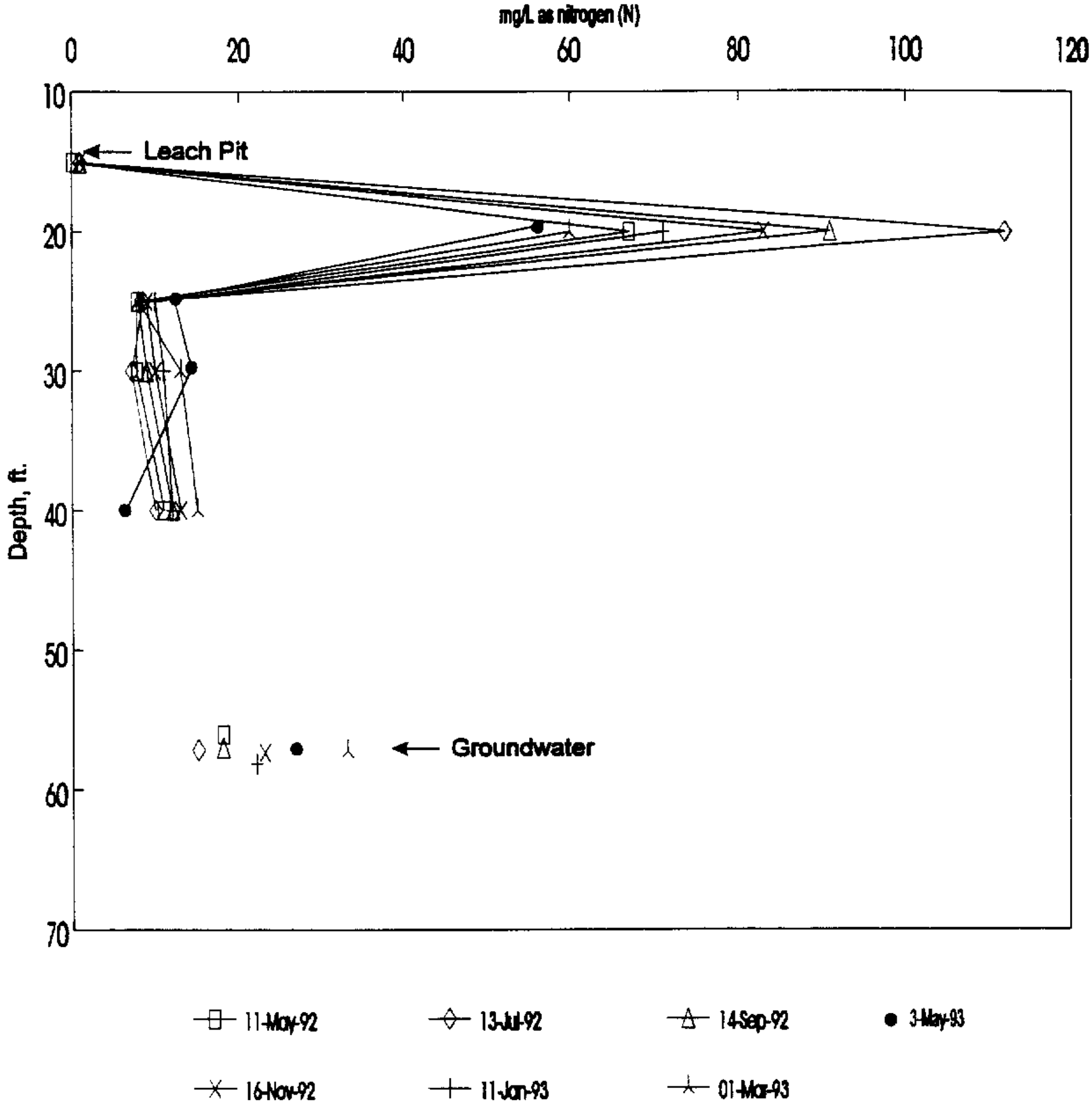
Upon release to the subsurface soil, wastewater nitrogen typically undergoes nearly complete nitrification in which ammonia and organic nitrogen are oxidized to the nitrate form.[a] {A3.34} Local data demonstrate this initial nitrification process in two instrumented study plots (13th Street and 14th Street) in Los Osos (Figures 3-4A and 3-4B) [34]. A third site (Bayridge Estates) was also instrumented, but results from that site are not used because they lack repeatable patterns (Figure 3-4C), unlike the 13th and 14th Street sites that exhibit consistency over time. {A3.35} The only interpretable results from the Bayridge Estates data is that effluent nitrogen is nearly completely converted to nitrate beneath the leach pit, which is also demonstrated at the other two sites. To account for nitrification, it is assumed that all 50 mg/L of nitrogen in onsite wastewater system effluent is converted to nitrate in the shallow subsurface (i.e., 220 mg/L as nitrate). {A3.36}

The fraction of nitrate apparently lost before reaching the groundwater is derived from results of soil moisture nitrate analyses at the 13th and 14th Street site. This nitrate loss is assumed to be primarily due to biological denitrification. The average nitrate loss in soil moisture in the first 10 feet under the leach pit was 50% for the 13th Street site and 85% for the 14th Street site. {A3.37} The average of both sites is 67% or 6.7% per foot for the first 10 feet. Beyond about 10 feet below the leach pits (typically about 25 feet below ground level) the nitrate levels appeared to level out or even rise slightly. {A3.38} Based on these data, the average denitrification used for this study is 67% for onsite wastewater system effluent. This value is higher than assumed or measured denitrification rates of 0 to 40% cited in previous studies (Appendix E, [19, 22]).

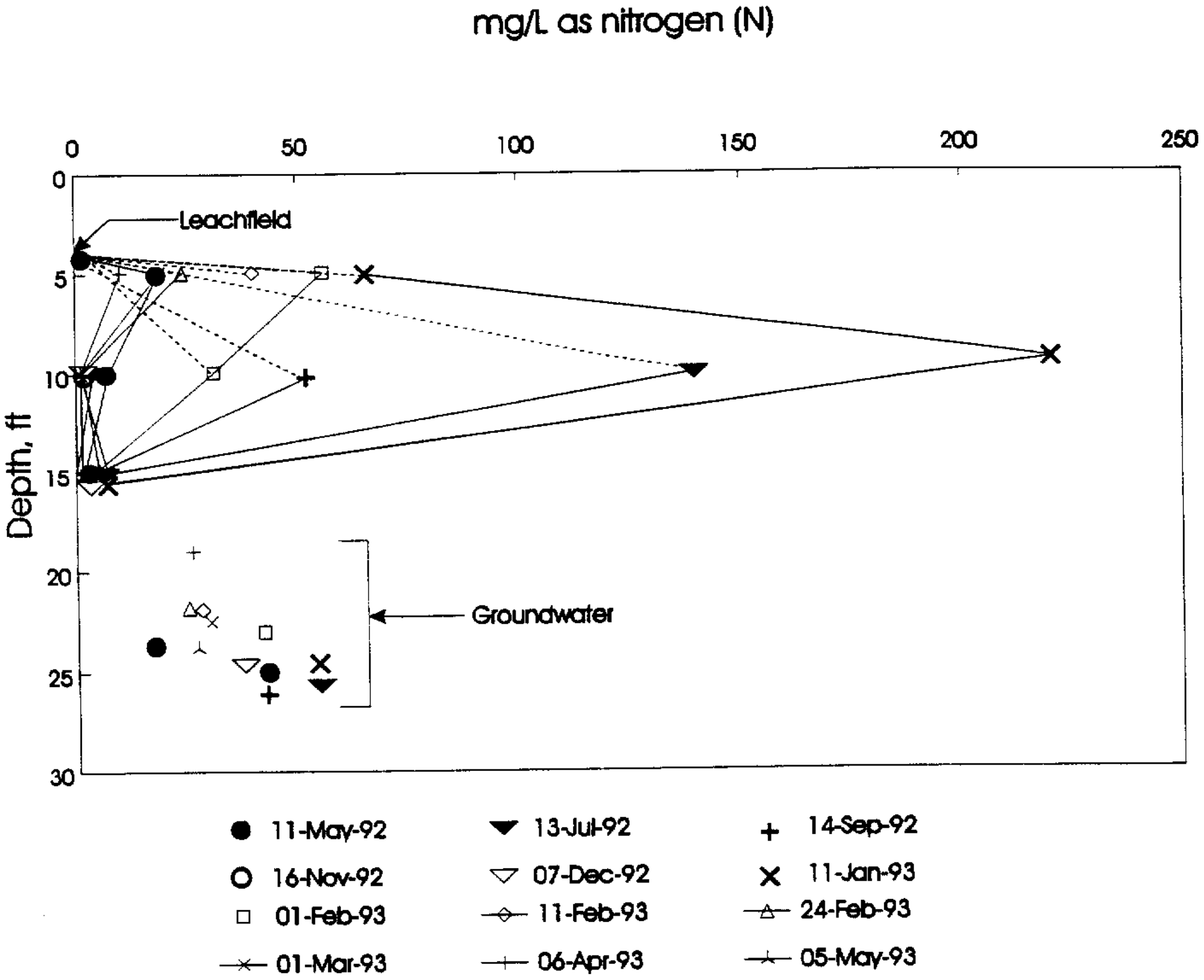
a. A brief technical description of onsite wastewater treatment is in Appendix E.



Los Osos Wastewater Study	Figure 3-4A
Nitrate in Soil Moisture - 13th Street Site	
Metcalf & Eddy	Date: August 1994



Los Osos Wastewater Study	Figure 3-4B
Nitrate in Soil Moisture - 14th Street Site	
M&E Metcalf & Eddy	Date: August 1994



Los Osos Wastewater Study	Figure 3-4C
Nitrate in Soil Moisture - Bayridge Estates Site	
M&E Metcalf & Eddy	Date: September 1994

This denitrification rate may not apply over the entire study area. In particular, in regions with shallow groundwater (20 to 30 feet or less below ground surface) leachfields or seepage pits may be very near the water table and onsite wastewater system effluent may be delivered to groundwater before undergoing any substantial denitrification. At these shallow groundwater areas, nitrate concentrations in effluent could be as much as 100 mg/L as nitrate (Figure 3-4B). {A3.39} It is possible that this "short-circuiting" of the soil denitrification zone may be responsible for the elevated levels of nitrate in groundwater at certain locations shown in Figure 1-2.

The data in [34] are also the subject of a study by a Nitrate Technical Advisory Committee (NTAC) [35]. This study has the following key conclusion: "At the lowest sampling depth, which was well above the groundwater, there was at two of the three sites a lower concentration of nitrate in the leachate than in the groundwater itself. This is strong evidence that the nitrate is not actually reaching the groundwater." As such, it was speculated that the nitrates in shallow groundwater must be from sources other than onsite wastewater effluent.

M&E's interpretation of the data is that:

- Some denitrification occurs in the subsurface with adequate separation between leachfield or seepage pits and the water table.
- Observed differences between nitrate concentrations in soil moisture and shallow groundwater may be due to nitrate loading from other onsite systems or to seasonal variations in performance of the vadose zone as a nitrogen treatment system due to variability in rainfall and/or effluent volume from onsite systems. {A3.40}

In other words, the use of the above 67% factor means that 33% of the nitrogen from onsite system effluent may be reaching the groundwater as nitrate. {A3.41} This value is derived from actual soil moisture data at the sites and does not consider extrapolations to groundwater. Other nitrogen losses from ammonia volatilization and plant uptake are assumed to be minimal.

The testing at the Lost Oaks development in 1985 is also given as proof of complete denitrification in Los Osos soils. This was a field test of wastewater percolating through soil columns, with all forms of nitrogen measured in the influent wastewater and the percolate. Evidence of nitrification and denitrification is ambiguous and indirect at best, primarily because of problems in the data collection procedures. {A3.42} This study is reviewed in Appendix I.

Natural Sources (Background)

A large mass of nitrogen exists in soil organic matter. Undisturbed soils have typically reached a steady state nitrogen level and release very little nitrogen which is mobile enough to reach groundwater. Several studies have demonstrated that the release of soil nitrogen can occur rapidly after cultivation of previously undisturbed land [36, 37, 38]. Other soil disturbances such as construction and weed abatement practices may also contribute nitrates. These sources are discussed separately below.

The background nitrate concentration accounts for inputs from the atmosphere, natural soil sources and vegetation, and groundwater flow into the study area. {A3.43, A3.44} The value is estimated to be 8 mg/L, based on limited data available from the 1950s when the population of the community was less than 1,000. Assuming that human activities had not yet significantly contributed to the natural nitrogen cycle, the mean value of all available nitrate analyses in the 1950s (11 available analyses) would be a reasonable approximation of nitrates from natural sources. This mean value corresponds with figures in the literature [21].

Another potential source of information on natural sources of nitrogen is the data from a series of seven soil borings throughout the community by the San Luis Obispo County Engineering Department in 1987-88. The locations of the borings were within 6 to 200 feet of monitoring wells 13L5, 21D13, 17F4, 18J6, 7R1, and at Bayridge Estates. Soil samples were analyzed for nitrate, conductivity, % moisture, and pH on a 1:1 extract of soil and deionized water at 0.5-ft intervals from surface to just above the water table (depths ranging from 12 to 42 feet). The County provided the results of these tests but no interpretation of the data was done and no report was written. Similar data are reported in reference [34]. {A3.45}

The results of the soil sample analyses showed that nitrate concentrations in soil decrease to below detectable levels above the water table in borings taken in relatively undisturbed locations. These data suggest that natural sources of nitrate may be nearly completely attenuated in the vadose zone in Los Osos. Because the analyses measured constituents in the soil and not specifically in soil moisture, the results are not used in this study. However, the data suggest that overall input from natural sources may be lower that the 8 mg/L mentioned above. Thus, the estimated relative contribution from natural sources is probably at the higher end of reasonable values.

Geological Sources

There are other natural, but relatively rare geological sources of nitrate which can impact groundwater in certain restricted regions:

- Nitrate evaporite minerals are associated with borates in arid climates. The most abundant nitrate mineral is the nitratite ($NaNO_3$), which is found only in the desert regions of northern Chile and Bolivia, as well as in Humboldt County, Nevada, and San Bernardino County, California.

- Niter, or saltpeter (KNO_3) is not as abundant as nitratite, but is found as delicate crusts in caves and in certain soils in Spain, Italy, Egypt, Saudi Arabia, Iran, and India [39].

- Large accumulations of fossilized bat guano that have been observed in certain caves in limestone terrains.

- There is also the possible presence of ammonium-nitrogen in various clay layers of the shales from which the soils of Los Osos have formed. This ammonium-nitrogen can come from either or both of the following sources: ammonium ions fixed between the individual layers of clay particles and from geologic organic matter (similar to coal) which then undergoes subsequent microbial decomposition to ammonium. Either or both forms of ammonium-nitrogen can then undergo conversion to nitrate-nitrogen by the microbial process of nitrification within the vadose zone. Shales of this type have been identified in the Coalinga area and in the Klamath Mountains of California (Appendix A has further references on these soils). However, these shales are not known to exist in the Los Osos area.

None of these geologic sources of nitrate are known to exist in coastal central California, so geologic sources are assumed to be insignificant in Los Osos. {A3.46}

Agricultural Fertilizers

Fertilizers are typically very rich in nitrogen, and when fertilization is combined with irrigation, agricultural land can be a source of nitrates to the subsurface. In the Los Osos study area, there are approximately 100 acres of irrigated commercial land, including crops, golf course, and the cemetery (Appendix C, [24]). A reasonable application rate for agricultural fertilizers is 150 pounds of nitrogen/acre/year [40]. However, only about 35 lb/acre/yr of nitrogen (or 23% of what is applied) is not fixed by the crops or volatilized to the atmosphere and thus would be available for leaching to groundwater. Additional losses from denitrification are generally considered to be low [41]: a denitrification factor of 0.2 is used. {A3.47}

Horticultural Fertilizers

Lawn and garden fertilizers constitute a potential source of subsurface nitrate. It has been estimated that after volatilization and plant uptake, potential loading to groundwater is only

10 to 30 pounds of nitrogen per landscaped acre. For residential areas in Los Osos, approximately 10% of the total land area is landscaped with fertilized turf (Appendix C). The denitrification factor is assumed to be 0.2, which is the same as for agricultural fertilizers. {A3.48}

Animal Waste - Horses

Urine and feces from horses constitute a potential nitrogen source in the community. According to County Health Department records, there are 163 horses in five communal stables in the study area [42]. To account for horses at private homes, it was assumed that a total of 200 horses reside in the study area. The calculation of nitrate contribution to groundwater from horse wastes is based on the assumption that horse waste is deposited on the ground surface and is not immediately removed to a landfill or some other treatment facility. The following data are used.

- Nitrogen produced, 110 lb/yr/horse (urine and feces) [43].
- 50% of nitrogen in the waste is lost through volatilization [43]. {A3.49}
- 40% of nitrogen in the waste is lost through plant uptake; this percentage is lower than for fertilizer to account for corrals that have little or no vegetation and pastures or yards which have some vegetation. {A3.49}
- Denitrification factor of 0.3. This figure is between the 0.67 value for onsite wastewater effluent and the 0.2 value for fertilizers because:
    - Like onsite system effluent horse waste contains carbon which is available as an energy source for denitrifying bacteria.
    - Unlike onsite system effluent and like fertilizers, the soil is not always maintained in a saturated, anaerobic state, which is most conducive to dentrification. {A3.50}

Animal Waste - Dogs and Cats

Another potential source of nitrogen in Los Osos groundwater is urine and feces from household pets, i.e., dogs and cats. The pet population is derived from dog registration data compiled by the San Luis Obispo County Health Department [42] (there are no cat registration data). However, since not all pets are registered, the following rules of thumb from the American Humane Society [44] are used to estimate the total pet population.

Total number of dogs = 2 x number of registered dogs
= 2 x 2,185 = 4,370 = (say) 4,400

Total number of cats = 3 x number of registered dogs
= 3 x 2,185 = 6,555 = (say) 6,600

Pet waste is not widely studied and there are no references in any overall study of nitrogen or nitrate in the environment [4, 45, 46, 47]. In the absence of data, the following assumptions were used to derive the amount of nitrate from pet waste. {A3.51}

- Nitrogen from dogs = 1/4 the amount from humans; this would be equivalent to a human population 1/4 x 4,400 = 1,100.
- Nitrogen from cats = 1/8 the amount from humans; this would be equivalent to a human population 1/8 x 6,600 = (say) 800.
- Pet urine and feces is deposited on the ground surface and not removed to a landfill or flushed down the toilet into the septic tank.
- 50% of nitrogen in the waste is lost through volatilization [43], and 77% through plant uptake, the same as for fertilizer.
- Denitrification factor of 0.3, the same as for horse waste.

Soil Disturbance

Soil contains a large reservoir of organic nitrogen which under normal conditions is fairly immobile. When soil is disturbed because of construction or tilling activities, including weed abatement for fire prevention, it is possible to mobilize soil nitrogen such that nitrification and denitrification (including volatilization) may occur and affect groundwater quality. The degree of nitrogen mobilization from construction and tilling has not been measured and remains a poorly understood phenomenon. {A3.52}

Construction. Vegetative matter is usually removed in construction activities, including both surface growth and roots. However, in the absence of data on nitrate contributions from soil disturbance from construction, a total nitrogen loading of 80 lb/acre was derived using the procedure in reference [43], with the following data and assumptions.

- Organic content of soil in the upper 5 ft = 0.8% [48]
- Ratio of organic matter to carbon = 2
- Ratio of carbon to organic nitrogen = 12
- Soil weight = 110 lb/cu ft
- Amount of nitrogen released to groundwater = 1.0%/yr [46]
- Area of soil disturbance = 50 acres/yr, based on approximately 2,000 acres of Los Osos developed over the past 40 years

Weed Abatement. Historically, weed abatement programs in the Los Osos area were conducted by the CSA 9B Fire Department and consisted of disking the soil on 250 t0 300 vacant lots. Typically, the disking was a 10-ft wide path around the outside of the property. More than 30 years ago, weeds on some lots were burned. The current program consists of mowing weeds on vacant lots and leaving the residue on the property. The mowing procedure is in two categories:

- For smaller parcels, generally less than 10,000 square feet, the entire lot is mowed where feasible, i.e., where no trees or other obstructions preclude mowing. An average of 90% of the overall area of these lots is mowed.

- For larger parcels, generally greater than 10,000 square feet, a 30-ft swath around the perimeter of the lot is mowed. For very large lots, a swath is mowed down the middle to create unmowed segments no greater than 200 feet. In general, about 70% to 80% of the area of these lots is mowed.

Approximately 400 lots totaling 150 acres were scheduled for mowing in 1994 [61].

For weed abatement, nitrogen loading is assumed to be the same as for horticultural fertilizers, i.e., 20 lb/acre/yr after plant uptake. The denitrification factor is also assumed to be the same, i.e., 0.2. {A3.53}

Results of Mass Loading

Using the parameters discussed above, the mass loading is summarized in Table 3-3. As shown in Table 3-3, it is estimated that over 60% of the nitrate in shallow groundwater may be derived from by onsite wastewater system effluent as it percolates through the vadose zone. {A3.54} Natural sources constitute the next largest portion, 18%, while other potential sources contribute 6% or less each. Although this mass loading calculation contains many uncertainties in the input parameter values, it does provide a semi-quantitative assessment of nitrate contributions to shallow groundwater. {A3.55}

In particular, parameters for dog and cat wastes, and soil disturbance from construction and weed abatement are uncertain. These sources of nitrate have never been studied to any great extent and are not generally considered as significant contributors of nitrate to groundwater. Also, the difference between the denitrification factor used for onsite system effluent and other studies suggests that the value of 0.67 varies with subsurface conditions such as soil type, soil moisture, and depth to groundwater, and redox conditions. {A3.58}

Table 3-3. MASS LOADING CALCULATION {A3.57}							
		Total applied nitrogen (N)					
Source	No./ Unit	lb/ unit/ yr	lb/yr	Total N after losses, lb/yr	Denitrification factor	Nitrate, lb/yr as N (rounded)	% contribution
Onsite system effluent	6,299 DUE {A3.56}	28.9	182,015	182,015	0.67	60,100	61
Natural	3,500 acres	5.0	--	17,374	--	17,400	18
Agricultural fertilizers	100 acres	150	15,000	3,450	0.2	2,800	3
Horticultural fertilizers	350 acres	--	--	7,000	0.2	5,600	6
Horse waste	200 horses	110	22,000	6,600	0.3	4,600	5
Dog waste	4,400 dogs	2.9	12,714	1,462	0.3	1,000	1
Cat waste	6,600 cats	1.4	9,536	1,097	0.3	800	1
Soil disturbance	50 acres	--	--	4,000	0.2	3,200	3
Weed abatement	150 acres	--	--	3,000	0.2	2,400	2
TOTAL	--	--	--	225,998	--	97,900	100

NOTES:

Source	Bases
Onsite system effluent	· Number of dwelling unit equivalents (DUE)--from Table D-1. · Unit wastewater flow = 189 gpd/DUE (Table D-2). · Nitrogen content of effluent = 50 mg/L as nitrogen [15,34]. · Minimal volatilization and uptake of nitrates by plants.
Natural	· Nitrate content of groundwater = 8 mg/L as nitrate (Appendix B for data before 1960). · Infiltration rate from rainfall and runoff = 12 in./yr [24]. {A3.57}
Agricultural fertilizer	· Applied nitrogen = 150 lb/ac/yr [40], of which 77% is fixed or volatilized. · Area includes golf course and cemetery.

Table 3-3. MASS LOADING CALCULATION {A3.57}	
Horticultural fertilizer	· Area landscaped = (say) 10%, excluding golf course and cemetery, which are included in agricultural fertilizer (Appendix C). · Applied nitrogen after fixation and volatilization = 20 lb/ac/yr.
Horse waste	· Applied nitrogen = 110 lb/yr/horse [43]. · Number of horses from County Health Department [42]. · 50% of applied nitrogen volatilized. · 40% of applied nitrogen utilized by plants.
Dog waste	· Number of dogs based on data from County Health Department [42]. · Ratio of nitrogen contribution to humans = ¼. · 50% of applied nitrogen volatilized [43]. · 77% of applied nitrogen utilized by plants (same as for fertilizer).
Cat waste	· Number of cats based on data from County Health Department [42]. · Ratio of nitrogen contribution to humans = 1/8 · 50% of applied nitrogen volatilized [43]. · 77% of applied nitrogen utilized by plants (same as for fertilizer).
Soil disturbance ([43] unless noted)	· Percent organic matter in soil = 0.8% [34,48]. · Ratio of organic matter to carbon = 2. · Ratio of carbon to organic nitrogen = 12. · Soil depth = 5 ft [48]. · Soil unit weight = 110 lb/cu ft. · Release of organic nitrogen = 1%/yr [46]. · Area = 2,000± ac/yr [49] developed over a 40 yr, or 50 ac/yr average.
Weed abatement	· Area mowed = 150 acres [61]. · Applied nitrogen after fixation and volatilization = 20 lb/ac/yr (same as for horticultural fertilizer)

It has been suggested that analysis of nitrogen isotopes be used to determine nitrate sources. Some limited work has already been done on samples from shallow wells in Los Osos. The results were ambiguous and no conclusion can be drawn on nitrate sources from this work. The results are reviewed in Appendix I.

SUMMARY AND CONCLUSIONS

The approach in this chapter is to compare current and historical population to groundwater nitrate levels over time, and to assess any correlation between these two time series. Also, a basin-wide nitrate mass loading was completed to assess the relative importance of identified potential nitrate sources. Based on this approach, the following conclusions can be drawn.

- Average annual nitrate concentrations in shallow groundwater have increased since 1954. Population has also increased in the same time period. There is a statistically significant correlation between nitrate concentrations and population or time, suggesting a relationship between these variables. However, such correlation does not establish a causal relationship between increasing nitrate and increasing population. {A3.59}

- Because nitrate concentrations in shallow groundwater differ widely within the community, the impact of onsite wastewater systems and other potential nitrate sources does not appear to be evenly distributed over the community.

- Individual onsite wastewater systems appear to be a major contributor of nitrate to shallow groundwater in the community as a whole. Over 60% of the nitrate currently in shallow groundwater may be derived from onsite wastewater system effluent. The data and calculations presented above provide evidence of a relationship between onsite wastewater system effluent and groundwater nitrate. {A3.60}

- Natural sources, such as soil organic matter, native vegetation, and inflowing groundwater, contribute approximately 18% of the nitrate in shallow groundwater. Contributions from other non-natural sources--agricultural fertilizers, horticultural fertilizers, and horse wastes--are smaller and less significant. The magnitudes of other non-natural sources--soil disturbance from construction, weed abatement, and dog and cat wastes--are less certain but probably minor. {A3.61}

SUMMARY OF TAC COMMENTS

A3.1, Page 3-1 ¶1. The TAC believes that the conclusions of these references are in opposition to the references which Metcalf & Eddy have cited. *[M&E note: a reference to the Los Osos/Baywood Park Nitrogen Study [34,35} has been added after {A3.5}.]*

A3.2, Page 3-1 ¶2. The TAC believes that no data have directly been obtained which connects the septic systems directly with the elevated level of nitrate in the ground water.

A3.3, page 3-1 ¶2. The TAC believes that M&E has based their model on assumptions. Based on the authors "professional judgment, " a seventy-one million dollar wastewater treatment project.should not be based on this assumption.

A3.4, page 3-1, ¶2. The TAC believes that M&E has based their model on assumptions of loading rather than actual field measured values of nitrogen inputs or outputs.

A3.5, page 3-1, ¶3. M&E's use of the stated references [3, 4, 20, 21, 22, 23] should be only considered as generalized references. TAC believes that M&E should have evaluated each site for its specific considerations. *[M&E note: a reference to the Los Osos/Baywood Park Nitrogen Study [34,35] has been added.]*

A3.6, page 3-2, ¶2. TAC strongly agrees with M&E's statement "Because subsurface processes cannot be directly observed as they occur, **it is difficult to prove or disprove the onsite wastewater system effluent-groundwater nitrate connection.**"

A3.7, page 3-3 Criteria #3. The TAC believes that whereas production wells meet both Public Health regulation and California well construction standards, observation wells do not meet this criterion and therefore the water quality data must be used with the greatest of care and be subjected to severe limitations.

A3.8, page 3-4, ¶1. The TAC agrees that the pre 1982 data should be viewed with caution and objects to M&E's indiscriminate inclusion of the total data set for the remainder of their analysis. The TAC questions the correctness of the data base analysis.

A3.9, page 3-4, ¶2. The TAC agrees that "shallow wells cannot be considered as representative of the entire basin." M&E does not follow this advice and proceeds to use a "mixing perspective" for their analysis.

A3.10, page 3-4, ¶4. M&E concludes in this paragraph that the two data sets are not compatible however M&E then proceeds in their report to continues to use these questionable data sets.

A3.11, page 3-5, Figure 3-1. TAC believes that an explanation is necessary.

A3.12, page 3-6, ¶1 &¶2. TAC believes that the use of the median may obscure a more accurate understanding of the relationships between time and nitrate concentrations levels. The linear regression should not have been calculated on the 'mean values'. The original data should have been used. Using the mean obscures the variation inherent in the data set and may lead to erroneous interpretation.

A3.13, page 3-6, ¶2. The TAC believes that Metcalf & Eddy's use of correlation coefficients to generate regression equations is unscientific and thus the trend lines generated from these equations are erroneous.

A3.14, Page 3-6, ¶3. The TAC believes that regardless of what the values of r were for either of these data sets, one can make no inference regarding any relationship among the two data sets if one knows the first set and expects to relate it to the second data set.

A3.15, Page 3-6, ¶4. The TAC believes that the omission of a regression equation from this report, to support Metcalf & Eddy's regression analysis, casts doubt on their conclusions.

A3.16, Page 3-8, Figure 3-2. The TAC believes that the multitude of data points close to zero are significant, that from 1974 to the present no trend is evident, and that the gap in data for 1980 and 1986 needs to be explained. The TAC believes that a correlation of 0.40, which says that TIME explains less than 20% of the variance in nitrates is very weak evidence for a 71 million dollar investment.

A3.17, Page 3-8, Figure 3-2. TAC questions the significance of the data points and has requested an explanation from M&E.

A3.18, Page 3-7, ¶4. The TAC believes that because no regression line is cited and because the significance level is not indicated, such a low correlation coefficient cannot be translated into a cause and effect relationship.

A3.19, page 3-7, ¶4. TAC questions M&E's lack of a reference to the type of lineal regression equation used.

A3.20, Page 3-9, ¶3. The TAC believes that the statement that "...these are not major sources of nitrate." is purely conjecture based upon guesses regarding the magnitude of various sources.

A3.21, Page 3-9, ¶4. The TAC believes that a clear, positive, statistically significant correlation is not apparent form the data, especially since 1974.

A3.22, Page 3-9, ¶4. The TAC believes that Metcalf & Eddy's acknowledgement that the shallow groundwater in some areas has not experienced rises in nitrate concentrations refutes their claim that septic systems are the source of nitrates in other areas and that nitrate levels are rising with population.

A3.23, Page 3-10, ¶1. The TAC believes that no valid statistical reason has been established for excluding these data from the trend analysis as statistics provides clear procedures for identifying spurious datum points. No explanation has been given for the exclusion of data from this data set.

A3.24, Page 3-10, ¶1. The TAC believes that because Metcalf & Eddy offers no explanation as to why some wells do not show increasing nitrate levels the credibility of their hypothesis is severely weakened.

A3.25, page 3-10. The arbitrary exclusion of "anomalous" values without justification undermines the validity of the analysis and raises serious questions about the report's conclusions.

A3.26, Pages 3-10 & 3-11, Table 3-2. The TAC believes that no statistical relationship has been developed because no regression line, or regression equation is presented.

A3.27, page 3-10, ¶3. TAC believes that the upward nitrate trend in the Baywood Park/Cuesta by the Sea areas should be compare to the "Hypothesized Mechanism for Nitrate Increase" [33] referenced by M&E on page 3-9.

A.3.28, Page 3-14, ¶1. The TAC believes the method used should have been Nitrate Balance which can and should produce a verifiable "model".

A.3.29, Page 3-14, ¶1. The TAC believes that at no time was any measurement made in the field for any of the nitrogen values which appear in this entire section under the heading Nitrate Mass Loading.

A.3.30, Page 3-14, ¶2. The TAC agrees with M&E that the calculation does not simulate or predict groundwater nitrate conditions. M&E after making this statement then proceeds to try to do so.

A3.31, page 3-15, ¶1. The TAC believes that a nitrate loading requires using all of the influent nitrate contribution. The in flowing groundwater is the contribution from all of the watershed unless it can be established that some portion of the watershed is not entering the groundwater basin. No such limitation has been established.

A3.32, Page 3-15. The TAC believes Table A-1 is a more accurate tabulation of water usage by the community of Los Osos.

A3.33, page 3-15. The TAC does not agree with M&E estimate of DUE. The TAC believes that 6100 or less is the appropriate number and Table D-1 does not support the M&E contention. See appendix A Table A-2 and A-3. In addition, the figure for indoor water use is grossly over estimated. The figure is closer to 45 gpd/person, which is closer to the figure given in EPA/625/R-92/005. The method used depends on too many assumptions, each of which M&E has over estimated. *[M&E note: The number of DUEs in Table D-1 has been revised to 6,299.]*

A3.34, page 3-16, ¶1. The TAC believes that M&E has not adequately reviewed, analyzed or integrated into this report the County's Los Osos-Baywood Park Nitrogen Study. [35]

A3.35, page 3-16 ¶1. The TAC believes that the data from the Baywood Estates site were repeatable and consistent.

A3.36, page 3-16 ¶1. The TAC believes that all of the Bayridge Estates data generated from the County's Los Osos-Baywood Park Nitrogen Study [35] has not been used by M&E. The data clearly supports the reduction in nitrate to very low values and that dilution is not a factor.

A3.37, Page 3-16, ¶2. The TAC believes that the nearly complete denitrification at the Bayridge Estates should not have been ignored. The reference to soil moisture is incorrect. The reference should be effluent, as used in the preceding paragraph. Leachate would be the most proper terminology. The TAC believes that the calculation of nitrate concentration in this effluent (leachate) is incorrect.

A3.38, Page 3-16, ¶2. The reference here is to leach pits which are typically 15 to 18 feet deep not leach fields. M&E continues to use the 20 to 30 foot depth as a reference when actually referring to leach fields which are typically 3 feet below ground surface.

A3.39, Page 3-20, ¶1. The TAC believes that no valid data exist to support the conclusion that in shallow groundwater areas, nitrate concentrations in effluent

A3.39, Page 3-20, ¶1. The TAC believes that no valid data exist to support the conclusion that in shallow groundwater areas, nitrate concentrations in effluent could exceed 200 mg/L as nitrate. *[M&E note: this has been changed to 100 mg/L as nitrate based on Figure 3-4B.]*

A3.40, page 3-20, bullet 2. The TAC believes that because the nitrates were higher in the groundwater than were observed in the leachate below the leach pits, one can conjecture many possible explanations which are as yet unproven. At least one additional factor has been suggested by the TAC and the Nitrate Study TAC for the additional limited increase in nitrates below 25 feet. M&E explanation of the changes does not account for the 500% increase in chloride and 200% increase in EC below 25 feet at the 14th Street site, while the nitrate remains relatively minimal.

A3.41, page 3-20, last ¶. The TAC believes that M&E's the contention that 33% of the nitrate nitrogen remaining in the leachate after denitrification reaches the groundwater has never been confirmed. This contention has certainly not been supported by the Los Osos/Baywood Park Nitrate Study.[34] *[M&E note: the sentence has been revised to read "...33% of the nitrogen from onsite system effluent <u>may be</u> reaching the groundwaer as nitrate."]*

A3.42, page 3-21, ¶2. The TAC disagrees with M&E's conclusion to the Los Oak Village test.

A3.43, page 3-21 last ¶. The TAC believes that the "natural sources" are the largest single contributor of nitrate to the groundwater basin. M&E's method of calculation grossly underestimates this factor.

A3.44, page 3-21, last ¶. The TAC believes that M&E does not address the background nitrate concentrations for the entire 18,000 acre watershed. The TAC does not agree with the calculations presented by M&E for use in determining the nitrate contribution of Agricultural and Horticultural fertilizers, Geological sources, Soil Disturbance and horses. Table A-2 summarizes the TAC's interpretation of nitrate loading sources for use when calculating the Mass Loading for the Basin.

A3.45, page 3-22, ¶1. The seven ground bore tests conducted in Los Osos should have been thoroughly evaluated, rather than being dismissed as out of hand by Metcalf and Eddy. The following observations should have been made from that data. The reasons given for not using data which was paid for by the county at the expense of the taxpayers do not appear to justify rejection of very useful local data without analysis; unless of course the authors were not capable of analyzing the data. The TAC subjected the data to the same analytical method used in reference [35] and established concentrations of nitrate-N at 640 mg/L near the

A3.46, page 3-23. The TAC believes that geologic nitrogen sources could be present in the Los Osos area and can not be ruled out as possible sources of nitrogen in this community. *[M&E note: a brief discussion of other geologic sources has been added.]*

A3.47, page 3-23. The TAC believes that the nitrate contribution from Agricultural Fertilizers could be much higher than Metcalf & Eddy has estimated.

A3.48, page 3-24. The TAC believes that the nitrate contribution from Horticultural Fertilizers could be much higher than Metcalf & Eddy has estimated.

A3.49, Page 3-24 Bullets 2,3. The TAC believes that the value of 77% as accounted for by plant uptake can not be anywhere near correct and that horses may represent about 11.5% of the total loading of nitrogen for this community. *[M&E note: the figure has been changed from 77% to 40%.]*

A3.50, page 3-24, last bullet. The TAC believes that Metcalf & Eddy demonstrates a complete lack of understanding of the denitrification process. *[M&E note: this sentence has been revised to read "Unlike onsite system effluent and like fertilizers, the soil is not always maintained in a saturated, anaerobic state, <u>which is most conducive to denitrification.</u>"]*

A3.51, page 3-25. This section does not measure the number of dogs and cats directly. Also, it does NOT measure the waste production nitrogen generation for these animals. Again, the results of this section are guesses which are not clearly referred to in this report.

A3.52, page 3-26, ¶1. The TAC believes the nitrate contribution from soil disturbance is far greater than indicated by Metcalf & Eddy.

A3.53, page 3-27. The TAC believes that Metcalf & Eddy has ignored an appreciable source of nitrogen by discounting biological nitrogen fixation by vegetation within the community.

A3.54, page 3-27. The TAC believes that because none of the nitrate nitrogen in the shallow ground water was tested for the proportion which came from any source, Metcalf & Eddy's can only guess at relative proportional contributions.

A3.55, page 3-27. TAC believes that the mass loading calculation can not represent an evaluation because no data were collected on the magnitudes of either the total amounts of inputs or of the nitrogen concentrations of any of the total inputs.

either the total amounts of inputs or of the nitrogen concentrations of any of the total inputs.

A3.56, page 3-28, Table 3-3. The 6610 DUE cannot be substantiated from the data in appendix D1. The TAC believes that the number is less than 6100 and the factor for #/DUE/yr is inflated by at least one third. In addition the area of contribution for natural inflow is grossly under estimated. See table A-2 appendix A.

A3.57, page 3-28, Table 3-3. The TAC believes that Metcalf & Eddy's mass loading calculation does not match real world values for either the concentration of the nitrate from the onsite system effluent or for the natural sources reaching the ground water and the TAC believes that this table consists entirely of a model based upon guesses for individual inputs and does not represent this community.

A3.58, page 3-27, last ¶. The TAC believes that there are no known data to substantiate any depth to ground water association with the denitrification process.

A3.59, page 3-30, 1st bullet. The TAC believes that a relationship between nitrate concentrations and population or time can not be suggested from a statistical interpretation stand point.

A3.60, page 3-30, 3rd bullet. TAC believes that it is important to indicate that no actual data were measured in the community to determine this approximation.

A3.61, page 3-30, 4th bullet. The TAC believes that all information relative to natural sources is very speculative and really only constitutes a computer model based entirely on guess work.

Chapter 4

ONSITE WASTEWATER SYSTEMS IN LOS OSOS

The purpose of this chapter is to document the problems and potential problems of existing onsite wastewater systems in the community. The information presented below consists of various data indicative of system performance including:

- Problems such as odors, wet spots, and plumbing backups, as indicated by the results of a sanitary survey
- Other problem indicators such as permits for onsite system repairs and records of complaints
- Potential problem indicators including lot size, density of development, depth to groundwater, and soil characteristics

SANITARY SURVEY

The survey was prepared and administered by the BRC and consisted of a two-page questionnaire. The questionnaire was used in house-to-house interviews of over 2,000 residents during October-November 1993, or about 44% of the total existing homes in the RWQCB prohibition area (Figure 1-2). Separate questionnaires were also given to businesses. The survey results were kept confidential by reporting the data to M&E by block; i.e., results for individual houses and business were not identified.

Summary of Results

All residences and business in Los Osos are served by onsite wastewater systems. With a few exceptions, the systems consist of a septic tank, typically 1,000 gallons, with either a leachfield (approximately 55% of all systems) or a seepage pit (45%). Only 16% reported having a dual leachfield. One-fourth of the respondents reported diverting "grey water," i.e., water from washing machines, lavatories, showers, and bathtubs (but not toilets and sinks), from their onsite system for use in landscape irrigation. Only 8% of respondents used water softeners and even fewer (3%) flushed the backwash to their septic tanks. Complete results for the residential survey are in Appendix F.

Reliability and Validity of Results

To determine if the sample was representative of all Los Osos residents and if the responses are valid, survey results are compared to other available data for the community, such as water records and the U.S Census. These comparisons are shown in detail in Appendix G and summarized as follows.

- **Question 8 - water supplier.** Although California Cities customers and individual well owners were under-represented, the actual distribution of customers is fairly close to the survey results.

- **Questions 12 and 15 - septage pumping frequency and septic tank size.** The septage volume derived from sanitary survey responses gives a total of over 1.3 million gallons/year. This is over twice the volume reported to the County Environmental Health Department by septic tank pumpers. For an average septic tank of 1,000 gallons, frequency of pumping is every 8 to 9 years based on County and pumpers' records and every 3 to 4 years based on sanitary survey results. The discrepancy of these data suggest that either the pumpers are under-reporting septage volumes or survey respondents are overstating frequency of pumping. Since most respondents (41%) stated that their septic tank has never been pumped and many (63%) checked "don't know" or did not respond on the septic tank size question, the validity of the results of these two questions is in doubt.

- **Questions 2, 4, 5, 6 - owner/renter, people living in residence, when home was built, number of bedrooms.** Survey results agree closely with data from the 1990 U.S. Census of Housing, although the census data are from April 1990 and the survey was conducted in October-November 1993.

- **Question 31 - septic system repairs or modifications.** From May 1985 to February 1994 there were approximately 900 building permits issued for such work, or about 2% of the systems in the community each year. Sanitary survey results indicated that 22% of the respondents reported having their systems repaired or modified. The question does not indicate the time frame for these repairs, but based on results of question 3, time lived in the house is an average of 5 to 10 years. If the repairs reported on the sanitary survey can be assumed to have occurred over the past 5 to 10 years (approximately the same time period as the permit data), then 2 to 4% of the total number of onsite systems were repaired or replaced each year, which is fairly close to the actual rate, i.e., 22% of approximately 5,000 units (Appendix D) ≈ 1,100 repairs (versus approximately 900 actual as reported by building permits).

These results show that a reasonably representative sample of the community was reached and that the survey data are probably valid.

Indicators of Problems

Respondents were asked other questions designed to reveal if there were specific symptoms of problems such as wet spots, odors, and backups in plumbing. These questions and the appropriate responses are summarized in Table 4-1.

Table 4-1. SANITARY SURVEY RESPONSES INDICATIVE OF ONSITE SYSTEM PROBLEMS

Question	Response		% with this response	Possible specific problem
14	3	Wet spots persist more than a month	1	· Poor drainage · Clogged leachfield
	4	Wet spots never go away	2	
17	1 (Yes)	Problems after heavy rains	3	· Leaking septic tank · Infiltration into leachfield lines or seepage pit · Poor drainage
18	1 (Yes)	Problems after visitors due to increased load	4	· Improperly designed and constructed system (insufficient leaching surface area)

Table 4-1. SANITARY SURVEY RESPONSES INDICATIVE OF ONSITE SYSTEM PROBLEMS				
Question	Response		% with this response	Possible specific problem
19	1 (Yes)	Backups or odors	8	· Plumbing deficiencies · Improperly designed or maintained system
Total[a]			16[a]	
a. Percent with at least one problem.				

Several other responses were considered as indicators of onsite system problems but were not used for the following reasons.

1. **Frequent Tank Pumping (Question 15)**. In normal use, solids accumulate very slowly in the septic tank. For the tank to continue to operate properly, it should be pumped whenever the solids or scum reach a certain level or thickness in the tank. Actual pumping frequency is a function of number of residents and lifestyle factors such as type of cooking, but a typical rate is every 3 to 10 years. Consequently, multiple pumpings over a period less than 3 years are often taken to be an indicator of onsite system problems.

   However, pumping frequency may be related to factors other than routine maintenance. Most lending organizations, such as mortgage companies and banks, and U.S. government agencies, such as Veterans Administration and Federal Housing Authority, require that whenever a real property transaction occurs--including refinancing--a "satisfactory certification or inspection report" of the onsite system be obtained. To issue such certification and to actually inspect the onsite system, the septic tank must be pumped [50].

   Data compiled by pumping firms indicated that for 1991-1993 about half of the pumping volume in Los Osos was for normal maintenance and another one-third for certifications by lending organizations. Only 14% of the total could be attributed to specific problems such as plumbing repairs, clearing tree root blockages, or leach line repairs or replacements [51].

It appears that in Los Osos, pumping frequency is affected by the need to issue certifications and normal maintenance. Only a small portion of the tanks were pumped as a result of specific problems. Consequently, multiple pumpings are not considered a valid indicator of onsite wastewater system problems in Los Osos.

2. **Tree Roots (Question 25).** Tree roots were reported as posing a problem for onsite systems by 7% of the sanitary survey respondents. Tree roots clog the leachfield lines or distribution piping and adversely affect the performance of the system. This is a problem which is solved by grinding the roots or removing the tree and is not an inherent defect of onsite wastewater systems. Tree roots are no more a problem for onsite systems than for sewer laterals.

3. **Diverting Grey Water for Landscaping (Question 21).** Grey water is typically wastewater from showers and laundry. One-quarter of those surveyed responded that they diverted grey water for landscaping. One possible explanation was that the onsite wastewater system was not functioning properly so that residents installed or replumbed their homes to directly discharge grey water onto lawns or gardens instead of septic tanks.

   Another possible explanation is that residents wanted to conserve water and/or save money on water bills. A follow-up survey of 116 residents found that all (i.e., 100%) diverted laundry wastewater only. Many of these residents stated that the diversions were only during the drought. Since minimal replumbing would be required to disconnect laundry from existing house plumbing compared to piping from other grey water sources, financial motives may have been at work. It is also possible that the laundry machines were installed without being hooked up to existing house plumbing, also saving money. In other words, grey water was probably being diverted for cost and water conservation reasons, not in response to a specific onsite wastewater treatment problem.

   Without more specific evidence for either reason, this question is not used as an indicator of onsite system problems.

4. **Use of Chemical or Biological Additives (Question 30).** Residents may buy such additives in response to some problem in their onsite system resulting from improper use or other reasons. A more likely explanation is that additives are bought because of successful marketing and advertising of the product. Without more specific evidence in the sanitary survey, this question is not used as an indicator of onsite system problems.

Results

The appropriate responses in Table 4-1 are plotted on Figure 4-1. The shading in each block represents the number of responses relative to the number of lots surveyed in that block. Each response in Table 4-1 is defined as one "problem." Each block is given a "score" equal to the number of problems divided by the number of lots surveyed. Scores were used for blocks where there were a sufficient number of responses. "Sufficient" is defined as 20% or greater ratio of lots surveyed to nonvacant lots in a block. The scores show the relative nature of problem incidence as defined by the questions in Table 4-1. The scores are summarized in Appendix J. There are three shadings, each representing approximately one-third of the total blocks with sufficient data. Lighter shaded blocks have the fewest relative number of problems and darker shaded blocks have the most. For example, a block with 3 problems and 10 lots surveyed (3/10 = 0.3) would be shaded darker than 4 problems and 20 lots surveyed (4/20 = 0.2). Blocks with a zero score are not shaded.

The overall picture shown in Figure 4-1 is that although problems occur throughout the community, there are no specific areas with a higher or lower relative incidence of problems.[a] {A4.1}

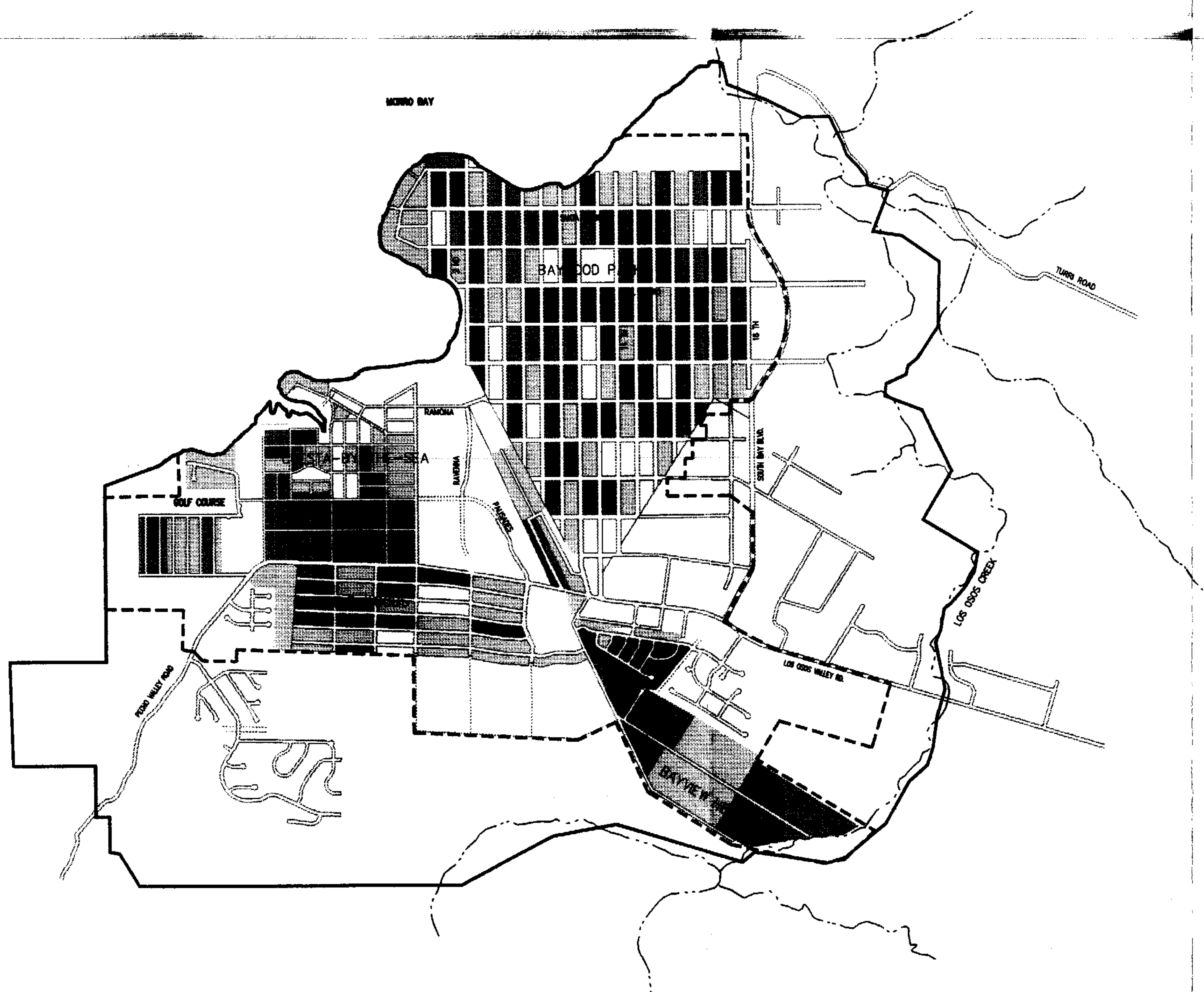
ONSITE SYSTEM BUILDING PERMITS AND COMPLAINTS

Permits

A conventional onsite wastewater system is essentially self-operating. There are no moving parts and the only required maintenance is periodic pumping of the tank to remove accumulated solids and scum. If properly designed, constructed, and maintained, an onsite

---

a. It is possible to divide the sanitary survey data into more than the three categories in Figure 4-1 and arrive at a different picture of the relative incidence of problems. See Appendix A.



0 2000 4000
SCALE FEET

No data, insufficient data,[a] or vacant

0[b]

0.01–0.22[b]

> 0.22[b]

Based on number of "problems" as defined by results of sanitary survey questions in Table 4-1 ÷ number of lots surveyed.

[a] Where number of lots surveyed is less than 20% of the total number of nonvacant lots in the block.

[b] These numbers are used only for comparing the relative incidence of problems revealed by responses to the Sanitary Survey questions in Table 4-1.

Prohibition Area Boundary

Urban Reserve Line

Los Osos Wastewater Study	Figure
Sanitary Survey Data	4-1
Metcalf & Eddy	Date: March 1995

system should serve its users indefinitely with no major repairs. Therefore, any type of work requiring a building permit done on an onsite system in the prohibition area is regarded as an indicator of potential onsite system wastewater problems, such as poor drainage or plumbing backups.

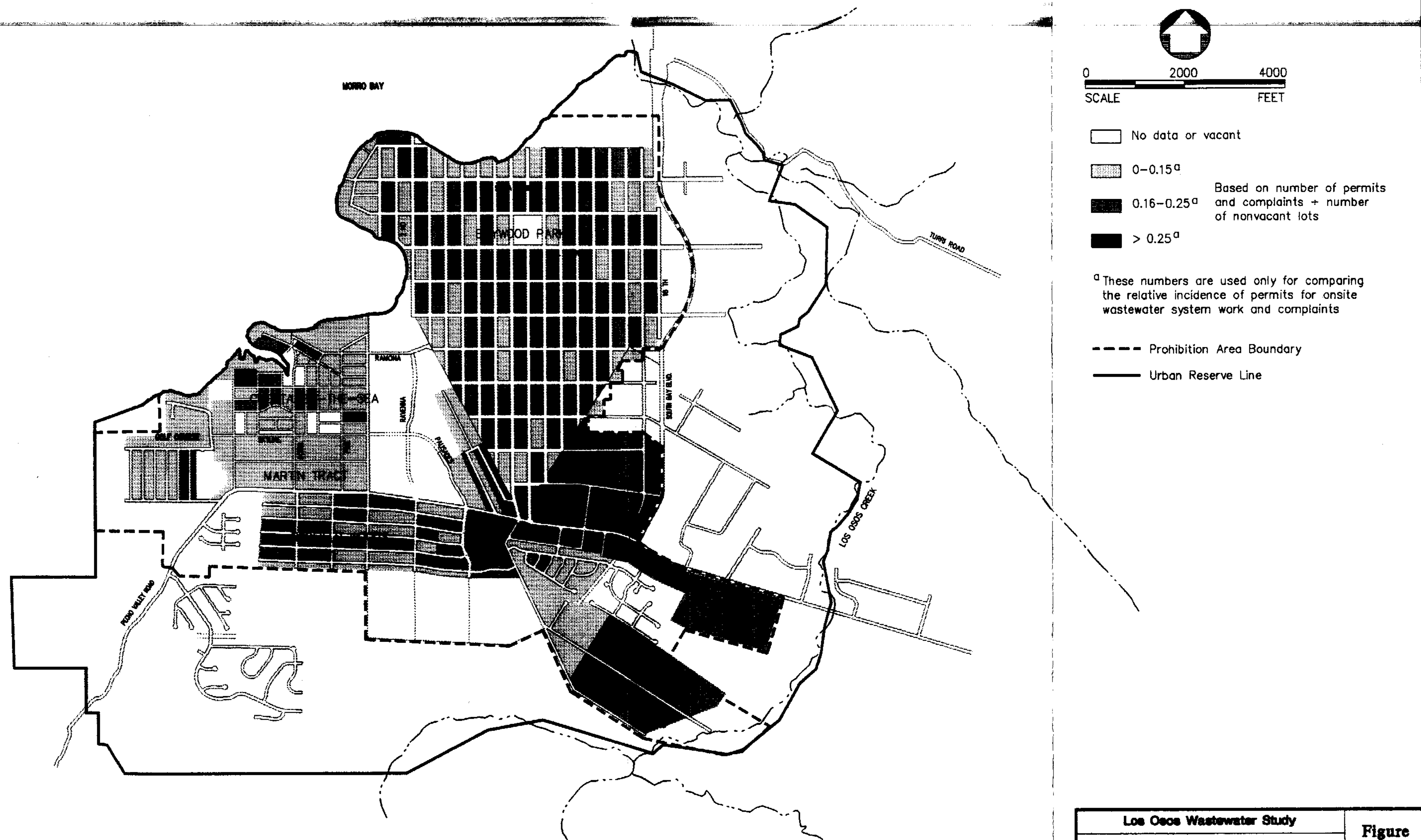
Within the prohibition area, from 1985 to 1994, there were approximately 900 building permits issued for such work, or about 2% of the systems in each year. The specific work done is not indicated on the permit; only words such as "leach line repair" appear. It is possible that some of these permits were for a second leachfield or leach pit. It is more likely, however, that work was probably for repair or replacement of a failed leach system [52].

Complaints

The County Environmental Health Department maintains records of public complaints on onsite wastewater systems. There were only 17 recorded complaints for 1985-93. Older records are apparently not available. However, there is correspondence in files on "septic system failures" as far back as the mid-1970s.

Results of Repair and Complaint Data Analysis

Permit and complaint data are shown in Figure 4-2. The shading in each block represents the number of permits and complaints relative to the number of non-vacant lots in that block. As with the Sanitary Survey data, each block is given a "score" equal to the number of permits and complaints divided by the number of non-vacant lots. The scores show the relative incidence of problems as indicated by the permits and complaints. The scores are summarized in Appendix J. There are three shadings, each representing approximately one-third of the total blocks with scores greater than zero. Lighter shaded blocks have the fewest relative number of problems and darker shaded blocks have the most. For example, a block



Los Osos Wastewater Study

Permit and Complaint Data

Figure 4-2

Metcalf & Eddy

Date: March 1995

with 3 permits/complaints and 10 non-vacant lots surveyed (3/10 = 0.3) would be shaded darker than 4 permits/complaints and 20 non-vacant lots surveyed (4/20 = 0.2). Blocks with a zero score are not shaded.

As shown in Figure 4-2, Cuesta-by-the-Sea and the Martin Tract have a lower relative incidence of repairs and complaints. However, as with Figure 4-1, although permits and complaints occur throughout the community, there are no specific areas with a higher or lower relative incidence of permits and complaints.[b] {A4.2}

LOT SIZE AND DENSITY OF DEVELOPMENT

Other important factors affecting onsite wastewater system performance and groundwater quality are lot sizes and the density of onsite wastewater systems. Typically, onsite systems are constructed in rural areas where density of development is low, usually less than two dwelling units/acre. Large lot sizes with this density allow enough room for a properly designed system in almost any type of soil.

Lot Size

To determine appropriate lot sizes for onsite systems, specific area requirements for these systems are calculated. County guidelines [53], which are based on the Uniform Plumbing Code [54], state that the minimum leachfield area (infiltrative surface) shall be 125 sq ft/bedroom. For a typical three-bedroom house, the minimum infiltrative surface area would be 375 sq ft, which includes both trench sidewall and bottom. At an average wastewater flowrate of 189 gpd (Appendix D), this area results in an infiltrative capacity of 0.5 gpd/sq ft, which is recommended for sandy loam according the EPA Design Manual for Onsite

---

b. It is possible to divide the permit and complaint data into more than the three categories in Figure 4-2 and arrive at a different picture of the relative incidence of problems. See Appendix A.

Systems [55]. The rate of soils more characteristic of Los Osos, i.e., fine sand or loamy sand, is 0.8 gpd/sq ft in this reference.

Another guideline for sandy soils is 0.2 gpd/sq ft applied to infiltration through sidewall areas only. This figure, termed the "Most Conservative Criterion," is based on experimental data for hydraulic loading rates for various soils [57]. These data show that hydraulic loading rate is not well correlated with results of percolation tests. An explanation for this phenomenon is that eventually all soils become clogged to essentially the same permeability from long-term application of wastewater. In other words, while initial permeability of a soil-based wastewater disposal system is controlled by soil characteristics, in the long-term the permeability is a function of the wastewater itself [56, 57]. The use of sidewall area only is based on evidence that most infiltration of wastewater occurs through trench sidewalls over time [57].

From these two criteria, a range of required surface areas for onsite wastewater systems can be calculated. The overall areas of a leachfield for three typical trench dimensions, including a 1,000-gal septic tank, without and with required setbacks, are summarized in Table 4-2 and shown in greater detail in Appendix H.

The areas are based on the above criteria and:

- 189 gpd/service (Appendix D).
- Setbacks in the County guidelines [53], i.e., generally 5 feet from the private property line and 8 feet from structures. Other guidelines give larger setback guidelines: 5-10 feet from the property line and 10-20 feet from structures [55]. Other guidelines for setbacks include 50-100 feet from wells, surface waters, or springs [10, 55]; these guidelines are not included in Table 4-2. Also not considered in Table 4-2 are other County setback requirements for water lines (5 ft), large trees (10 ft), water supply wells (50-150 ft), and streams (50-100 ft).
- 4 feet edge-to-edge between trenches per County guidelines [53]. Other guidelines suggest twice the depth below the trench pipe [10]; and 6 feet primarily to facilitate construction of trenches [55].

Table 4-2. SUMMARY OF REQUIRED AREAS FOR LEACHFIELD					
Trench dimensions, in.		Approximate overall area, sq ft			
		County guidelines [53,54][a]		"Most Conservative Criterion" [56, 57][b]	
Width[c]	Depth	Without setbacks[d]	With setbacks[d,e]	Without setbacks[d]	With setbacks[d,e]
18	24	1,100	1,900	1,300	2,100
24	36	700	1,400	900	1,700
36	48	600	1,200	800	1,600

a. Includes area for 1,000-gal septic tank. Rounded to nearest 100 sq ft.
b. Based on 0.2 gpd/sq ft. Includes total area, but for sandy soils, replacement area is apparently neither included nor required. Also includes area for 1,000-gal septic tank.
c. Below distribution pipe.
d. 4 ft between trenches (edge-to-edge).
e. 5 ft from property line; 8 ft from structures (Figure H-1).

For leach pits[c], a infiltrative capacity is based on twice the value of the "Most Conservative Criterion" for leachfields, i.e., 0.4 gpd/sq ft [58]. Based on this criterion and the same factors as in Table 4-2, the overall areas required for various depths, including a 1,000-gal septic tank, without and with required setbacks, are summarized in Table 4-3 and shown in greater detail in Appendix H.

c. The terms leach pit and seepage pit are often used interchangeably. A seepage pit is typically lined while a leach pit may be lined or unlined. However, they perform fundamentally the same function.

Table 4-3. SUMMARY OF REQUIRED LEACH PIT AREAS {A4.3}						
	County guidelines [53, 54]			"Most Conservative Criterion" [56, 58][a]		
		Approximate overall area, sq ft[b]			Approximate overall area, sq ft[b]	
Pit depth, ft[c]	Diameter, ft	Without setbacks	With setbacks[d]	Diameter, ft	Without setbacks	With setbacks[d]
10	12	400	1,600	15	600	1,900
15	8	200	1,200	10	300	1,400
20	6	200	1,100	7.5	200	1,200

a. Based on 0.4 gpd/sq ft [58].
b. Including a 1,000-gal septic tank. Rounded to nearest 100 sq ft.
c. Below inlet pipe.
d. 8 ft from property line and structures (Figure H-2).

The areas calculated in Tables 4-2 and 4-3 range from approximately 1,100 to 2,100 sq ft and represent minimum land areas required for the indicated trench or pit dimensions based on the guidelines and criteria. With different orientation of septic tanks and leachfield trenches or leach pits, the land area could be larger. The RWQCB suggests a 20 ft distance between leach pit side walls [10] which would further increase these required areas.

Area requirements for leach pits are slightly less than for leachfields. The areas in Table 4-3 for pits range from 1,100 to 1,900 sq ft, so that the area constraints in Figure 4-3 would apply. {A4.6} Although leach pits require less land area, they need to be excavated much deeper to obtain the required infiltrative surface. If too deep, the pit bottom could be at or near the water table, negating the nitrification/denitrification treatment in the unsaturated zone (Appendix E).

Developed lot sizes in Los Osos vary from 5,000 to over 20,000 square feet. Most sanitary survey respondents (97%) reported having lots 10,000 sq ft or smaller (question 7). The only portions of the community currently having lot sizes 20,000 square feet or greater are in

Bayview Heights and the Martin Tract. {A4.4} A large majority of sanitary survey respondents (84% - question 24) reported not having dual leachfields, probably because of lack of a specific requirement in County guidelines requiring a 100% replacement area on the lot [53][d], cost factors, or insufficient lot size.

The required 1,200-2,100 sq ft area for leachfields or leach pits is a significant fraction of the total area of lots less than 10,000 sq ft. There are few specific lot size guidelines available, but reference [59] states that 1-5 acres is a typical land area for a conventional onsite system. The RWQCB prohibits discharges from onsite systems when lot sizes are less than 1 acre or less than 1/2 acre when "soil and other physical constraints are particularly favorable" [10]. However, reference [60] states that leachfield trenches can function effectively with "small lot sizes;" but "small" is not defined.

Guidelines in references [55, 59] also state that, in general, onsite systems should be on an open expanse without:

- Trees or woody shrubs with roots that can clog leach lines.
- Other structures such as patios, decks, driveways, or garden sheds that could prevent the shallow subsurface soil from maintaining aerobic conditions conducive to nitrification.

---

d. The guidelines state that:

"Individual systems on new land divisions shall be designed and constructed to either reserve sufficient site area for dual leachfields (100% replacement area) or construct the dual leachfields with a diverter valve at the time of initial septic system installation. Installation of dual leachfields will be required if site access for installation of the expansion area could be limited after initial site development."

The intent of this language seems to indicate that dual systems are required ultimately. However, the guidelines also appear to create an exception by allowing for installation of the second field at a later date.

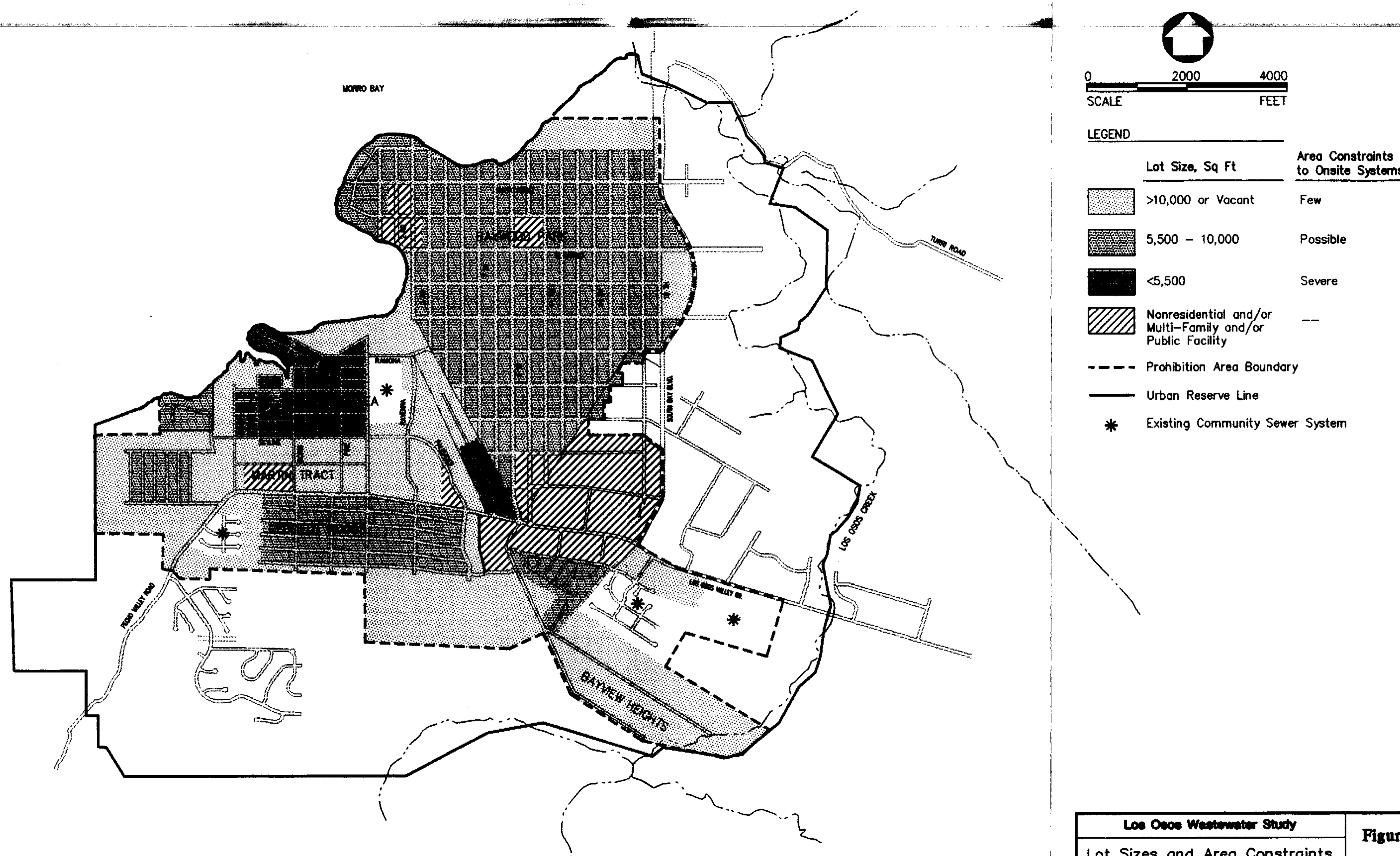
Furthermore, slopes should be less than 15% with no undulating surface which could interfere with drainage and concentrate runoff.

Assuming these conditions are in place, it is possible to accommodate a leachfield or leach pit system of 2,000 sq ft or greater on lots in most of Los Osos. Sample layouts prepared by the Los Osos Technical Advisory Committee (TAC) are shown in Appendix H for typical lots in Baywood Park (Town of El Moro), Sunset Terrace, and Redfield Woods. These lots are 6,300, 6,250, and 5,500 sq ft, respectively. After laying out the septic tank and leachfield or leach pit, including replacement area, based on County guidelines [53], the area left for the house footprint and other structures on these lots is 2,320 to 2,800 sq ft. To fit on these lots, the septic tank and leachfields or leach pits are placed:

- In the front yard with the replacement area in the backyard (or vice versa), leaving little room for other structures outside the house footprint and trees and woody shrubs. In this case, if the lot is sloped upward from the street, use of the replacement area requires installation of a pump.

- In the front yard (or backyard) only, leaving little or no room for other structures outside the house footprint, trees, and woody shrubs.

In either case, the fit is tight and may constrain the property owner from fully developing the lot. {A4.5} In general, lots over 10,000 to 15,000 sq ft have few such constraints, while lots smaller than 5,500 sq ft (such as in Cuesta-By-The-Sea and along Ferrel Avenue) have severe constraints. {A4.6} Area constraints and lot sizes in the community are shown in Figure 4-3. In most of the community, there are area constraints to leachfield or leach pit system location. {A4.6} Since these systems are already in place, this means that residents may have planted trees or shrubs or constructed other structures over their leachfields or leach pits, possibly adversely affecting system performance.



Los Osos Wastewater Study

Lot Sizes and Area Constraints for Onsite Systems

Figure 4-3

M&E Metcalf & Eddy

Date: March 1995

Density of Development

It is conceivable that a properly designed, installed, and maintained onsite system on a small lot could adequately treat wastewater if soil and groundwater conditions were suitable. However, the large number and proximity of such small lots, each with an onsite system, has the potential to affect groundwater quality. The housing density of the community varies from less than 1 to 14 dwelling units (DU)/developed acre (total area less vacant land). Within the Urban Reserve Line, the average density is about 4 DU/developed acre [49], i.e., there are an average of 4 onsite systems/developed acre. {A4.7} The overall density, based on total area within the Urban Reserve Line, is about 1.9 DU/acre. This compares with 2.3 DU/acre for the total area within the Prohibition Zone.

The impact of housing density on shallow groundwater quality is summarized in Table 4-4.

Table 4-4. IMPACT OF HOUSING DENSITY ON NITRATE CONTRIBUTION TO SHALLOW GROUNDWATER

Housing (onsite system) density, % of current	Approximate population	Examples of typical lot size, sq ft	Estimated nitrate contribution of onsite wastewater systems, %
Current	14,400[a]	6,000-10,000	61[b]
50	7,200	12,000-20,000	44
33	4,800	18,000-30,000	35
25	3,600	24,000-40,000	28

Note: Based on data and assumptions in Table 3-3. Current number of DUs is reduced to percentages shown and other factors are held constant.
a. From Table 1-1 (rounded).
b. From Table 3-3.

The mass loading calculation in Chapter 3 is used to evaluate how the nitrate contribution from onsite wastewater systems varies with changes in housing density, i.e., onsite system density. If densities are reduced while other factors are held the same, the percent contribution of nitrates attributable to onsite systems decreases. For example, if Los Osos had half its current population over the same area (i.e., typical lot sizes were 1/3 to 1/2 acre), onsite wastewater systems would no longer contribute a majority of the nitrate loading to the shallow groundwater.

DEPTH TO GROUNDWATER

One of the most critical factors in onsite wastewater system performance is nitrogen transformation, i.e., denitrification, in the soil column. The RWQCB staff has issued a probable discharge requirement of 5 mg/L of total nitrogen at the point of discharge [9]. {A4.8} This requirement or limitation is based on public health concerns and the Maximum Contaminant Limit of 10 mg/L (as nitrogen) [2] as discussed in Chapter 1. If this limitation is formally adopted by the RWQCB, denitrification is essential to mitigate the potential adverse public health effects of nitrate. Furthermore, both the County and RWQCB have minimum separation distances from trench bottom to usable groundwater (including perched groundwater) ranging from 5 to 50 ft depending on the percolation rate and soil type [10, 53].

Available data for Los Osos indicate that nitrogen transformations, most likely nitrification and denitrification, proceed and reach a limit at a depth of 10 to 15 feet below the bottom of the leachfield or leach pit. At this limit, approximately 67% of the nitrate in the effluent is lost ([34] and Figures 3-4A and 3-4B) and 33% of the effluent nitrate reaches the groundwater[e]. In other words, in areas where depth to groundwater is less than about 15 feet for leachfields and 30 feet for leach pits, less than 67% of the effluent nitrate is being

e. The impact of this amount of nitrate on shallow groundwater has been presented in the discussion of nitrate sources in Chapter 3.

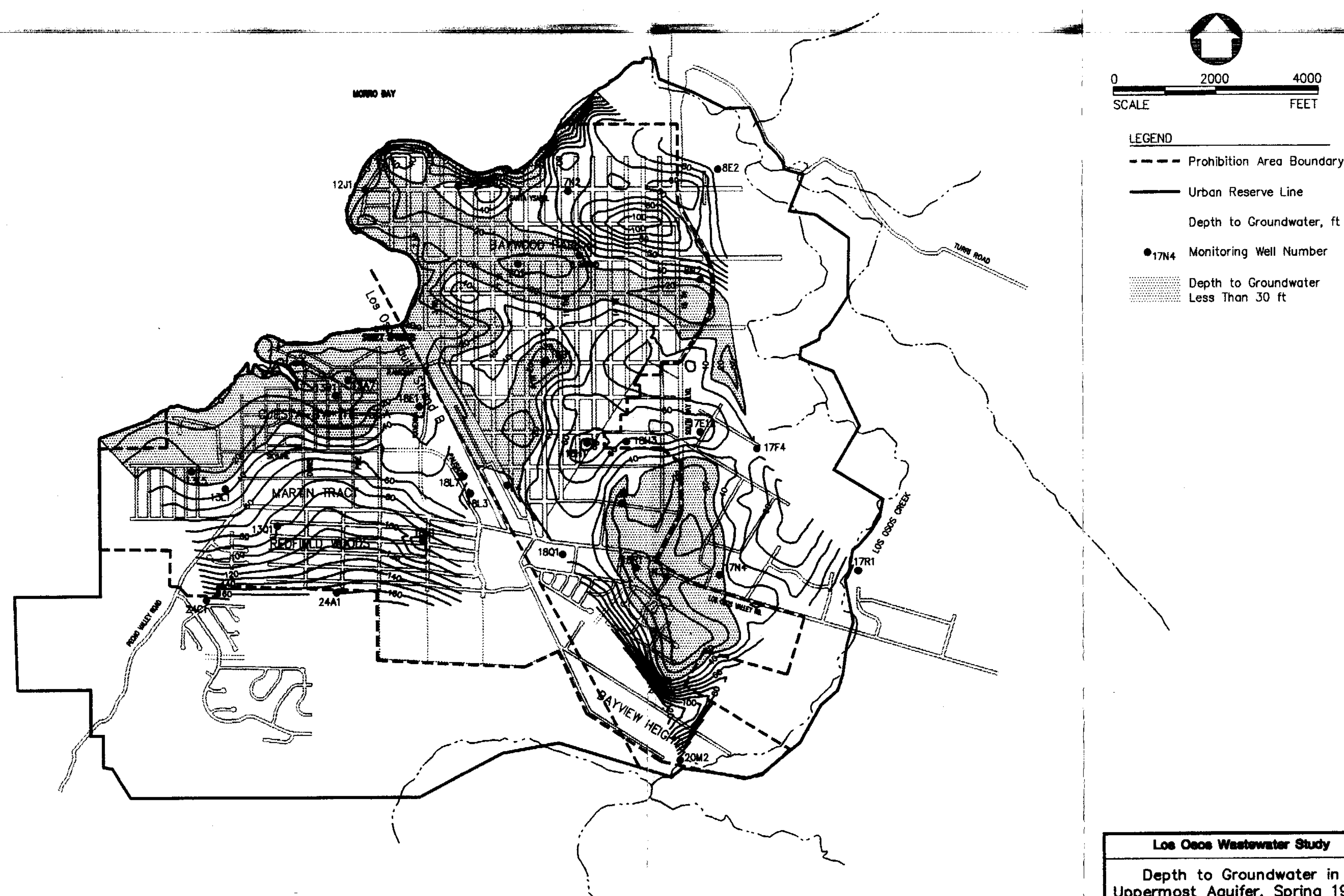
transformed and more than 33% of the effluent nitrate is entering the groundwater. In such areas, wastewater effluent reaching the groundwater may have higher nitrate concentrations than in areas having deeper groundwater.

Depth to groundwater contours for Spring 1993 are plotted on Figure 4-4. The contours are based on data in wells monitored by the County Engineering Department and represent the highest levels in recent years. The areas where depth is 30 ft or less are shaded and constitute about one-third of the Prohibition Area. In these portions of the community, use of conventional onsite wastewater systems could pose water quality problems from higher nitrate discharges.

SOIL DATA

Based on U.S Soil Conservation Service (SCS) soil survey [48], Los Osos is covered by Baywood fine sands, a soil characterized as "somewhat excessively drained" and having "rapid permeability." {A4.9} These terms are related to agricultural and irrigation qualities of soil, i.e., water drains away from the root zone rapidly, requiring frequent irrigation to maintain suitable soil moisture for plants. The SCS survey generally covers only the upper 5 feet of soil and is limited in the number of survey sampling points, but this description is generally supported by other reports [19, 24]. SCS classifies this soil as having "severe" limitations for use as a leachfield primarily because of poor filtration capability resulting from permeability and potential for piping. This means that the soil is so unfavorable or difficult that special design considerations are necessary. The "severe" classification seems to reflect many functions of onsite wastewater treatment systems. For example, sands generally do not filter or sorb pathogens and remove small particulates as well as clay soils, (Appendix E).

Furthermore, rapid movement of water through the soil is conducive to high nitrification, but not as conducive to subsequent denitrification because of the aerobic conditions in the soil



Los Osos Wastewater Study	Figure
Depth to Groundwater in Uppermost Aquifer, Spring 1993	4-4
Metcalf & Eddy	Date: March 1995

column. SCS classifications for waste disposal ("slight," "moderate," "severe") have been adapted and incorporated into onsite system design manuals [55]. Other sources and guidelines state that areas with rapidly permeable sandy soils are typical applications where onsite systems can function, rather than areas to avoid [59, 60]. Judgments on suitability of soils in these references reflect the emphasis placed by their authors on the various functions of onsite systems.

Previously, it has been demonstrated that Los Osos soils are capable of some treatment of wastewater, at least in terms of nitrogen transformation and nitrate loss. Consequently, the existence of Baywood fine sands as an indicator of wastewater problems throughout the community may not be warranted.

SUMMARY AND CONCLUSIONS

The data plotted in Figures 4-1 through 4-4 indicate that most of Los Osos exhibits some type of problem or potential problem with continued use of conventional, onsite, soil-based wastewater treatment and disposal systems. Problems are defined by the sanitary survey, permit and complaint data, lot size and density of development, and depth to groundwater. {A4.10}

Problems revealed by the results of the sanitary survey include wet spots, odors, and plumbing backups. Data from the sanitary survey indicate that although such problems occur throughout the community, there are no clusters with relatively high incidence of problems. {A4.11}

A building permit for a leachfield or pit repair may be an indicator of a potential onsite wastewater system problem. Based on data from 1980 to 1994, the rate of repairs in Los Osos is approximately 2% of the systems/year. As with the sanitary survey data, while repairs have occurred throughout the community, there are no clusters with a relatively high incidence of repairs. {A4.12}

In most of Los Osos, lots are large enough to fit an onsite system according to County guidelines. The onsite system should be in an open expanse without trees and other structures such as patios, decks, or driveways. However, on lots less than 10,000 to 15,000 sq ft, the fit is very tight and there are constraints to developing the lot with trees and other structures such as patios and garden sheds.

As indicated by the limited data in the community, nitrogen transformation, which is assumed to be biological denitrification, occurs beneath onsite systems and appears to reach a maximum at 10 to 15 feet below the effluent discharge point. Depending on the type of onsite system, this is equivalent to 20 to 30 feet below the ground surface. Thus, in areas where groundwater depth is 30 feet or greater, denitrification is maximized and nitrates entering the groundwater are minimized. Where groundwater is less than 30 feet deep, effluent is probably entering the groundwater at higher nitrate concentrations. About one-third of the community within the Prohibition Area overlies groundwater less than 30 ft deep.

SUMMARY OF TAC COMMENTS

A4.1, page 4-6. The TAC believes that an appropriate analysis of the data shows that there are specific areas with significantly higher incidence of problems that should be recognized and dealt with and that it is unfair to suggest that significant problems are "widespread."

A4.2, page 4-10. The TAC believes that an appropriate analysis of the data shows that there are specific areas with significantly higher incidence of permits and complaints that should be recognized and dealt with, and that it is misleading to suggest that a significant incidence of permits and complaints is "widespread."

A4.3, page 4-13, Table 4-3. M&E's report makes numerous references to seepage pits which are illegal and not allowed within the County of San Luis Obispo. *[M&E note: the term "seepage pit" has been changed to "leach pit" throughout the report.]*

A4.4, page 4-14. M&E's incorrectly states the zoning standard for the Martin Tract as 4 DU/acre. *[M&E note: this sentence has been deleted.]*

A4.5, page 4-15. The TAC strongly disagrees that the septic tank/leach area constraint and "tight fit" analysis by M&E will prohibit the property owner from fulling developing the owners lot.

A4.6, pages 4-13, 4-15. TAC believes that M&E's generalized use of Figure 4-3 does not adequately delineate the variability or the developmental constraints of the lot sizes for the various subdivision boundaries of Los Osos. Reader is advised to reference M&E's appendix H for information on lot sizes and septic system layouts in the community of Los Osos.

A4.7, page 4-17. TAC believes that M&E's use of "average density" analysis for understanding the impact of housing density on shallow groundwater quality is inappropriate and inaccurate.

A4.8, page 4-18. The TAC believes that M&E's inclusion of a standard for limits on nitrate of 5mg/L and 10mg/L is misleading. The TAC has requested M&E to remove all references to these unestablished nitrate limits or to provide proof of the establishment of any nitrate limit during the TAC's review of this study. M&E has refused to do either.

A4.9, page 4-19. M&E's use of the U.S. Soil Conservation Service (SCS) Soil Survey [48] consisting of <u>only one soil sample</u> is not acceptable for use in this report when characterizing the soils in Los Osos/Baywood Park.

A4.10, page 4-21. TAC believes that Metcalf & Eddy chose to misrepresent sanitary survey and permit data in order to prove a preconceived notion that septic system problems are widespread.

A4.11, page 4-21. The TAC believes that an appropriate analysis of the data shows that <u>there are specific areas with significantly higher incidence of problems</u>, that should be recognized and dealt with, and that it is unfair to suggest that significant problem are "widespread."

A4.12, page 4-22. The TAC believes that an appropriate analysis of the data shows that <u>there are specific areas with significantly higher incidence of permits and complaints</u> that should be recognized and dealt with. The TAC believes that it is misleading to suggest that a significant incidence of permits and complaints is "widespread."

[M&E note on A4.10, A4.11, and A4.12: footnotes have been added that recognize TAC's analysis of the data and the different conclusion drawn.]

CHAPTER 5

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The following were major tasks in this report.

1. Comparing historical population with nitrate concentrations in shallow groundwater.

2. Documenting and estimating sources of nitrate in the shallow groundwater.

3. Documenting the incidence of onsite wastewater system problems based on results of a sanitary survey, data on permits, data on land uses, and data on groundwater depths.

FINDINGS {A5.1}

1. Average annual nitrate concentrations in shallow groundwater have increased since 1954. {A5.2} Population has also increased in the same time period. There is a statistically significant correlation between nitrate concentrations and population or time, suggesting a relationship between these variables. However, such correlation does not establish a causal relationship between increasing nitrate and increasing population.

2. Because nitrate concentrations in shallow groundwater differ widely within the community, the impact of onsite wastewater systems and other potential nitrate sources does not appear to be evenly distributed over the community. {A5.3}

3. Individual onsite wastewater systems appear to be a major contributor of nitrate to shallow groundwater in the community as a whole. Over 60% of the nitrate currently in shallow groundwater may be derived from onsite wastewater system effluent. The data and calculations presented above provide evidence of a relationship between onsite wastewater system effluent and groundwater nitrate. {A5.4}

4. Natural sources, such as soil organic matter, native vegetation, and inflowing groundwater, contribute approximately 18% of the nitrate in shallow groundwater. {A5.5} Contributions from other non-natural sources--agricultural fertilizers, horticultural fertilizers, and horse wastes--are smaller and less significant. The magnitudes of other non-natural sources--soil disturbance from construction, weed abatement, and dog and cat wastes--are less certain but probably minor.

5. Problems revealed by the results of the sanitary survey include wet spots, odors, plumbing backups. Of the approximately 2,000 residences surveyed, 16% reported at least one of these problems. These data indicated that such problems occur throughout the community but there are no clusters with a relatively high incidence of problems. {A5.6}

6. A building permit for a leachfield or pit repair may be an indicator of a potential onsite wastewater system problem. {A5.7} Based on data from 1980 to 1994, the rate of repairs in Los Osos is approximately 2% of the systems/year. As with the sanitary survey data, repairs occur throughout the community but there are no clusters with relatively high incidence of repairs.

7. In most of Los Osos, lots are large enough to fit an onsite system according to County guidelines. The onsite system should be in an open expanse without trees and other structures such as patios, decks, or driveways. On lots less than 10,000 to 15,000 square feet, the fit is tight and there are constraints to developing the lot with trees and other structures. {A5.8}

8. As indicated by the limited data from the Los Osos Nitrogen Study [34, 35], nitrogen transformation occurs beneath onsite systems but appears to reach a maximum at 10 to 15 feet below the effluent discharge point. This transformation is most likely to be nitrification and dentrification. Depending on the type of onsite system, this is equivalent to 20 to 30 feet below the ground surface. Thus, in areas where groundwater depth is 30 feet or more, denitrification is maximized and nitrates entering the groundwater are minimized. Where groundwater is less than 30 feet deep, effluent is probably entering the groundwater at higher nitrate concentrations. {A5.9} About one-third of the community within the Prohibition Area overlies groundwater less than 30 feet deep.

CONCLUSION

Based on these findings, continued use of existing conventional onsite wastewater systems is not justified in portions of the community having small lots (high density of onsite systems) and depths to groundwater less than 30 feet. This includes most of the community except Bayview Heights, the Martin Tract, and vacant areas.

RECOMMENDATIONS

Consequently, it is recommended that Task G - Alternative Technologies for Wastewater Collection, Treatment, and Disposal be completed as follows.

- For all of the community except Bayview Heights, the Martin Tract, and vacant areas with zoning for small lots (generally less than 10,000 square feet), evaluate variations to existing conventional onsite systems that increase nitrate removal as well as clustered or centrally located collection, treatment, and disposal technologies.

- For Bayview Heights, the Martin Tract, and vacant areas with zoning for large lots and groundwaer greater than 30 feet, evaluate continued use of conventional onsite, soil-based wastewater systems but with appropriate design, maintenance, and operating criteria, standards, and regulations as part of a maintenance district.

SUMMARY OF TAC COMMENTS

A5.1, Page 5-1. The TAC believes that the continued use of conventional onsite wastewater systems is justified for regions within the community of Los Osos.

A5.2, page 5-1. The TAC believes that the data collected since 1954 does not indicate or demonstrate a consistent increase in nitrate concentration.

A5.3, page 5-1. The TAC agrees that nitrate concentrations are highly variable, are inconsistent, and differ widely within the community.

A5.4, page 5-1. The TAC believes that M&E's mass loading calculation is in error and that the nitrate concentrations determined by Metcalf & Eddy do not agree with the data from actual nitrate concentrations measured in the shallow groundwater. The TAC also disagrees that individual onsite wastewater systems have contributed over 60% of the nitrate currently in the shallow groundwater.

A5-5, page 5-1. The TAC strongly disagrees that natural nitrate sources have contributed only 18% of the nitrate currently in the shallow groundwater.

A5.6, page 5-2. The TAC disagrees with the M&E analysis that the sanitary survey data indicates on-site system problems are wide spread. The TAC believes that areas with poor drainage and high groundwater have a greater incidence of problems. *[M&E note: the term "widespread" has been deleted and replaced with "occurs throughout the community."]*

A5.7, page 5-2. The TAC disagrees that the [permit and complaint data indicates on-site system problems are wide spread. The TAC believes that areas with poor drainage and high groundwater have a greater incidence of problems and the remainder are scattered. *[M&E note: the term "widespread" has been deleted and replaced with "occurs throughout the community."]*

A5.8, page 5-2. The TAC disagrees with M&E's opinion that lot owners may be constrainted when developing lots that are less than 10,000 square feet in size because "the fit is tight."

A5.9, page 5-2. The TAC disagrees that the Los Osos Nitrogen Study data supports the idea that higher nitrate concentrations enter groundwater in areas of Los Osos where depth of groundwater is less than 30 feet.

REFERENCES

1. Phase Two - Basis of Design Report, CSA No. 9 - Los Osos, Baywood Park, Cuesta-By-The-Sea Sewerage Project. Engineering-Science. February 1987.

2. California Code of Regulations. Title 22, Chapter 15, Article 4, §64435.

3. Nitrate in Drinking Water. Report to the Legislature. Report No. 88-11WQ. California State Water Resources Board. 1988

4. Nitrates: An Environmental Assessment. A report prepared by the Panel on Nitrates of the Coordinating Committee for Scientific and Technical Assessments of Environmental Pollutants. National Academy of Science. 1978. 723 p.

5. California Regional Water Quality Control Board. Central Coast Region. Staff Report. Water Quality Data. Los Osos/Baywood Park. August 1987.

6. California Regional Water Quality Control Board. Central Coast Region. Los Osos/Baywood Park Area Basin Plan Amendment. Staff Report. August 1983.

7. California Regional Water Quality Control Board. Central Coast Region. Los Osos/Baywood Park Area. Consideration of an Immediate Prohibition of Waste Discharge from Additional Wastewater Disposal Systems. Staff Report. November 1984.

8. California Cities Water Company and San Luis Obispo County Engineering Department. Unpublished Data.

9. Leonard, W.R. Letter to Laurence Laurent. San Luis Obispo County Board of Supervisors. July 15, 1992.

10. California Regional Water Quality Control Board. Central Coast Region. Water Quality Control Plan. 1989.

11. Brown & Caldwell. San Luis Obispo County Service Area No. 9, Los Osos Baywood Park Phase II Facilities Planning Study. January 1984.

12. Phase One - Sewerage Planning Study. CSA No. 9 - Los Osos, Baywood Park, Cuesta-By-The-Sea Sewerage Project. Engineering-Science. May 1986.

13. The Morro Group. Final Environmental Impact Report, CSA No. 9 Wastewater Treatment Facilities. August 1987.

REFERENCES (Continued)

14. San Luis Obispo County Engineering Department, Water Quality Laboratory. Baywood Park Groundwater Study. October 15, 1993. Also, Unpublished Updates for December 1993-March 1994.

15. Brown & Caldwell. San Luis Obispo CSA No. 9, Los Osos/Baywood Park Phase I Water Quality Management Study. Volume I and Volume II, Appendixes. April 1983.

16. Metcalf & Eddy. County of San Luis Obispo, Los Osos/Baywood Park CSA No. 9. estimated Cost Update. July 1989.

17. John L. Wallace & Associates. Engineer's Report for the County of San Luis Obispo. Los Osos/Baywood Park Assessment District. January 1990.

18. California Department of Water Resources. Geohydrology and Management of Los Osos Valley Groundwater Basin. San Luis Obispo County. District Report. 1989.

19. Hantzsche, N.N. and E.J. Finnemore. Predicting Groundwater Nitrate-Nitrogen Impacts. Ground Water. 30:490-499, 1992.

20. Tinker, J.R. Jr. Analysis of Nitrate-Nitrogen in Groundwater Beneath Unsewered Subdivisions. Ground Water Monitoring Review. 11:141-150, 1991.

21. Brauman, B.J. and W.M. Schafer. Estimating Groundwater Quality Impacts from Onsite Sewage Treatment Systems. In: Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems. American Society of Agricultural Engineers. 1984.

22. Walker, W.G., G.J. Bouma, D.R. Keeney, and F.R. Magdoff. Nitrogen Transformations During Subsurface Disposal of Septic Tank Effluent in Sands: I. Soil Transformations. Journal of Environmental Quality. 2:521-525. 1973.

23. Walker, W.G., G.J. Bouma, D.R. Keeney, and F.R. Magdoff. Nitrogen Transformations During Subsurface Disposal of Septic Tank Effluent in Sands: II. Ground Water Quality. Journal of Environmental Quality. 2:521-525. 1973.

24. Yates, E.B. and J.H. Wiese. Hydrology and Water Resources of the Los Osos Valley Groundwater Basin, San Luis Obispo County, California. U.S. Geological Survey. Water Resources Investigations Report 88-4081. 1988.

25. Portopapas, George. Letter to Al Switzer, CSA 9 Advisory Group. January 3, 1979.

REFERENCES (Continued)

26. Portopapas, George. Letter to Al Switzer, CSA 9 Advisory Group. February 1, 1977.

27. California Department of Water Resources, Southern District. Los Osos-Baywood Park Groundwater Protection Study. October 1973.

28. Aleshire, R., and C. Coray. Report on Nitrate Concentration in Shallow Wells in Baywood/Los Osos Area on March 24-26, 1981. California Regional Water Quality Control Board, Central Coast Region.

29. Beaton, John. San Luis Obispo County Engineering Department, Water Quality Laboratory. Personal Communication. March 1994.

30. U.S.EPA. Handbook, Groundwater. Volume H: Methodology. EPA/625/6-90/016b. July 1991.

31. Water Environment Federation. Standard Methods for the Examination of Water and Wastewater. 18th Edition. 1992.

32. Bowker, L. Analysis of NO3 in Wells of Los Osos. Unpublished Manuscript. March 11, 1991.

33. Engle, P. and F. Freiler. Analysis of the Baywood Park Groundwater Study: Data from 1950 through 1993. Unpublished Manuscript. July 4, 1994.

34. Los Osos/Baywood Park Soil and Groundwater Nitrogen Study. Raw Data Report. January 1994.

35. Technical Advisory Committee. Los Osos/Baywood Park Nitrogen Study. Prepared for the County of San Luis Obispo. July 1994.

36. Reinhorm, T. and Y. Avnimelech. Nitrogen Release Associated with the Decrease in Soil Organic Matter in Newly Cultivated Soils. Journal of Environmental Quality 3: 118-121, 1974.

37. Spalding, R.F., J.R. Gormly, B.H. Curtiss, and M.E. Exner. Nonpoint Nitrate Contamination of Groundwater in Merrick County, Nebraska. Ground Water. 16: 86-95, 1978.

REFERENCES (Continued)

38. Spalding, R.F., M.E. Exner, C.W. Lindau, and D.W. Eaton. Investigation of Sources of Groundwater Nitrate Contamination in the Burbank-Wallula Area of Washington, USA. Journal of Hydrology 58:307-324. 1982.

39. Klein, C. and C.S. Hurlbut, Jr. Manual of Mineralogy, 10th Edition. New York, Wiley & Sons. 1977.

40. Bouchard, D.C., M.K. Williams and R.Y. Surampalli. Nitrate Contamination of Groundwater: Sources and Potential Health Effects. Journal of the American Water Works Association. 84:85-90, September 1992.

41. Rolston, D.E., et al. Field Measurement of Denitrification: III. Rates During Irrigation Cycles. Soil Science Society of America Journal. 1982.

42. Lemoine, K. Memo to Metcalf & Eddy. June 15, 1994.

43. Rolston, D.E. et al. Identification and Evaluation of Methods for Determining Sources of Nitrate Contamination in Groundwater: Guidance Manual. California Water Resources Control Board and Regional Water Quality Control Board, Central Coast Region. Davis, June 30, 1994.

44. Lemoine, K. Personal Communication. June 1994.

45. USEPA. Manual - Nitrogen Control EPA/625/R-93-010. Washington, DC. September 1993.

46. Winneberger, J.H.T. Nitrogen, Public Health, and the Environment: Some Tools for Critical Thought. Boston, Ann Arbor Science. 1982.

47. National Academy of Science. Accumulation of Nitrate. Washington, DC. 1972.

48. U.S. Department of Agriculture. Soil Conservation Service, Soil Survey of San Luis Obispo County. Coastal Part. September 1984.

49. San Luis Obispo County Planning Department. Estero Area Plan Update. Land Use Survey & Buildout Projections. Draft Background Report. June 1994.

50. Gregory, Jerry. Personal Communications. February-March 1994.

51. Ross, Glenn. Personal Communication. March 3, 1994.

REFERENCES (Continued)

52. Freiler, Frank. Personal Communication. March 3, 1994.

53. San Luis Obispo County Department of Building and Planning. Private Sewage Disposal System. Information Bulletin.

54. International Association of Plumbing and Mechanical Officials. Uniform Plumbing Code. 1991 Edition.

55. USEPA. Design Manual: Onsite Wastewater Treatment & Disposal Systems. EPA-625/1-80-012. 1980.

56. Metcalf & Eddy. Wastewater Engineering: Treatment, Disposal, Reuse. Third Edition. McGraw Hill. 1991.

57. Winneberger, J.H.T. Septic Tank Systems. A Consultant's Toolkit. Boston, Ann Arbor Science. 1984.

58. Kaplan, O.B. Septic Systems Handbook. Second Edition. Lewis Publishers, 1991.

59. Water Environment Federation. Natural Systems for Wastewater Treatment. Manual of Practice FD-16. Alexandria, Virginia. 1990.

60. Otis, R.J. Site Evaluation. Onsite Treatment and Disposal. USEPA Small Waste Flows Clearinghouse. WWBLDM12. Charleston, West Virginia. Undated.

61. Baiamonte, M. Personal Communication. September 8, 1994.

Preface to Appendix A

It is important for the reader of this report to understand the historical developments relative to the Los Osos/Baywood Park Alternative Technologies Review and Technical Advisory Committee (hereafter referred to as the TAC). The role and responsibility of the TAC was spelled out in a Resolution approved by the Board of Supervisors and in a County contract with the engineering firm Metcalf and Eddy. That is; "the TAC is to reflect the interests of the Los Osos/Baywood Park Community and to assure the overall objectivity of the Alternative Technologies Review as conducted by Metcalf and Eddy ("Consultant"). The TAC will assist, advise, monitor and confer with the Consultant and the County on the issues and findings, in each and every phase of work related to the Alternative Technologies Review as provided in the scope of work of Amendment No. 2 of the Metcalf and Eddy Consulting Contract for the Los Osos/Baywood Park Sewer System Project." This is quoted directly from the Board's Resolution in regard to the M&E contract.

The various members of the TAC include 8 official members representing the County Services Area 9, the Los Osos Chamber of Commerce, the Blue Ribbon Committee, and the Citizens for Affordable Waste Water Systems. In aggregate, the members of the TAC represent a wide diversity of talent and expertise covering all facets of the report dealing with Task F. The reader is encouraged to examine the page in the front of the Metcalf and Eddy report where the various TAC members are identified along with their professional affiliations.

The TAC Committee members collected and cataloged all available reports and databases regarding the water quality in the Los Osos Basin over the last forty years. Copies of our extensive TAC library were made available to Metcalf and Eddy. Members of the TAC in conjunction with volunteers from the Blue Ribbon Committee donated their time and energy to develop a questionnaire for the Sanitary Survey. Metcalf and Eddy reviewed and evaluated this questionnaire before circulation. TAC and Blue Ribbon Committee volunteers went door to door to administer the questionnaire throughout the community of Los Osos. Other volunteers entered all of the data into a computer database. This computer database file was provided to Metcalf and Eddy for analysis of wastewater problems as recommended by the United States Environmental Protection Agency and stipulated in the consultant's contract.

A total of 66 public weekly meetings of the TAC have been held to date. The TAC has communicated by telephone conference call with Metcalf and Eddy on a biweekly schedule. In addition, a member of the County Engineering staff has attended almost every meeting of the TAC.

The TAC believes that Metcalf and Eddy ignored many of the available reports and databases which were made available to them. The TAC members spent many meetings reviewing the initial draft of Metcalf and Eddy's Task F.4 report which resulted in the submittal of a revised draft report by M&E. Only a few TAC comments were accepted by Metcalf and Eddy for inclusion in the revised Draft Report. Unfortunately, the revised Draft report did not address the extensive comments, suggestions and critiques suggested by the TAC and only a limited number will have been incorporated into the Final Task F.4 Report. As a result of Metcalf and Eddy's rejection of the TAC's major concerns, the TAC decided that an accurate assessment of the water quality situation in Los Osos required extensive written comments and further critique for inclusion within the Final Task F.4 Report.

The TAC has therefore reviewed and analyzed the two draft reports and has included written comments which will appear as Appendix A in the final Metcalf and Eddy report. Many of the TAC's comments are based upon our original analysis and development of available data which was rejected or not used by Metcalf and Eddy. Examination of additional factors affecting; nitrogen mass loading, lot size limitations, evaluation of the statistical interpretations of Nitrate concentrations and Sanitary Survey and Permit/Complaint data is presented, for the readers analysis and understanding, as Appendix A.

The Appendix A contains these comments and critique along with additional points of clarification to present the concerns of the TAC. The TAC feels that the comments of this Committee must be studied and understood fully. Ignoring the information in this Appendix A may lead to a very poor overall evaluation of the next step in the process, namely the development of the various wastewater treatment alternatives in Task G.

In conclusion, the TAC strongly disagrees with all of the statistical interpretations, nitrogen mass loading calculations, and the interpretation of lot sizes for conventional on-site systems developed in Metcalf and Eddy's report. This has resulted in findings and conclusions, which the TAC believes, are inaccurate and may affect the next phase of the consultants work, that is, the recommendation for alternative wastewater treatment systems.

Introduction

Appendix A has been compiled by the Technical Advisory Committee in order to inform the reader of the scientific facts supporting the differences in opinion between the Technical Advisory Committee (TAC) and Metcalf & Eddy, the consultant. The members of the TAC, appointed by the San Luis Obispo Board of Supervisors to represent the interests of the Los Osos community, have meticulously reviewed the two draft reports submitted by Metcalf & Eddy in June and October of 1994. Detailed written comments, questions and suggestions were forwarded to Metcalf & Eddy to ensure a comprehensive and accurate report. The consultants response to the TAC's reports was viewed as inadequate by the committee.

The members of the TAC, with professional backgrounds in engineering, finance, architecture, statistics, law, hydrogeology, contracting, real estate, wastewater technologies and soil science, unanimously voted to compile a detailed review of Metcalf & Eddy's report highlighting the problems. The TAC has written this review as provided in the Metcalf & Eddy Professional Services Contract and as dictated by the Resolution from the Board of Supervisors creating the TAC.

Disagreements have been handled as follows:

1. Differences in opinion will be listed at the end of the Executive Summary.

2. Braces { } are placed within each chapter to alert the reader to the end of chapter-comments about differences in opinion between Metcalf & Eddy and the TAC.

3. End-of-Chapter Comments are found at the end of each chapter and will give the reader a brief description of each disagreement.

4. Appendix Comments will be found in Appendix A of the report. These comments describe and detail the specific scientific and technical factors which the TAC uses to support its opinions, summary and conclusions.

A great deal of time, effort and knowledge have been incorporated into Appendix A. The TAC requests that the reader carefully compare the scientific methods and analysis which are presented in Appendix A with the Metcalf & Eddy report.

Understanding the nature of the "problem" is the key to realizing a solution. The proposed recommendation by the TAC would, if implemented, decrease the nitrate concentrations in the ground water basin, lower high ground water levels and ensure the proper operation of septic systems through a wastewater maintenance district. The TAC believes that the conclusions and recommendations which immediately follow this introduction are supported scientifically and will provide the basis for implementing solutions which will minimize the fiscal impact to the Los Osos community and solve the waste water dilemma.

Conclusions of the TAC

1) The TAC has reviewed the available well data and concludes that most of the shallow ground water basin is of high quality and meets all state standards for drinking water. Although samples of a few isolated shallow groundwater monitoring wells have sporadically exhibited elevated levels of nitrates, our review indicates that these elevated nitrate levels have no connection to on-site septic systems. The TAC concludes that the major contributor of nitrates in the basin is natural sources of nitrogen.

2) The TAC has collected and reviewed the Sanitary Survey Data. These data indicate that few physical problems were identified and that most of the existing on-site systems are functioning properly. However, the Sanitary Survey Data and the County Building Permit Logs indicate some isolated areas and a few clusters within the community that have a history of higher incidence of onsite system problems. TAC research has shown that these particular areas are also subject to problems often associated with high ground water and flooding.

3) After reviewing the On-Site Septic System design requirements, the TAC concludes that most lots in Los Osos are of sufficient size to support on-site systems that comply with County construction regulations and State discharge requirements.

(4) The TAC concludes that implementation of the RWQCB's Basin Plan could define the appropriate clearance to the ground water and validate the continued use of smaller lot sizes. The Basin Plan limit of 80 grams total nitrogen per day per acre can be used to establish a quantitative requirement for nitrate loading and nitrate denitrification.

Recommendations by the TAC

The TAC believes that by implementing the following recommendations, the community of Los Osos will efficiently and economically insure compliance with all present water quality concerns and that these measures will protect our water resources well into the future.

1) The TAC recommends that regions within Los Osos should continue to be served by on-site septic systems, with proper use and maintenance insured by the formation of a Septic System Maintenance District.

2) For those few areas that are inappropriate for the use of on-site systems due to insufficient depth to ground water and or insufficient total lot area, the TAC recommends that each of these areas be further evaluated for possible system modifications or new system installations.

3) In order to manage the shallow ground water basin properly and to alleviate problems associated with high ground water, the TAC recommends that special pumping wells be installed in shallow ground water areas. The TAC believes that extracting shallow ground water, treating it to remove nitrates, and then using this treated water within the community will reduce the basin nitrate levels, reduce the high ground water problem and enable the community to increase the sustainable yield from the basin's deep aquifer. Evaluation of the Basin Plan to establish if this alternative solution is viable and legal is a prerequisite to the implementation of this approach.

4) The TAC recommends the formation of a Watershed Basin District with the specific goal of overseeing water issues to include and not be limited to, surface drainage, waste water disposal, aquifer recharge, domestic well production for municipal and agricultural purposes, and shallow ground water usage.

5) The TAC recommends that the specific alternative technology review (consultant Task G.) be completed in a manner which incorporates these recommendations.

Table of Contents

<u>Technical Advisory Committee Figures & Tables</u>

Appendix A

Nitrate Limits - Nitrate Sources - Nitrate Loading-
Mass Balance - Statistical Analysis -
Lot Size and Dwelling Density
Sanitary Survey and Permit/Complaint Review

Comments to Chapter 1

Nitrate Legal Limits
Chapter 1, page 3

{A 1.1 } Establishing the required concentration limit of nitrate and the amount of denitrification is essential in solving the Los Osos waste water problem with the best "alternative". On page 1-3, Metcalf and Eddy suggests that the RWQCB issued discharge limits of nitrite for effluent to not exceed 5 mg/L. Limits were never adopted by the RWQCB.

Chapter 1, page 5

{A 1.1 } On page 1-5, Metcalf & Eddy state the nitrogen limit which, is half of the MCL of 10 Mg/L (as nitrogen), could be changed subject to engineering justification. This is a very important error because a low nitrate limit will have a very limiting effect on the alternates the TAC can consider.

There has not been a nitrate limit established for the septic tank effluent (water) in the soil vadose (unsaturated) zone located under the leach field before reaching the ground water. The limit of 5mg/L and 10 mg/L was taken in error from a letter dated July 15, 1992 from Bill Leonard, past Executive Director of the California Regional Water Board staff [9], to District 2 Supervisor Bud Laurent. These limits clearly apply to the discharge from the treatment facility of the proposed Los Osos conventional sewer when discharging to Los Osos Creek. Even these limits, which are creek discharge limits and not vadose zone limits. are limits which were only proposed by the Water Board staff and were not approved or adopted by the Regional Water Board.

An approach used by the Water Board and other agencies to establish the vadose effluent limit is to prohibit levels of Nitrate concentrations in the effluent higher than those in the ground water. The Los Osos/Baywood Park Nitrate Test shows concentrations as high as 55 mg/L, which means the effluent level could be 54 mg/L or less. The latest RWQCB Basin Plan-1989 [10] uses this approach on page IV-5. The Bill Leonard letter, referenced above also confirms this rule. [9]

Another legal approach for establishing nitrite concentration limits and the required performance of our waste water systems is to use the RWQCB's allowable nitrate loading per acre, per day. Nitrate loading limits and nitrate concentration limits are interrelated, but must be applied differently.

The current legal nitrate loading limit of a maximum of 80 grams of nitrate (as nitrogen) per acre per day from community on-site systems was established in 1983 as a part of Resolution 83-12.

This nitrate limit is stated on page IV-53, Paragraph 6 of the latest issue of the Water Quality Control Plan hereafter known as the Basin Plan.[10] The nitrate loading limit can be illustrated in terms of nitrate concentration by first assuming no denitrification in the vadose zone and then combining the nitrogen generated by each person per year (nine pounds per year 9#/yr.) in solution with 23,725 gallons of water (65 gallons per person per day) will produce a legal Nitrate concentration of 45.5 mg/L for the effluent being deliver to the leach field.

There is a precedent in which the Regional Water Board used this law in the original Los Osos prohibition area. Resolution 83-13 [10] defined a prohibition area as described in Fig. 10 in the Water Board Staff Report [6] and included all areas inside the Urban Reserve Line. Later, the Water Board studied a 76 acre tract with 183 homes and determined this tract could be removed from the prohibition zone and could continue to legally use their existing on-site septic systems. This subdivision is just south of the existing prohibition boundary with its wastewater effluent moving towards the community ground water basin. The calculation was based on 2.4 residences per acre, 2.5 people per residence and 9 lbs/capita/yr N (from EPA studies), this results in 67.2 grams per acre per day.

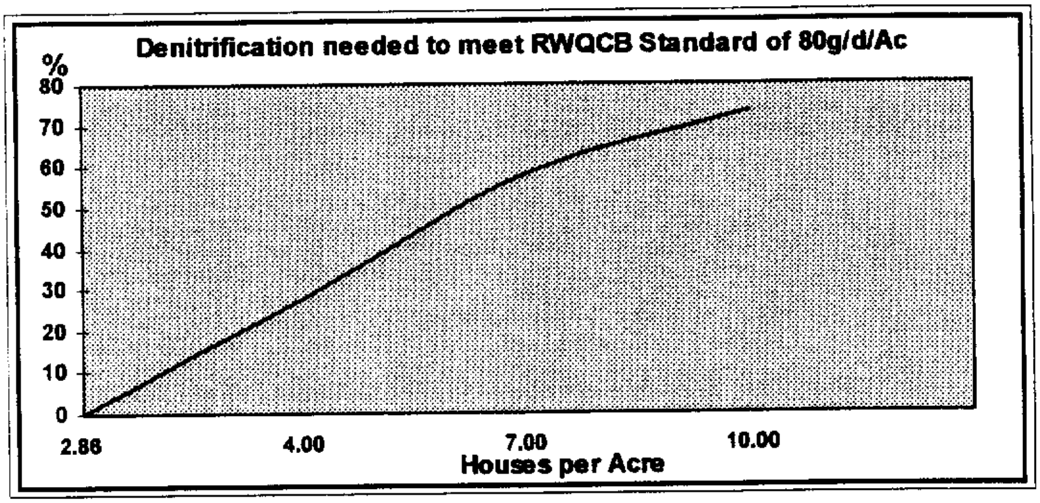
Resolution 83-12 and the Basin Plan should have been considered and used by Metcalf and Eddy in establishing the methods of compliance. The Basin Plan is required by the Porter-Cologne Law and is the dominating 'rule book' for solving our problems. The Basin Plan set the legal language for the imposition of the prohibition, the building moratorium, and the requirements resulting in the proposed sewer.

Metcalf & Eddy have not established a concentration limit or the amount of denitrification required under our leach systems, even though a legal concentration limit will be a dominating criteria in choosing wastewater treatment alternates. On numerous pages in this report (Chapter 4 p. 17/18, Chapter 5 p. 2/3 and Ex 6), Metcalf and Eddy has stated that, "the use of on-site systems in most of the community is not justified because the lots are too small and the depth to ground water is less than 30 feet." The TAC believes that this conclusion and associated findings by M&E are not supported by scientific or quantitative analysis.

Chapter 1, page 1-5

{A 1.1} The terms of resolution 83-12 define the permissible limits of nitrate-nitrogen discharged to the ground water as 80 grams per acre per day. Since this is directly related to the housing density, the chart below shows the percentage of denitrification needed to meet this criterion based on 9 pounds of nitrogen per capita per year and 2.5 people per house.

Figure A-1



Note: The chart above shows that:

The housing density requiring no denitrifications is . . . . . 2.86 houses/acre
Cabrillo Estates has a housing density of . . . . 2.41 houses/acre
The Urban Reserve density = 5178/3500 = 1.72 houses/acre

The limit of 80 grams, per acre. per day can be applied to the nitrate loading. For example, since 11.2 grams (N) per day is equivalent to 9 lbs. (N) per year the 2000 acres in the prohibition area would allow: 2000 X 7.15 (people per acre) x 9 Lbs.N/C/Yr) = 128,700 Lbs.(N) per year into the vadose zone from their septic systems.

Using the above criteria and 65 gals/c/d would result in a concentration level of 45 mg/l which would require no denitrification to meet the basin plan requirements for onsite wastewater systems. This is approximately the concentration found in the leach systems used in the Los Osos/ Baywood Nitrate Study and cited in the current report. (p1-16)

This means that discharges from current on site systems meet the current law as written in the Basin Plan and Resolution 83-12.

By using this law in areas with both high dwelling density (small lots) and high ground water levels, only 30% denitrification would be required in the vadose zone. Any amount over this limit from additional houses or other sources would have to be eliminated by some means such as denitrification. These calculations need only be applied to 30% of the prohibition zone or 626 acres in order for the attainment of acceptable loading limits. The reader should note that the RQWCB's Basin Plan contains rules which enable other methods of nitrate reduction and removal to be a applied with in the prohibition zone.

Note: The cited regulation does not discuss denitrification, which has been assumed to be absent when it was propounded. The erroneous criterion of 10 mg/l cited in this report by Metcalf and Eddy the denitrification required would be 77% and at 5 mg/l the denitrification would be 89%.

Comments to Chapter 3

Chapter 3, Page 3-1 ¶ 1

{A 3.1 } Sentences 1 and 2 above ignore the studies reported in References [34] and [35] which have made a study of the septic tank effluent and the ground water. The conclusions of these references are in opposition to the References which M&E have cited. However, M&E has not even indicated that any references offer an alternative viewpoint. *[M&E note: a reference to the Los Osos/Baywood Park Nitrogen Study [34,35] has been added after {A3.5}.]*

Chapter 3, Page 3-1 ¶2

{A 3.2 } The sentence by M&E stating "These studies have concluded that onsite septic systems are responsible for nitrate contamination in the shallow groundwater at Los Osos" is incomplete because it does not say that no cause and effect has ever been established for this location and that no data have directly been obtained at this location to connect the septic systems directly with the elevated levels of nitrate in the ground water.

Chapter 3, Page 3-1 ¶ 2

{A 3.3 } The sentence by M&E stating "Conclusions from these studies were based on professional judgments of the authors, observations of water quality in shallow wells, and/or results of modeling" is incorrect. The statement ignores the fact that they were based upon assumptions that the data examined had a cause and effect relationship which has never been established for this community. Modeling means building a model which can be testing it against real time data and testing against other sets of real time data.

Chapter 3, Page 3-1 ¶ 2

{A 3.4 } The M&E sentence "Some of these studies used a mass loading approach for nitrogen but did not account for denitrification in the soil and other nitrogen losses such as plant uptake and volatilization." The mass loading aspects must be recognized for what they are, only assumptions of what these loadings were. No data exist anywhere for actual field measured values of the mass of any of the nitrogen inputs or outputs for this system. Again, all "data" are derived from assumptions about what is happening. Unfortunately, the previous reports did not receive a careful critique. Also, they have not indicated in their reports when they were using hard verifiable facts and when they were using assumptions. It is all run together as if it were an established fact.

Chapter 3, Page 3-1 ¶3

{A 3.5 } The references cited at the very end "[3,4,20,21,22,23] are valuable." However, the references can not be expected to be transferred to any specific site without specific considerations for the unique nature of each site being evaluated.

Chapter 3, Page 3-2 ¶ 2

{A 3.6 } The first sentence stating, "Because subsurface processes cannot be directly observed as they occur, it is difficult to prove or disprove the onsite wastewater system effluent-groundwater nitrate connection" is the best sentence in this report. It must be repeated several times throughout and should be restated in the Executive Summary and in the Summary and Conclusions.

Chapter 3 page 3-3 Criteria #3 Nitrate Sources

{A 3.7 } Metcalf & Eddy states that to obtain the most representative picture of nitrate in shallow ground water over time, all available well data was screened for inclusion in the database using criteria which specified that wells be structurally intact and not subject to direct contamination from the surface as reported in [14]." TAC research of all of the observation wells used in the county monitoring program [14] indicates that monitoring wells consist of 1" to 2" diameter pipe with perforations in the ground water. These types of observation wells are normally designed for the observation of water levels. None of these wells has a sanitary seal and all are subject to surface contamination [ref. 15]. Four of the six wells cited by M&E on p3-10 are observation wells. Specifically, Brown and Caldwell recommend against using wells 13L5 and 13Q1 for monitoring because the low nitrate to Total Dissolved Solids (TDS) ratios indicated other sources of contamination. A drop in the ratio of Nitrate - nitrogen to chloride, Total Dissolved Solids (TDS) or Electrical Conductance (EC) is a sure indication of biological activity.

Chapter 3, Page 3-4 ¶ 4

{A 3.8 } None of the data sets used indicate the standard deviation expected for any given nitrate concentration value in the water. The analysis does not indicated when newer analysis methods or instruments were used with greater precision and accuracy of measurement. This makes a big difference in the interpretation of the validity of the various databases, but ignored in this report.

Chapter 3, Page 3-4 ¶ 1

{A 3.9 } The sentence "the data from these shallow wells should not be considered representative of the entire aquifer" is one of the most important statements made in this report. It must be repeated in the Executive Summary and in the Summary and Conclusions. M&E has an obligation to the readers to repeat this assumption and limitation for the use of this data elsewhere in the report.

Chapter 3, page 3-4, ¶4

{A3.10 } Although M&E acknowledges the "dubious quality" of the data collected prior to 1982, and suggest that "qualitative comparisons between pre-1982 and post-1982 data should be done with caution" (page 3-4), they proceed to base all of their arguments on the full 1950-1994 range of data. Never do they report any analysis on the 1982-1994 data set, which show no change in nitrate levels over time ($r=.07$), in contrast to the correlation of $r=.38$ (according to M&E, $r=.40$) over the entire time period. (reference No. 33)

Chapter 3, page 3-5 Figure 3-1

{A 3.11 } M&E implies that nitrates are caused by the population increase but the population continued to increase during years when the nitrate levels went to nearly zero about 1968 and was significantly lower in 1978-1979. The TAC believes an explanation is necessary.

Chapter 3, page 3-6, ¶1 and ¶2

{A 3.12 } The disadvantage of using the median is that it does not consider the magnitude of all the data, using only the 'middle' value where the statistical properties are not as well known. If extreme values are considered to be a problem, then use of a trimmed mean should have been considered.

M&E has used the mean of all the nitrate readings in a year to compare with time and population in spite of the increased number of data readings in "suspect areas" during the later monitoring period. A better analysis would correlate individual sites with time and population (if population estimates of well vicinity could be made). This would reflect more accurately the dependency of nitrate concentration on time and population and would also be able to identify specific problem areas within the community.

Chapter 3, page 3-6 ¶2

{A 3.13 } Much of the report dwells upon a presumed statistical analysis of the well data. They report only half of the statistics. They use correlation coefficients which are intended to assess the degree of scatter in points about a trend line. The real trends are represented by the other half of the statistics which Metcalf and Eddy failed to present in this report. The needed information which was obviously generated by their modern computer programs was the regression equation which would provide the slope of the trend lines. By examining the slope of these trend lines one can determine on a statistical basis whether the well data are changing over time. The use of the correlation coefficient can not provide this information. However, Metcalf and Eddy have purported to use statistics in a new way to state that the correlation coefficients explain things that they can not scientifically do.

Chapter 3, Page 3-6 ¶ 3 last line

{A 3.14 } The sentence "a r value between +1.0 and 0 (or between -1.0 and 0) represents some degree of correlation less than perfect and suggests that there may be a trend between the variables." The TAC believes the first half of this statement is statistically correct. However, the second phrase starting with "...and suggests..." is entirely incorrect statistically. First, the correlation coefficient r means very little without the associated regression equation which appears no where in this report. In addition, it is not clear whether strictly linear regression or whether multiple regression was used on these data. Again, no information are presented and therefore the value of looking only at the correlation coefficient r is almost worthless. Also, just because two values are related to nitrate-N does not mean that they are related to one another. However, M&E has tried to twist statistics to attempt to illustrate something which they do not relate. The text suggests that a researcher can establish some "trend" by examining the correlation coefficients from two different relationships. A correlation coefficients (r value) applies only to the data set which had a regression and correlation performed on it. In this study two different data sets were subjected to regression and correlation statistics. Regardless of what the values of r were for either of these data sets, one can make no inference regarding any relationship among the two data sets if one knows the first data set and expects to relate it to the second data set. This is a complete misunderstanding and misrepresentation of a valuable statistical parameter.

Chapter 3, Page 3-6 ¶4

{A 3.15 } The M&E sentence, "In other words, the regression analysis suggests that nitrate concentrations are increasing with time and population but that the data exhibit much scatter." The TAC finds no regression equation or regression analysis has been provided with this data analysis in this report. The reader must notice the slight of hand from the previous sentence where the author carefully used the word "or" and this sentence where the word "and" has been substituted in its place. The word "or" should have been used in this second sentence as well as the first one. *[M&E note: the second "and" has been changed to "or."]* The linear regression should not have been calculated on the 'mean values'. The original data should have been used. Using the mean obscures the variation inherent in the data set and may lead to erroneous interpretation.

Chapter 3, page 3-8, Figure 3-2

{A 3.16 } The M&E sentence, "A plot of all nitrate data is provided in Figure 3-2......" The correlation coefficient, r, is +0.40." There is no indication of the regression line and no assessment of the degree of significance of this regression is not known. The fact that using only the mean values generated a correlation which was significant at the 99% level does not mean that the correlation and regression for all the data will even be significant at the 50% level. The data here say more by what is not said than what is said. The r value of +0.40 reported on page 3-7 paragraph 2 translates to an r2 of .16. The interpretation is that there is a positive correlation between nitrate levels and population but that the relationship is weak, accounting for only 16% of the variability in the data. Correlation coefficients vary between -1 and +1. They are used to measure how much one variable depends linearly on another variable. If r=0, then the two variables are considered to have no relation or be random with respect to one another. The amount of linear dependency between the two variables increase as |r| (absolute value of r) gets close to 1. The value r is a test of the hypothesis that "There is no linear dependency between the two variables." A value of r=.4 would be significant in denying that hypothesis, but it would not indicate a very great degree of dependency between the two variables. In fact the coefficient of determination, r2, tells what proportion of the viability of one variable can be attributed to the other variable. M&E correctly report that the correlations that they found between nitrate and population (r=.471) and between nitrate and time (r-.439) indicate that these relations have less than a .1% of being random. What they omit is that population only accounts for 22.2% of the variability in the nitrate concentration, while time accounts for only 19.3%. M&E does not address the question of what other factors can account for the variability of the nitrates.

Chapter 3, page 3-8 Figure 3-2

{A 3.17 } The TAC questions the significance of so many data points close to zero. Also, looking at the wide distribution of points one is very hard pressed to find any trend in the data. M&E has failed to provide any explanation as to why there are obvious gaps in the data for 1980 and about 1986.

Chapter 3, Page 3-7 ¶ 4

{A 3.18 } The M&E sentence, "The actual r value for nitrate concentrations and population was found to be +0.471 and for the nitrate and year, +0.439. These are obviously not perfect correlations, but indicate that some trend is present." The TAC believes that again, no regression line is cited and the level of significance of the data are not indicated. Such low correlation coefficients suggests that the level of significance is probably less than 50%. If the correlation coefficient was 0.0 it would mean that the points were approximately randomly distributed about any line drawn through these points. As the report indicates, a correlation coefficient of 1.0 would mean that all points fell directly on the line. Since the reported correlation coefficients are so low it is difficult to see how anyone can conclude that this represents "...some trend is present." This is as bad as to suggest a trend exists if one tries to correlate the number of sex crimes in Nome, Alaska with the number of hot dogs sold at Disneyland during a typical year. Even if these data sets had a trend, there is little reason to expect that a trend can be translated into a cause and effect relationship.

Chapter 3, Page 3-7 ¶ 4

{A 3.19 } The M&E sentence, "Furthermore, the correlations are statistically significant at the 0.001 level, which means that the probability that the correlation was a random, chance occurrence is less than 0.1%." is questioned by the TAC. Again, no regression equation is provided. It is not clear whether simple linear regression or multiple regression was used. The TAC suspects that it was the latter to have such a high reported significance level to the data. If these data were so significant and so highly correlated as M&E indicates that Dr. Bowker found, then why did Metcalf & Eddy not attempt to repeat and verify these data? Was there a problem with Dr. Bowker's statistics? Did Metcalf & Eddy not understand what Dr. Bowker actually did? If multiple regression was used, then the interpretation of 0.1% may be totally unjustified from the data.

Chapter 3, Page 3-9 ¶ 3

{A 3.20 } The M&E sentence, "As will be demonstrated later in this report, these are not major sources of nitrate." This report must begin to be honest about what it did and did not measure. In no way did it measure any number in the field or in the soil of Los Osos regarding the claims made in this sentence. The statement that these are NOT major sources is purely conjecture based upon guesses regarding the magnitude of various sources. It also dismisses out of hand the possibility of other sources of nitrate which were NOT mentioned by the authors of reference [33]. No data have been indicated for median or mean nitrate concentration with area of the community. Such data would help to clarify whether the hypotheses set forward by the authors of reference [33] have any legitimate possibility. The analysis of the current report fails to substantiate or refute these hypotheses in any statistical manner.

Chapter 3, Page 3-9 ¶4

{A 3.21 } The M&E sentence, "The existence of any positive, statistically significant correlation in these data-even though they are "noisy"-leads to the conclusion that there is a trend of generally increasing nitrate concentrations in shallow groundwater underlying Los Osos." The TAC believes that the previous comments above in the critique suggest that the statement made in this sentence is highly questionable. A clear, positive, statistically significant correlation is not apparent from the data especially since 1974. The M&E statement, "This analysis applies only to the study area as a whole; some local areas do not experience rises in nitrate concentrations but the overall trend in shallow groundwater is one of rising concentrations over time and as population increases." The TAC believes that the first clause is accurate. The second clause is interesting and highly informative. Some local areas DO NOT experience rises in nitrate concentration. Metcalf and Eddy have provided no explanation of how or why some areas have no rise in nitrate concentrations. Since the later contend that the nitrates are rising, they must explain how they fail to rise in these areas. Metcalf and Eddy's proposed mechanism of septic tanks as the source can not be turned off in some areas of the community and turned on in other areas. At the very least the impact of their argument is strongly weakened by the lack of explanation of this relationship. The third clause is a huge leap of faith which is NOT supported by the data. No statistical connection has actually been established between a direct linkage of time, population, and nitrate concentrations. In fact, a multiple regression including these three factors has never been reported in the current report or elsewhere. Neither has a measure of statistical covariance been reported for this data set. Therefore, no conclusion of any definite relationship of these three variables can be claimed with any degree of statistical certainty.

Chapter 3, Page 3-9 ¶ 4

{A 3.22 } The M&E statement, "This observation does not establish a causal link between rising nitrate concentrations and time or population. It does, however, suggest a connection between these parameters." The first sentence is absolutely true. No statistics even if highly significantly correlated can establish a cause and effect relationship. The second sentence can be nothing more than wishful thinking of Metcalf and Eddy. It is completely unfounded based upon the lack of any clear multiple regression or analysis of covariance of these two data sets. The second sentence also is the exact antithesis of the first sentence. Thus, these two statements negate each others meaning. One can not have it both ways in the same breath. *[M&E note: the second sentence has been revised to read "It does, however, suggest that these parameters may be related."]*

Chapter 3, Page 3-10 ¶ 1

{A 3.23 } The M&E sentence, "Although overall nitrate levels appear to be increasing, not every well in the area shows an increasing trend in nitrate concentration." The TAC believes again that no explanation is offered for why some wells do NOT show this "trend" which the authors continually persist in assuming. Failure to argue and explain both sides of their thesis strongly weakens what little credibility there may be in their hypothesis of the source of the nitrates being derived from septic tank effluent. Consequently, multiple samplings of one well (which may or may not be contaminated) provides little insight as to what is actually going on in the entire community. The data void of missing well data over time is dependent upon choices made by the County Engineering Department relative to what wells to continue monitoring. This leads to an obvious bias of the data in favor of those wells which they selected to follow most closely over time, rather than the unbiased approach of providing data on all wells on a regular basis.

Chapter 3, Page 3-10 ¶ 1

{A 3.24 } The M&E statement, "The remaining 16 wells had fewer than 10 data points and are not included in the trend analysis in this section." The TAC believes that the authors conveniently chose to exclude a set of data from 16 wells which may have included as many as 144 individual datum points simply because the number of measurements was too few. Does multiple sampling of one well make a datum point any more or less significant than one with fewer sampling times? This has not been established from the statistical analysis. Therefore, no valid statistical reason has been established for excluding these data from the trend analysis. What is the statistical analysis when these data are included. The readers deserve to see the statistical regression lines for both the inclusion and the exclusion of these data points.

Chapter 3, page 3-10

{A 3.25 } Differences between the correlations reported for the 1982-1994 data in Table 3-2 and the TAC's analysis for two wells (7Q1 and 7N1) are due to their removal of "anomalous values". In a careful examination of the actual data points, it is not at all clear why these particular points were eliminated. In each case, the elimination of the data points resulted in a significant correlation between time and nitrate levels, whereas when they were included, their correlation was not significant. Thus the issue of which data points are used has substantial effect on the final conclusion.

There are several concerns about this procedure. First, the presence of such values should raise the concern about the quality of all the these data. These values should not simply be excluded without a more careful analysis of why they are considered "anomalous". Second, if one were to remove data points because they did not appear to "fit", there are a number of other data points which are equally or more suspect, but which the authors does not choose to remove. For example, well 18J6 has one data point in 1993 which is 95mg/L, fully 55mg/L from the next nearest point (much farther than the average of about 10-15mg/L from the next nearest point for the "anomalous values") that was not eliminated. *[M&E note: the data point at March 1993 from Well 18J6 has been excluded as apparently anomalous--see footnote i in Table 3-2.]* The criteria for elimination of course is not the distance to the next nearest point, but it serves to illustrate the arbitrary nature of these removed values. Similarly, well 13L1 in 1987 has a value of 41.2 mg/L which is 26 mg/L from the next nearest value, well 13L5 has a value of approximately 176 mg/L which is more than 101.2 mg/L from the next nearest value, etc. There needs to be consistency in the elimination of these values or an inaccurate conclusion may be reached. Therefore, all values should be included as measured. The conclusion on page 3-1- would say, "Of the nine wells.......three (not five) have an upward trend, two show a downward trend, and four (not two) exhibit no discernible trend."

Chapter 3, Pages 3-10 and 3-11 Table 3-2

{A 3.26 } M&E's Table 3-2 has again used the word "trend" when no statistical relationship has been developed. This table fails completely to provide even one regression line for these data. Only by examining the slope value of the regression line can the reader begin to make any claims about the nature of the true rise of fall in any trend. If these trends are so strong and to highly significantly correlated, then let the reader see what they actually predict in terms of nitrate concentration for 1994 and for the year 2050 based upon these statistical regression lines. Placing all of the emphasis upon correlation coefficients ignores more than half of the data which is normally gained by doing a statistical analysis. Also, it hides the true relationships (if any) among the various data. In addition, it is not at all clear whether simple linear regression or whether multiple regression was used on these data. Multiple regression often will greatly improve the data analysis statistically, but it will generate completely ridiculous conclusions for the regression lines if one uses them to project either into the future or into the past very far. This table says more about what it does not say than what it does have to offer the reader in terms of understandable explanations. No explanation is provided for the failure of 10 of the 13 wells to show "a trend". If one is going to rest all of the rest of the report on three wells, then one has an obligation to resolve clearly the nature of the failure of 10 of the 13 wells to show "a trend" and also to explain what effect the other 16 excluded wells might have shown if they had been examined. Such convenient omissions are serious failures of this data analysis. The Y intercept (initial nitrate values) are missing because no regression equation has been included. What are these values moving from and what are they moving to in terms of nitrate concentration?

Chapter 3, Page 3-10 ¶ 3

{A 3.27 } The sentence, "In either time period, the wells with upward trends are primarily in Baywood Park and Cuesta-By-The-Sea, as shown in Figure 3-3." No mention is made that these observations would be consistent with the hypotheses 2 and 3 on page 3-9 from reference [33]. The TAC believes that this should be explained in the text.

Chapter 3, Page 3-14 **Mass Loading Calculations**

{A 3.28 } It should be noted that the 'Mass Balance' is a better analytical method than 'Mass loading' for predicting changes in conditions, because, by, using both sides of the equation, (input and out go) it is possible to develop a model and verify any assumptions made. However, this method is more costly in time and resources. In this study, we must accept most of the limitations for mass loading cited in Chapter 3. This calls for even greater care in developing criteria and refining estimates to arrive at valid conclusions. All available data must be used and subjected to the most careful scrutiny.

The calculations which follow have been made based on the M&E revised draft of this report dated October 1994. The TAC has been informed that M&E has made additional changes which have not been reviewed prior to publication. Consequently the input data may not reflect actual numbers found elsewhere in this final report, but the principles involved, the calculations and relative values are valid.

Table A-1 Revised Mass Loading Calculations

revised TABLE 3-3 MASS LOADING CALCULATIONS							
		Total Applied Nitrogen		Total N after losses	Denitrification factor	Nitrateas N (rounded)	% contribution
source	no/unit population	#/unit/yr.	#/yr.	#/yr		#/yr	
On site system effluent	14,377 pop.	9.0	129,400	129,400	0.83	22,000	15
Natural	18,000 ac.	5#	90,000	90,000	0	90,000	62
Agricultural fertilizers	237 ac	150	35,600	8,200	0	8,200	5.6
Horticulture fertilizers	350 ac	150	52,500	12,000	.2	9,700	6.7
Horse waste	200 horses	110	22,000	11,000	.3	7,700	5.3
Dog waste	4,400	2.9	12,700	1,460	.2	1,000	0.7
Cat Waste	6,600	1.4	9,500	1,090	.2	700	0.5
Soil disturbance	62	-	-	5,000	.2	4,000	2.6
Weed Abatement	150	-	-	3,000	.2	2,400	1.6
TOTAL				261,200		145,700	100

The TAC believes that Table A-1 (revision of Table 3-3 in the revised report) more accurately reflects the relative contributions to the nitrate loading as explained in the following analyses. The method used by M&E for arriving at the pounds of Nitrogen discharged through the septic systems is a very convoluted. It requires:

(1) estimating nitrate concentration in mg/L,

(2) estimating flow volumes through the septic systems either by estimating in house use, or by estimating % in house use.

(3) defining several parameters to calculate the DUE.

Chapter 3, Page 3-14 ¶ 1

{A 3.29 } The sentence, "The analytical method used to identify and quantify nitrate sources on a basin-wide scale is mass loading." This statement fails to explain to the reader several very important facts about this "analytical method". One is left with the impression that something was actually analyzed in this process. It must be made perfectly clear to the reader that at no time was any measurement made in the field for any of the nitrogen values which appear in this entire section under the heading Nitrate Mass Loading. It must be made very clear that in the absence of such actual measurements, all datum inputs are guesses.

The TAC was under the impression that an agreement had been reached to use the conservatively high (since it assumes use of garbage disposers which add a 25% increase) figure of 8.5 #/c/yr. as the human contribution to the individual septic systems. This method is direct and requires only a population figure to calculate the total.

Population of the Urban Reserve from 1990 census = 14,377
14,377 x 9 = 129,400# of nitrate as N per year

not 191,000 pounds as shown in TABLE 3-3.

Assuming numbers in Table A-3 are correct for the current population, the calculations below show the actual occupancy for each of the several estimates of DUE. (See Appendix G-1 for comparison)

(Population/residential units) = occupancy/dwelling unit)

14,377/5,873 = 2.43 res/DUE (not 2.5)
14,377/6,100 = 2.35 res/DUE..
14,377/6,610 = 2.18 res/DUE
or
14,773/2.5 = 5,751 DUE (From Table A-3)

Listed in the M&E D-1 of the revised draft are 227 non residential dwelling units. Since no definition is provided, it is assumed that these are the same as shown in the cited reference. Without a better clarification that table takes into account all such establishments and any necessary allowances for differential use and concentration. Therefore the listing of reference "b" in the second column and the multiplier used in column 3 are duplications and should be removed from the calculation and the number of "DUEs" becomes 6036 not 6610.

Non residential commercial establishments, If we accept the B&C figures of 178, the multiplier of approximately 3 is clear evidence of a lack of understanding of the mathematics of the situation. To use the argument used by the school board; all of the people using waste facilities in those establishments live within the community. Far more people go out of the community each day to shop and work or to school in Morro Bay or the colleges than come into the community for any reason; probably by a factor of 200 to one. Therefor adding a population equivalent of 1375 is certainly stretching things a little far. With the exception of approximately 29 food preparation establishments and a half dozen garages, non of these commercial establishments should be counted at all. This is still a conservative estimate.

Table A-3 Dwelling Unit Equivalents (Revised D-1)

Table A-3 (a) DWELLING UNIT EQUIVALENTS (revised D-1)			
Land Use Designation	Number of dwelling units (b)	No. of Commerial Est. with increased flows	Number of dwelling unit equivalents
Residential	--	--	5869
Single Family	5186	--	--
Multi Family	683	--	--
Nonresidential: .33 of normal flows (c)	--	--	--
Office and Professional	90	--	27
Commercial: Retail	40	--	12
Motel rooms	48	--	14.4
Commercial Service	38	--	11.4
Nonresidentail: increased flows(d)			
Restaurants	--	29	87
Public Facilities	--	2	12
Total	**6085**	**31**	**6032.8**

Land Use Designation	Type of Use
Office and Professional	Real Estate, Medical Offices, Insurance, Law, Consulting
Commercial Retail	Markets(1), Drug Stores(3), Liquer Stores (3) Clothing, Hardware(2),
Commercial Service	Auto Service, Manufacturing, Cabinet, Rental
Restaurants	Take-out(11), Sit-down(18)

(a) Revised by TAC using Estero Area Plan Update, Background Report. June 1994. Table A-A

(b) San Luis Obispo County Planning Depart, Estero Area Plan Update, Appendix Part I Summary Tables Existing Dwelling Unit and Population Buildout. Background Report. June 1994. Table A-A

(c) Nonresidential flows reduced to 33% of residential flow due to absence of food disposal, washing machine or bathing loads.

(d) Based on nitrogen concentrations of effluent in nonresidentail wastewater as reported in Managnement of Small Waste Flows, EPA-600/2-78-173. U.S.EPA.,1978. Tables A012 and A-88.

Multiplying 5873 units x 2.5 x 9#/c/y = 132,800 #/yr.

This compares favorably with the figure of 129,400 #/yr. given above, adding for transient population at 400 #/yr., total applied Nitrogen

Nitrogen = 129,900 #/yr.

Applying the d factor n = .17

n = .17 x 129,900 #/yr. = 22,000#/yr.

Using DUE = 6036 (from table A-3)

6036 x (9 x 2.5) = 135,800#/yr.

135,800#/yr x .17 = 27,000 #/yr.

> ****Please note:** The authors of record of the Los Osos/Baywood Park Nitrogen Study do not accept the 67% denitrification figure from M & E as representing the results of that study since it ignores the data from Bayridge Estates. The calculations shown above were taken from the basic data presented in that nitrogen study. Consequently, the figure of 83% is much more appropriate for the actual percentage of nitrate- nitrogen which is denitrified in the Los Osos area.

Chapter 3 p 3-16 ¶1

{A 3.34 } The M&E evaluation of the data developed in the County's Los Osos/Baywood Park Nitrogen Study [35] lacks an understanding of the principles involved. The analysis which follows is the interpretation of the principal authors of that study of all of the data developed therein.

1. The 14th Street site provided a classical nitrification - denitrification pattern indicating maximum nitrification at 5 feet below the bottom of the leach pit and nearly complete denitrification at 5 feet below the point of maximum nitrification. (see figure 3-4B p-3-18) The average (mean) of all maximum nitrate values for 7 readings was 77 mg/l as N. The average of all of the minimum values recorded at 25 feet was 9 mg/l as N. This is an 88% reduction in nitrates not 84.6 % as recorded by M&E. The slope of the line is 13.5 mg/l/ft or 8.6%/ft

2. The 13th Street site was easy to interpret by projecting the nitrification and denitrification curves to a point of intersection. This produces a maximum nitrification of 82.5 mg/l as N at 22 feet or 7 feet below the bottom of the leach pit. (it should be noted that if the bottom of the leach pit were two feet lower this would match the 14th street data.)

Although The data for the point of maximum denitrification is less certain for reasons given below. The mean is 26.4 mg/l as N . This is a 68% reduction not 49.5% as recorded by M&E the slope of the line is 8 mg/l/ft (or 10%/ft)

****Note:** An examination of all the data for these two sites and the authors' comments shows that below 25 feet there seems to be some external factor which abruptly changes the slope of the line. At 14th Street the chlorides and Electrical Conductivity (EC) show systematic increases (200% at 30 feet and 100% more at

40 feet) while the nitrates remain relatively constant. Either some outside influence (not effluent) has affected the tests or the sampling methods may have introduced a systematic error increasing with depth. It is impossible to extract a sample by vacuum from a depth greater than about 25 feet. Therefore, the sample must be forced to the surface by air pressure .

This problem did not exist at the third site (Bayridge Estates) since the maximum depth used for the sampling lysimeters was 15 feet.

Chapter 3, Page 3-16 ¶ 1

{A 3.35 } The sentence, "A third site, Bayridge Estates, was also instrumented, but results from that site were not used because they lack repeatable patterns (Figure 3-4C), unlike the 13th and 14th Street sites that exhibit consistency over time." The author of reference [34] and [35] from which this work is taken and a member of the TAC challenges the validity of the assumption that the Bayridge Estates site was not consistent or repeatable over time. It was completely consistent with depth and over time. It had a great deal of variability at the 10 foot depth. However, this is not what Metcalf and Eddy has stated as being repeatable and consistent over time. The data were repeatable and consistent. It is true that the high degree of variation in the 10 foot depth data reflect the fact that the leach field was on and then off during different parts of the total time period of the study. This should be clearly explained here so that the reader is fully informed.

Chapter 3, Page 3-16 ¶ 1

{A 3.36 } The sentence, "The only interpretable results from the Bayridge Estates data is that effluent nitrogen is nearly completely converted to nitrate beneath the leach pit, which is also demonstrated at the other two sites." The author and the TAC agrees with the conclusion reached in this sentence as the second and third clauses of this sentence. The first clause is disagreed with. The data clearly support the interpretation of the disappearance of nitrate to very low values (well below the maximum contaminant level of 44 mg nitrate/L) and most values are nearly zero. This can easily be interpreted as a disappearance of nitrate presumably by the process of denitrification. This interpretation is explained in reference [35].

Chapter 3, Page 3-16 ¶ 2

{A 3.37 } The sentence, "The average nitrate loss in soil moisture in the first 10 feet under the leach pit was 41.5% for the 13th Street site and 84.6% for the 14th Street site. The average of both sites is 67% or 6.7% per foot for the first 10 feet." The first sentence completely ignores the nearly complete denitrification exhibited at the Bayridge estate as indicated in point number 32 above. It also suggests that somehow these values for denitrification were measured accurately to 3 significant values in the field. *[M&E note: the percentages have been changed to two significant values.]* It is very important that the reader is reminded at this point in time that these are calculated values based upon assumptions from the data set and are not in any way actual measured quantities in the field.

Regarding Bayridge Estates Test Site: It should be noted that sampling for nitrate transformations at all three sites was done on the same seven dates. In addition, during the tracer studies at Bayridge at the end of 1993, four additional samples were taken to find the tracer. Although they were analyzed for nitrate, these samples were probably corrupted by the presence of other ions in the potassium bromide which was used as the tracer. Therefore, these data have been rejected as a part of the nitrate evaluation which should be restricted to the seven scheduled sampling dates.

Using the data for the dates and techniques shown above generates the following:

The maximum nitrate values for the same dates used above average 75 mg/l at 10 feet (6.5 feet below the discharge).
The minimum measured values for Nitrate-N at 5 feet below the maximum nitrification averaged 4 mg/l as N.
The reduction in nitrate-N is 94.7% in 5 feet
The slope of the line is 14.2 mg/l /ft. or 19 %/ft.

Chapter 3, Page 3-16 ¶2
{A 3.38 } Using these calculated figures for the three sites, the mean nitrate reduction is 83.6 % not 67% as reported by M & E or 12.5 %/ft. The mean rate of reduction is 11.9 mg/L/ft.

****Note: In the remainder of this Appendix the figure of 83 % will be used for denitrification because it more truly represents all of the data which are available for this community.**

Chapter 3, Page 3-20 ¶ 1
{A 3.39 } The M&E statement, "At these shallow groundwater areas, nitrate concentrations in effluent could exceed 200 mg/L as nitrate. It is possible that this "short-circuiting" of the soil denitrification zone may be responsible for the elevated levels of nitrate in groundwater at certain locations shown in Figure 1-2." These statements are purely conjecture. There is no evidence to support them from any scientific study. In fact, they are most probably exactly the opposite of what happens. This is based upon soil science research [see First--Broadbent, F.E. and Francis Clark. 1965. Denitrification. pages 344 to 359 in W.V. Bartholomew and Francis E. Clark (eds). Soil Nitrogen. American Society of Agronomy, Inc. Publisher, Madison, WI; Second-- Firestone, M.K. 1982. Biological denitrification. pages 289 to 326 in Frank J. Stevenson (ed.). Nitrogen in agricultural soils. American Society of Agronomy, Inc., Crop Science Society of

America, Inc. and Soil Science Society of America, Inc. Publisher, Madison, WI. and Third-- Patrick, W.H., Duane S. Mikkelsen, and B.R. Wells. 1985. Plant nutrient behavior in flooded soil. pages 197 to 228 in O.P. Engelstad. Fertilizer technology and use. Soil Science Society of America, Inc. Publisher, Madison, WI.]. This research indicates that denitrification can occur within a few inches in water-saturated rice soils. A somewhat similar situation exists in water saturated soils below septic tanks and leach fields. Because no valid data exist to support the conclusion made by Metcalf & Eddy and no valid data exist to support the suggestion that saturated soils under septic tanks will operate in a manner similar to flooded rice paddies, then either this conjecture should be removed entirely, or both hypotheses should be advanced as equally plausible. *[M&E note: the 200 mg/L has been changed to 100 mg/L as nitrate based on Figure 3-4B.]*

Chapter 3, Page 3-20 bullet 2

{A 3.40 } The statement, "Observed differences between nitrate concentrations in soil moisture and shallow groundwater may be due to nitrate loading from other on-site systems or to seasonal variations in performance of the vadose zone as a nitrogen treatment system due to variability in rainfall and/or effluent volume from onsite systems." This conclusion made by Metcalf & Eddy contains several parts. First, the suggestion that nitrates are coming from other onsite systems has no direct support from the monitored systems in the study of nitrates in Los Osos (see reference 35). The second hypothesis suggests seasonal or yearly variations. It is true that the study in reference [35] was run for only about 18 months. However, this was a relatively normal rainfall year. This important point to be made is that the data in reference [35] supports the conclusion that the pattern of nitrate concentration was consistent at each sampling depth and at each sampling time, at each of the three monitored sites. Thus, neither of the two conclusions reached in the sentence cited can be justified from the data. Because the nitrates were higher in the groundwater than were observed in the soil below the leach fields, one can conjecture many possible explanations which are as yet unproven.

Chapter 3, Page 3-20 last ¶

{A 3.41 } The M&E sentence, "In other words, the use of the above 67% factor means that 33% of the nitrogen from onsite system effluent is still reaching the groundwater as nitrate." It must be very clearly explained that this is a value derived from calculations of the data presented in reference [34} and [35]. This value was never actually measured directly. This is based upon several assumptions. Therefore, one can assume (with all of the attendant precautions) that 33% of the nitrogen based upon the other assumptions is still reaching the groundwater. However, no isotope data have either confirmed or denied whether indeed this is a fact or not. The suggestion (developed in reference [35]) is that the denitrification process may have been nearly complete above the ground water table. The problems include one of at least 5 foot intervals in the sampling protocol and limited sample sites in this zone of denitrification. The authors of the above referenced report (35) and this TAC believe that using all of the data, the denitrification value is 83%. *[M&E note: the sentence has been revised to read "...33% of the nitrogen from onsite system effluent may be reaching the groundwater as nitrate."*

Chapter 3, Page 3-21 ¶ 2

{A 3.42 } The position stated by M&E that, "This study is reviewed in Appendix I." The test conducted at the Lost Oaks Village as reported on page I-1 is of very limited use. It is a completely artificial test for too short of a period of time and I agree with Metcalf & Eddy regarding this study. I disagree with Metcalf & Eddy regarding their conclusion on page I-3 ¶2 Sentence 5 "The above preliminary assessment is not justified by the data and analyses in this reference." No data are actually provided that refute the findings of the reference 3 on the nitrogen isotope tests. This is the only data available on the possible nature of the nitrogen in the ground water. All other data from all other sources (and there are a lot of data) do not provide any single datum point which has been measured in this way to document the source of the nitrogen. Appendix I also fails to mention the existence of seven ground bore tests which the San Luis Obispo County Engineering Department conducted and data of which study were made available to Metcalf & Eddy. That data represents samples taken to 20 feet or more within the soils and vadose zones of the Los Osos community. The data clearly indicate that the nitrate values are decreasing with depth to nearly zero. In addition, an examination of the nitrate-N to chloride ratios for these samples with depth indicates that this ratio was decreasing. This indicates clearly that some biological process was active in the removal of nitrates in these vadose samples. This further supports the hypothesis of denitrification.

Nitrate Sources and Nitrate Loading

Chapter 3, Page 3-21 **Natural Sources**

{A 3.43 } An appreciable source of nitrogen in this community has been ignored in the above process to develop a mass loading. That source is biological nitrogen fixation. Various legume plants, such as clovers in lawns and peas in the garden, have root nodules with Rhizobium bacteria which fix nitrogen gas from the atmosphere and convert it into organic tissue. When this tissue dies and decays, the organic nitrogen is converted to ammonium, which in turn is converted into nitrate. The consequence of biological nitrogen fixation is the generation of miniature fertilizer factories in the lawn or garden. In addition, this particular area of California has an additional biological nitrogen fixation source. This is the presence of Ceanothus and other non-leguminous plants which have root nodules with Frankia actinomycetes that fix nitrogen in the same general manner as do legumes. The exact amount of fixation is unknown, but it is greater than zero. In some areas, home owners have chosen to landscape with this native plant. During the rainy season it can be noticed by the bright blue flower clusters on the dark green shrubs. Also, the native chaparral vegetation south of the town has a high proportion of Ceanothus. This may contribute to the overall mass loading of nitrate from natural sources to the ground water surrounding the community. This source has been ignored in the above calculations. It should be evaluated and assessed some value rather than zero.

Chapter 3, Page 3-21 last ¶

{A 3.44 } M&E cites the, "mean nitrate values from limited data from the 1950's." Since none of these figures included samples from wells such as the observation wells constructed later to a depths of 10 feet maximum into the water table (currently the highest NO3 producers) and since the cited reference is not taken from the local watershed , the figure of 5 #/ac/yr can only be accepted as a valid figure if other data is lacking. But other data is not lacking. Both the data referenced in paragraphs 2 and 3 on page 3-22 and the recently published Nitrate Study show that concentrations of nitrogen in the soil at the vados zone to be from 40mg/L to over 600 mg/L. Although in the upper 3 to 6 feet of the soil mantle evaporation and evapotranspiration may result in the higher numbers cited, it is very unlikely that they have any significant effect at depth where soil moisture content is as high as 24%.

This says that the annual rainfall or irrigation will carry these **evaporites** downward to the ground water along with the natural nitrates included in the 5#/acre figure used in other areas and will result in high concentrations at depth, unless inhibited by a barrier and or denitrification. Examination of the data in Table A-4, the Baywood Soils Analyses (7 Groundbore Tests), which was rejected by M&E, clearly shows that both of these processes are occuring.

The term Natural Sources should include all underflow from infiltration of rainfall throughout the watershed. This means 18,000 ac not 3,500 ac. Calculations should be provided to show what portions of the watershed are considered to contribute nitrates to the groundwater.

Using the figure from table 3-3 of 5#/ac/yr and multiplying this by 18000 Ac.

18000 Ac. x 5#/ ac/yr = 90,000#/yr.

equals 90,000 pounds per year from natural sources, rather than the 17,400 pounds as shown in Table 3-3

Chapter 3, page 3-22 ¶1 **Baywood Soil Analysis**

{A 3.45 } The data from the "Seven Ground Bore Tests" conducted in Los Osos by the county laboratory were dismissed summarily by Metcalf and Eddy and erroneous conclusions drawn from them without analysis. These data can be readily evaluated by the method used in the Los Osos nitrate study and described below. Had this been done different conclusions can be drawn which do not agree with those on page 3-22 or at the end of chapter 3.

Method

The moisture content of the cores was evaluated by the laboratory at various depths by the simple standard procedure of drying the core sample to determine the weight of water in each kilogram of soil, not as indicated on page 3-22. This moisture content is given in Table A-4 (column B) as percentage moisture as they were published (grams of water per 100 grams of dry soil). The grams of water per 100 grams of dry soil are then converted to kilograms of water (or liters) to kilograms of soil (column C).

All other parameters were then extracted from a solution of equal weights of water and dry soil. It then becomes a simple matter to relate concentrations of (nitrate-N) in this 100% solution (1 liter per kilogram of dry soil or 1 kilogram of dry soil per liter of water) to the concentration of the same dissolved solid in any other soil/water mixture. Clearly a given weight of nitrogen per kilogram of soil in the extract from this 100% solution would have. a much higher concentration in the lower moisture content of the original sample. Column "D" emphasizes this by showing the kilograms of soil needed to extract one liter (kilogram) of water. It also provides a multiplying factor to calculate the concentrations of each parameter in the original soil moisture.

TABLE A-4 shows this conversion for two parameters, nitrate-N and Electrical Conductance (EC) for each of the 138 samples analyzed in the study. In addition table A-4 is reproduced from the Los Osos Nitrate Study which was presented to the Board of supervisors in July 1994 but is not even mentioned in the current report except as raw data (ref. 34) from 39 samples taken in that study. TABLE A-5 is taken from the same report and is a copy of the laboratory data analyzed by Fruit Growers Laboratory . This table has a much more complete set of nitrogen cycle data, particularly the total nitrogen and Kjeldahl nitrogen values in relation to nitrate nitrogen numbers.

Electrical conductivity (EC) is used to represent the level of dissolved salts in water, and is reasonably accurate for waters which have similar chemical makeup which should be true for shallow waters in this basin. Normally additional anions and cations (particularly chloride) are sampled to allow determination of differences in character of the soil water and to indicate biological activity. Normally the Nitrate to chloride ratio is used as a clear indication of biological action; however in this situation the Nitrate-n to EC will work equally well. One limitation of both studies is that the very large amount of water used to extract the minerals reduced the precision of the results since the detection limits (in mg/l) remains constant. It is evident that less that 0.5 milligrams per kilogram (< 0.5 mg/kg) in these weak solutions does not mean zero or no ion present. Therefore in the tables the same convention has been retained using the less than (<) symbol to define the precision of these numbers. The data derived for concentrations near the detection limit related well to adjacent figures below the detection limits.

Although controlled to a degree by the detection limits in each case, in general the two sets of data agree reasonably well excepting as noted below. In general nitrogen levels are high in the top few feet of the soil column and become lower with depth. The Kjeldahl nitrogen figures in TABLE A-6 indicate much higher nitrogen levels (especially ammonium and Kjeldahl) at depth in the "native" and Park sites than in the vicinity of the septic systems used in that study with the exception of Bayridge Estates which, because it is large in area is potentially subject to surface runoff infiltration. Please remember that these numbers are expressed as mg/kg of dry soil not mg/L of soil moisture, which if converted to concentrations in soil moisture would be higher by a factor of ten or more.

Thus there is a tremendous reservoir of nitrogen within the undeveloped as well as the developed portion of the watershed tributary to the Los Osos ground water basin.

If we accept the lowest of these figures of 99 mg/kg (ppm) at the park site this is equivalent to 11,000 pounds per acre of watershed area waiting for the first highly oxygenated, slightly to highly acid rainfall to come begin the nitrification process and carry it down into the upper levels of the groundwater. Of course, only a small portion of this bulk of nitrogen will be nitrified, but this has been going on for thousands of years with extremely high values at the surface (700 mg/kg) reducing to less than 20% of that at 20 feet. The Nitrate study showed evidence that a significant population of the chaparral community of plants are capable of fixing nitrogen from the air, which may well be the original source.

43560 sq, ft./ac x 21feet depth = 915,000 cu ft;
@120#/cu. ft. /Ac. = 110 million #
110,000,000# x 100 mg/kg (ppm) = 11,000 #/acre of nitrogen in the soil.

Site 13L5 had very high nitrate-N levels in the soil solution near the surface. This value is 64 times the limit for drinking water and is very close to the 673 figure from the Nitrate Study at the native site.[35] All sampling levels down to 21 feet exceeded this public health level of nitrate-N in the soil solution. This would be the same water which would reach the ground water. As noted above the EC value for the soil solution can be extracted from the laboratory data and the Nitrate-N / EC ratio can be used to show biological activity. If the value of the nitrate-N / EC ratio increases it indicates that nitrification is taking place. If this ratio decreases it indicates a strong probability of nitrogen transformation by denitrification is taking place. If the ratio remains constant with depth even though nitrate-N is decreasing, it is a sure indication that no biological changes are taking place.

Site 13L5 showed nitrification and denitrification taking place within the top four feet of the soil column and again between 6 feet and 21 feet. A similar pattern occurred at the site 18B1 with nitrification and denitrification took place within the top foot of soil and again at 4.5 feet to 10.5 feet. The Bayridge Estate cores showed nitrification and denitrification between 6 and 12 feet in both studies. (**NOTE**: This is the only location in the seven ground bore study which was drilled in a leach field system.) The presence of this evidence in the cores at this site from the two studies and in the leachate at this site in the Nitrate study, confirms the pattern for this site. There is no native vegetation on the surface, only green grass which would tend to use rather than fix nitrogen. There is almost no nitrate-nitrogen at the surface and it rapidly increases to 11.5 feet then decreases to 12.5 feet clearly indicating nitrification denitrification. In the Nitrate Study, the ground water at this site varied between 18 and 54 mg /L.

TABLE A - 4

Baywood Soils Analyses(7 Groundbore Tests)

'Nitrate-Nitrogen concentrations in soil moisture in drill cores

A	B	C	D	E	F	G	H	I
Depth	Water	Water	Soil in Soln	NO3 as N	NO3 as N	EC (lab)	EC correct	N/ EC
Feet	%	L/kg	kg/L	mg/kg	mg/L	µmhos/cm	µmhos/cm	ratio*1000
				13L5				
0.5	2.3	0.023	43.5	2.1	91.3	44	1913	47.7
1	2	0.02	50.0	4.5	225	28	1400	160.7
1.5	2.3	0.023	43.5	14.7	639.1	39	1697	376.7
2	6.8	0.068	14.7	9.5	139.7	31	456	306.6
2.5	3.3	0.033	30.3	4.2	127.3	22	667	190.9
3	3.3	0.033	30.3	3.7	112.1	29	879	127.6
4	4.3	0.043	23.3	1.1	25.6	19	443	57.8
4.5	4.9	0.049	20.4	1.5	30.6	20	400	76.5
5	6.1	0.061	16.4	3.4	55.7	24	394	141.6
5.5	4.6	0.046	21.7	1.4	30.4	29	629	48.4
6	4.3	0.043	23.3	0.63	14.7	16	373	39.3
6.5	5.9	0.059	16.9	4.1	69.5	24	406	171.3
10.5	9.8	0.098	10.2	1.7	17.3	15	153	113.4
11	7.1	0.071	14.1	2.6	36.6	15	212	173.1
11.5	6.7	0.067	14.9	2.3	34.3	16	238	143.8
15.5	14.5	0.145	6.9	1.9	13.1	10	69	189.9
16	15.5	0.155	6.5	2.1	13.5	20	130	104.2
16.5	15.1	0.151	6.6	2.2	14.6	17	112	129.9
20.5	7.8	0.078	12.8	1.5	19.2	15	192	100.2
21	6.5	0.065	15.4	1.6	24.6	13	200	123
21.5	7.2	0.072	13.9	<0.5	<6.9	30	417	<16.7
				21D13				
Feet	%	L/kg	kg/L	mg/kg	mg/L	µmhos/cm	µmhos/cm	ratio*1000
0.5	10.5	0.105	9.5	4.7	44.8	110	1045	42.8
1	12	0.12	8.3	6.2	51.7	65	541	95.4
1.5	8	0.08	12.5	2.2	27.5	55	688	40.0
2	8.2	0.082	12.2	4.8	58.5	76	927	63.1
2.5	6.7	0.067	14.9	1.6	23.9	55	820	29.1
3	8.1	0.081	12.3	<0.5	<6.2	42	517	<11.9
3.5	7.2	0.072	13.9	<0.5	<6.9	35	487	<14.3
4	5.7	0.057	17.5	<0.5	<8.8	28	490	<17.9
4.5	6.2	0.062	16.1	<0.5	<8.1	27	435	<18.6
5	6.4	0.064	15.6	<0.5	<7.8	44	686	<11.4
5.5	7.2	0.072	13.9	<0.5	<6.9	30	417	<16.7
6	10.8	0.108	9.3	<0.5	<4.6	60	558	<8.3
10.5	18.1	0.181	5.5	<0.5	<2.8	60	330	<8.4
11	19.6	0.196	5.1	<0.5	<2.6	64	326	<7.8
11.5	24.2	0.242	4.1	<0.5	<2.1	61	250	<8.3
16	16.1	0.161	6.2	<0.5	<3.1	60	372	<8.3
16.5	18.4	0.184	5.4	<0.5	<2.7	57	308	<8.8
20.5	15.2	0.152	6.6	<0.5	<3.3	63	416	<7.9
21	16.6	0.166	6.0	0.6	3.6	53	318	11.4
21.5	17.2	0.172	5.8	<0.5	<2.9	57	331	<8.8

TABLE A-4 (continued)								
17F4								
Feet	%	L/kg	kg/L	mg/kg	mg/L	µmhos/cm	µmhos/cm	ratio*1000
0.5	10.5	0.105	9.5	9.8	93.3	41	391	238
1	12	0.12	8.3	8.3	69.2	31	258	268
1.5	3.1	0.031	32.3	<0.5	<16.1	64	2067	<7.8
2	4.7	0.047	21.3	7.7	163.8	54	1150	142.4
2.5	4.1	0.041	24.4	1.5	36.6	22	537	68.2
3	4.2	0.042	23.8	1.4	33.3	17	405	82.4
3.5	5.4	0.054	18.5	2.7	50	38	703	71.1
4	3.8	0.038	26.3	1.9	50	14	368	135.8
4.5	4.1	0.041	24.4	<0.5	<12.2	15	366	<33.3
5	5.8	0.058	17.2	<0.5	<8.6	17	292	<29.5
5.5	5.1	0.051	19.6	<0.5	<9.8	21	412	<23.8
6	5.1	0.051	19.6	<0.5	<9.8	17	333	<29.4
10.5	5.3	0.053	18.9	<0.5	<9.4	19	357	<26.4
11	10.4	0.104	9.6	<0.5	<4.8	26	250	<19.2
11.5	7.4	0.074	13.5	0.9	12.2	28	378	32.2
15.5	18.8	0.188	5.3	<0.5	<2.7	27	144	<18.5
16	18.8	0.188	5.3	<0.5	<2.7	21	112	<23.8
16.5	17.4	0.174	5.7	1	5.7	22	297	19.4
20.5	23.6	0.236	4.2	1	4.2	28	119	35.7
21	17.6	0.176	5.7	<0.5	<2.8	24	136	<20.8
21.5	16.6	0.166	6	<0.5	<3	24	144	<20.8
25.5	24.9	0.249	4	2.1	8.4	31	125	67.7
26	13	0.13	7.7	<0.5	<3.8	22	169	<22.7
26.5	7.8	0.078	12.8	<0.5	<6.4	19	243	<26.4
30.5	21.9	0.219	4.6	<0.5	<2.3	26	119	<19.2
31	23.3	0.233	4.3	<0.5	<2.1	24	103	<20.8
31.5	24.7	0.247	4	<0.5	<2	29	117	<17.2
35.6	20.5	0.205	4.9	<0.5	<2.4	30	146	<16.7
36	16.6	0.166	6	<0.5	<3	24	144	<20.8
36.5	16.8	0.168	6	<0.5	<3	24	143	<20.8
40.5	23.8	0.238	4.2	<0.5	<2.1	32	134	<15.6
41	19.1	0.191	5.2	<0.5	<2.6	25	131	<20.0
41.5	9.3	0.093	10.8	<0.5	<5.4	21	227	<23.7
18J6								
Feet	%	L/kg	kg/L	mg/kg	mg/L	µmhos/cm	µmhos/cm	ratio x 1000
0.5	5.2	0.052	19.2	<0.5	<9.6	100	1920	<5
1	4.5	0.045	22.2	1	22.2	80	1776	12.5
1.5	5.3	0.053	18.9	0.8	15.1	141	2665	5.7
2	8.2	0.082	12.2	<0.5	<6.1	133	1623	<3.8
2.5	4.6	0.046	21.7	0.53	11.5	229	4969	2.3
3	6.2	0.062	16.1	<0.5	<8.1	136	2190	<3.7
3.5	26.9	0.269	3.7	<0.5	<1.9	45	167	<11.2
4	21.8	0.218	4.6	<0.5	<2.3	103	474	<4.8
4.5	8.6	0.086	11.6	<0.5	<5.8	150	1740	<3.3
5	19.7	0.197	5.1	<0.5	<2.6	31	158	<19.0

TABLE A-4(Continued)								
18J6 continued								
Feet	%	L/kg	kg/L	mg/kg	mg/L	µmhos/cm	µmhos/cm	ratio*1000
11	21.7	0.217	4.6	<0.5	<2.3	30	138	<16.7
11.5	20.2	0.202	5	<0.5	<2.5	26	130	<19
15.5	11	0.11	9.1	<0.5	<4.5	27	246	<18.5
16	16.5	0.165	6.1	<0.5	<3	195	1190	<2.5
16.5	20.7	0.207	4.8	<0.5	<2.4	40	192	<12.6
18B1								
Feet	%	L/kg	kg/L	mg/kg	mg/L	µmhos/cm	µmhos/cm	ratio*1000
0.5	2.8	0.028	35.7	4.6	164.3	42	1499	109.6
1	2.3	0.023	43.5	<0.5	<21.7	38	1653	<13.2
1.5	0.9	0.009	111.1	<0.5	<55.6	59	6555	<8.5
2	2.2	0.022	45.5	0.51	23.2	17	774	30.0
2.5	1.9	0.019	52.6	1.9	100	24	1262	79.2
3	1.4	0.014	71.4	2.4	171.4	100	7140	24.0
3.5	3.4	0.034	29.4	1.5	44.1	79	2323	19.0
4	2.7	0.027	37	<0.5	<18.5	24	888	<20.9
4.5	2.3	0.023	43.5	<0.5	<21.7	21	914	<23.8
5	3.5	0.035	28.6	1	28.6	11	315	90.8
5.5	3.8	0.038	26.3	0.78	20.5	14	368	55.7
6	2.9	0.029	34.5	0.83	28.6	15	518	55.3
10.5	5.6	0.056	17.9	<0.5	<8.9	10	179	<49.9
11	5.2	0.052	19.2	<0.5	<9.6	15	288	<33.4
11.5	5.5	0.055	18.2	<0.5	<9.1	9	164	<55.5
Bayridge Estates								
Feet	* %	l/kg	kg/L	*mg/kg	mg/L	µmhos/cm	µmhos/cm	x1000
0.5	9.2	0.092	10.9	<0.5	<5.4	28	305	<17.8
1	17.8	0.178	5.6	0.97	5.4	77	433	12.6
2	7.1	0.071	14.1	<0.5	<7	31	443	<15.9
2.5	3.3	0.033	30.3	<0.5	<15.2	10	303	<50
3	4	0.04	25	<0.5	<12.5	18	450	<27.8
3.5	4.5	0.045	22.2	<0.5	<11.1	22	489	<22.8
4	3.8	0.038	26.3	<0.5	<13.2	19	500	<26.3
4.5	5.6	0.056	17.9	<0.5	<8.9	100	1786	<5
5	3.1	0.031	32.3	<0.5	<16.1	115	3710	<4.3
5.5	3.2	0.032	31.3	<0.5	<15.6	107	3344	<4.7
6	3.1	0.031	32.3	<0.5	<16.1	128	4129	<3.9
10.5	16.8	0.168	6	1.9	11.3	27	162	69.8
11	20.1	0.201	5	0.74	3.7	24	120	30.7
11.5	20.1	0.201	5	2.5	12.4	25	125	99.5
12	27.1	0.271	3.7	1.7	6.3	26	96	65.2
12.5	17.8	0.178	5.6	<0.5	<2.8	21	118	<23.9
13	19.3	0.193	5.2	<0.5	<2.6	21	109	<23.7

Table A-4 - (Continued)								
7R1								
A	B	C	D	E	F	G	H	I
Feet	* %	l/kg	kg/L	*mg/kg	mg/L	µmho/cm	µmho/cm	ratiox1000
0.5	1.9	0.019	52.6	<0.5	<26.3	53	2788	<9.4
1	2.3	0.023	43.5	1.1	47.8	59	2567	18.6
1.5	13.7	0.137	7.3	0.58	4.2	136	993	4.3
2	2.1	0.021	47.6	0.92	43.8	75	3570	12.3
2.5	2.1	0.021	47.6	<0.5	<23.8	67	3189	<7.5
3	4.5	0.045	22.2	0.68	15.1	231	5128	2.9
4	4.6	0.046	21.7	<0.5	<10.9	16	347	<31.3
4.5	1.8	0.018	55.6	<0.5	<27.8	38	2113	<13.1
5	1.8	0.019	52.6	<0.5	<26.3	19	999	<26.3
5.5	1.8	0.018	55.6	<0.5	<27.8	16	890	<31.2
6	1.7	0.017	58.8	<0.5	<29.4	16	941	<31.3
10.5	2.5	0.025	40.0	<0.5	<20	14	560	<35.7
11	2.4	0.024	41.7	<0.5	<20.8	14	584	<35.7
11.5	2.3	0.023	43.5	<0.5	<21.7	23	1001	<21.7
15.5	2.8	0.028	35.7	<0.5	<17.9	15	536	<33.3
16	3.4	0.034	29.4	<0.5	<14.7	13	382	<38.5
16.5	3.0	0.030	33.3	<0.5	<16.7	13	433	<38.5

EXPLANATION OF TABLE

Column

A=Depth from ground surface.

B=% = grams of water per 100 grams of Soil (laboratory determination)

C= kilograms of water per kilogram of soil= liters of water per kg soil

D= kilograms of soil containing one liter of water (inverse of C)

E= miligrams of nitrate/nitrogen per Kilogram of soil (lab analysis)

F=milligrams of nitrate/nitrogen per liter of soil moisture. (column D times column E)

This is the actual concentration of nitrate nitrogen in the soil moisture of the sample.

G=Electrical Conductance (EC) in microMhos as extracted from a 1:1 solution of dry soil in distilled water (lab)

H= EC corrected for actual moisture content of original soil sample (multiply column G by column D)

I= Ratio of nitrate N to EC (column F/ column H)(x1000)

* Shaded Columns are Lab analyses data expressed relative to dry wt of soil. (NA=Not Analyzed)
Nitrate<nitrogen <u>concentrations</u> are calculated from those data relative to the soil moisture content of the samples.
(1 kg water = 1 liter at normal temperatures)

****Example:*** $^{Water}/_{soil}$ = 2.3 % = 0.032 l/kg. therefor: $^{soil}/_{water}$ = 1kg/ 0.032 l = 43.5 kg/l;
hence:if NO_3 = 1.1mg/kg soil, then :concentration = 1.1mg/kg x 43.5kg/l = 47.9mg/l ;

\+ Where N ($NO_3^<$ or NH_4^+) is below detection limits it can not be defined as 0. (< 0.5 may not = 0) Therefor, where the N/nitrate value has been expressed as below the detection limits, the concentration has been expressed as below the concentration represented by that detection limit using the actual field moisture content.

TABLE A-5

NITROGEN CONCENTRATION IN SOIL CORES (from Nitrate Study)

DEPTH	MOISTURE		SOIL	(NO_3^-) N		(NH_4^+) N	$(NH_4^+ + NO_3^-)$ N		Cl^-	
Feet	* %	l/kg	kg/l	*mg/kg	mg/l	*mg/kg	mg/kg	mg/l	*mg/kg	mg/l
NATIVE										
0--1.5	2.2	0.022	45.0	1	45	5	6	120	NA	NA
5--6.5	4.8	0.048	20.8	<1	< 21	3	3+	63+	NA	NA
10-11.5	8.0	0.080	12.5	2	25	3	5	63	NA	NA
15-16.5	6.0	0.060	16.7	2	33.5	3	5	84	NA	NA
20-21.5	13.2	0.132	7.6	2	15.2	3	5	38	NA	NA
PARK										
0--1.5	7.8	0.078	13.4	2	26.8	6	8	106.	NA	NA
5--6.5	5.0	0.050	20.0	<1	<40	3	3+	60+	NA	NA
10-11.5	7.6	0.076	13.2	<1	<26.4	3	3+	40+	NA	NA
15-16.5	5.6	0.056	17.8	<1	<35.6	3	3+	53+	NA	NA
20-21.5	7.2	0.072	13.9	<1	<27.8	3	3+	42+	NA	NA
THIRTEENTH ST										
0--1.5	4.4	0.044	22.7	<1	< 23	2	2+	45+	NA	NA
5--6.5	4.0	0.040	25	<1	< 25	8	8+	200+	NA	NA
10-11.5	3.6	0.036	27.5	<1	< 28	2	2+	56+	NA	NA
15-16.5	3.2	0.032	31.5	<1	< 32	3	3+	94+	NA	NA
20-21.5	4.0	0.040	25	<1	< 25	2	2+	50+	NA	NA
25-25.5	3.4	0.034	29.4	<1	< 29	3	3+	88+	NA	NA
30-30.5	5.0	0.050	40	<1	< 40	2	2+	80+	NA	NA
35-36.5	4.0	0.040	25	1	25	<2	1+	25+	NA	NA
40-41.5	4.6	0.046	21.7	1	22	<2	1+	22+	NA	NA
45-46.5	5.6	0.056	17.9	1	18	2	3	54	NA	NA
50-51.5	3.9	0.039	26.3	<1	<26	3	3+	79+	NA	NA
55-56.5	4.8	0.048	20.8	2	42	3	5	104	NA	NA
FOURTEENTH STREET										
0--1.5	4.4	0.044	22.7	14	318	9	23	522	NA	NA
5--6.5	3.4	0.034	29.4	2	58.8	4	6	176	NA	NA
10-11.5	3.4	0.034	29.4	<1	< 29	4	4+	118+	NA	NA
15-16,5	2.8	0.028	35.7	<1	< 36	5	5+	179+	NA	NA
20-21.5	4.4	0.044	22.7	<1	< 23	6	6+	136+	NA	NA
25-26.5	3.6	0.036	27.8	<1	< 28	2	2+	56+	NA	NA
30-31.5	2.4	0.024	36.0	<1	< 36	3	3+	108+	NA	NA
35-36.5	3.0	0.030	33.3	<1	< 33	3	3+	100+	NA	NA
40-41.5	3.0	0.030	33.3	<1	< 33	3	3+	100+	NA	NA
45-46.5	2.8	0.028	35.7	<1	< 36	3	3+	107+	NA	NA
50-51.5	3.6	0.036	27.8	<1	< 28	3	3+	83+	NA	NA
55-56.5	2.8	0.028	35.7	<1	< 36	2	2+	71+	NA	NA
BAYRIDGE ESTATES										
0--1.5	3.6	0.036	28	<1	< 28	4	4+	112+	7	196
5--6.5	5.6	0.056	18	<1	< 18	3	3+	54+	3	54
10-11.5	7.0	0.070	14.3	10	143	2	12	172	4	57
15-16.5	12.4	0.124	8	2	16	5	7	57	7	56
20-21.5**	14.2	0.142	7	4	28	3	7	49	8	56

|* Shaded Columns are Lab analyses data (Table 3) expressed relative to dry wt of soil. (NA=Not Analyzed)
Chloride, Nitrate-nitrogen and combined $NO_3 + NH_4$ nitrogen <u>concentrations</u> are calculated from those data relative to the soil moisture content of the samples. (1 kg water = 1 liter at normal temperatures)

**Example: from bottom line of table $^{Water}/_{soil}$ = 14.2 % = 0.142 l/kg. therefor: $^{soil}/_{water}$ = 1kg/ 0.142 l = 7 kg/l; hence:if NO_3 = 4mg/kg soil, then :concentration = 4mg/kg x 7kg/l = 28mg/l ; Cl=8 mg/kg x 7 kg/l =56mg/l

\+ Where N (NO_3^- or NH_4^+) is below detection limits it can not be defined as 0. (< 1 may not = 0)

Technical Advisory Committee May 28,1994

TABLE A - 6
SOIL CORING DATA (from nitrate study)

Location	Depth feet	Ammonium Nitrogen mg/kg	Moisture %	Nitrate Nitrogen mg/kg	Nitrite Nitrogen mg/kg	Total Nitrogen mg/kg	Kjeldahl Nitrogen mg/kg	pH	Exchange Capacity meq/100g*	Organic Matter %	Chloride ppm
Native	00 - 01.5	5	2.2	1	<1	673	672	5.7	3.0	0.41	NA
	05 - 06.5	3	4.8	<1	<1	293	293	6.4	2.5	0.07	NA
	10 - 11.5	3	8.0	2	<1	153	151	7.1	3.6	<0.02	NA
	15 - 16.5	3	6.0	2	<1	124	122	7.5	3.9	<0.02	NA
	20 - 21.5	3	13.2	2	<1	152	150	7.9	4.2	<0.02	NA
Park	00 - 01.5	5	7.8	2	<1	712	710	6.9	6.8	1.05	NA
	05 - 06.5	3	5.0	<1	<1	250	250	6.9	3.4	0.05	NA
	10 - 11.5	3	7.6	<1	<1	212	212	6.7	3.7	<0.02	NA
	15 - 16.5	3	5.6	<1	<1	150	150	7.4	3.7	<0.02	NA
	20 - 21.5	3	7.2	<1	<1	99	99	7.7	4.6	0.03	NA
13th Street	00 - 01.5	2	4.4	<1	<1	292	292	7.6	6.2	0.52	NA
	05 - 06.5	8	4.0	<1	<1	231	231	7.6	3.5	0.09	NA
	10 - 11.5	2	3.6	<1	<1	58	58	8.1	3.5	<0.02	NA
	15 - 16.5	3	3.2	<1	<1	54	54	7.3	3.0	<0.02	NA
	20 - 20.5	2	4.0	<1	<1	58	58	7.5	2.9	<0.02	NA
	25 - 26.5	3	3.4	<1	<1	63	63	7.5	3.6	<0.02	NA
	30 - 31.5	2	5.0	<1	<1	68	68	7.8	3.9	<0.02	NA
	35 - 36.5	<2	4.0	1	<1	56	55	7.4	3.1	<0.02	NA
	40 - 41.5	<2	4.6	1	<1	234	233	7.4	3.7	<0.02	NA
	45 - 46.5	2	5.6	1	<1	65	64	7.7	3.6	0.03	NA
	50 - 51.5	3	3.8	<1	<1	156	156	7.8	3.6	<0.02	NA
	55 - 56.5	3	4.8	2	<1	74	72	7.7	3.9	<0.02	NA
14th Street	00 - 01.5	9	4.4	14	<1	447	433	6.3	8.4	1.09	NA
	05 - 06.5	4	3.4	2	<1	70	68	7.5	3.4	0.03	NA
	10 - 11.5	4	3.4	<1	<1	90	90	7.1	3.7	<0.02	NA
	15 - 16.5	5	2.8	<1	<1	82	82	7.4	3.1	<0.02	NA
	20 - 21.5	6	4.4	<1	<1	168	168	7.6	3.5	0.02	NA
	25 - 26.5	2	3.6	<1	<1	62	62	7.6	3.3	<0.02	NA
	30 - 31.5	3	2.4	<1	<1	65	65	7.7	3.2	<0.02	NA
	35 - 36.5	3	3.0	<1	<1	79	79	7.7	3.7	<0.02	NA
	40 - 41.5	3	3.0	<1	<1	170	170	7.7	3.6	<0.02	NA
	45 - 46.5	3	2.8	<1	<1	63	63	7.7	3.3	<0.02	NA
	50 - 51.5	3	3.6	<1	<1	63	63	7.5	3.4	<0.02	NA
	55 - 56.5	2	2.8	<1	<1	62	62	7.6	3.1	0.03	NA
Bayridge Estate	00 - 01.5	4	3.6	<1	<1	270	270	6.9	4.1	0.65	7
	05 - 06.5	3	5.6	<1	<1	196	196	6.7	2.5	0.33	3
	10 - 11.5	2	7.0	10	<1	162	152	6.1	3.0	0.05	4
	15 - 16.5	5	12.4	2	<1	120	118	6.4	3.4	0.02	7
	20 - 20.5	3	14.2	4	<1	134	134	6.8	3.5	<0.02	8

*meq/100g = cmol(+)/kg
NA - Not Analyzed
Revised 8/3/94

CONCLUSIONS:

The TAC is convinced that the major contributor to the nitrate concentrations in the very shallow ground water is not the onsite waste disposal (septic/leach) systems but the "natural" contribution as shown in Table A-1. The figure of more than 55% contribution from natural inflow is supported by the data presented concerning concentrations in soil water and area involved from data which was available to M&E but was not used by or included in this report. This conclusion is fully supported by the 178 tests run on soil cores and cited above and in TABLES 4, 5 and 6.

NOTE: Additional references that pertain to Appendix A:

Final Environmental Impact Report for Bayridge Estates Tract 527 Appendix 2

Geology report by John H.Wiese registered geologist. July, 1974 (consultant and coauthor of ref. [24])

Geohydrology and Water Quality- Baywood Los Osos Groundwater Basin (Zipp), San Luis Obispo County California State Water Resources Control Board October 1979

Los Osos Evaluation by J. F. Kreissl, U.S. Enviromental Protection Agency, Office of Research and Development, Cincinnati, Ohio 1994

Chapter 3, page 3-23 **Geological sources**

{A 3.46 } The statement by M&E, "None of these geologic sources of nitrate are known to exist in coastal central California, so geologic sources are assumed to be insignificant in Los Osos." It is true that the mentioned nitrate sources are probably insignificant in this study area. However, this does not rule out a major geologic source of nitrogen which has been transformed into the nitrate form. This is the possible presence of ammonium-nitrogen in various clay layers of the shales from which the soils of Los Osos have formed. This ammonium-nitrogen can come from either or both of the following sources: ammonium ions fixed between the individual layers of clay particles and from geologic organic matter (similar to coal) which then undergoes subsequent microbial decomposition to ammonium. Either or both forms of ammonium-nitrogen can then undergo conversion to nitrate-nitrogen by the microbial process of nitrification within the vadose zone. The Regional Water Quality Control Board in the San Jaoquin Valley is familiar with the fact that a shale layer on the west side of the valley near Coalinga contains a high level of organic nitrogen and has a dark color. This layer which is generally less than a foot thick, contributes the major natural source of nitrates to the ground waters on the west side of the San Joaquin Valley near Coalinga. This work was published in

California Geology. A recent report in the international journal of science Nature (Dahlgren, Randy A. 1994. Soil acidification and nitrogen saturation from weathering of ammonium-bearing rock. Nature 368:838-841.) reported that an area in the Kalamath Mountains of California has soils where no trees grow. After investigating the reason for the failure of trees to grow on these soils, the researchers presented clear evidence that the geologic material of these soils contained ammonium-nitrogen in the shale. They concluded that the trees were not growing because the nitrification process of the ammonium into nitrate made the soil too acidic to support the growth of trees. Either or both of these geologic nitrogen sources could be present in the Los Osos area. No one has looked for them here as so one can not rule them out as possible sources of nitrogen which ends up as nitrate in this community. *[M&E note: a brief discussion of other geologic sources based on the above has been added.]*

M & E cites the last sentence on page 3-23 under this heading at least one geologist supports probability of geological sources. See: State Water Resources Control Board, October 1979, (Zipp) page 10 par. 3 "there is also a confined connate zone of high total dissolved solids (TDS) water under an alluvial fan deposited by Los Osos Creek....etc." "This tends to concentrate the effluent in the perched zone" "water samples...had a much higher TDS level than anticipated." page 11 par. 1., pg. 14, par. 2 & pg. 15 par. 2. Although the Zipp report has many weaknesses, this is the opinion of a geologist, (not a sanitary engineer) who has worked in the area.

Chapter 3, Page 3-23 **Agricultural fertilizers**

{A 3.47 } This section is pure guesses. Here is one place where Metcalf & Eddy could have collected data from the owners of the golf course and cemetery, but the did not. Both of these locations often use nitrogen at much higher than the normal rate of nitrogen application for most agricultural uses. These higher rates are tolerated because a crop is not harvested, but the grass must be kept green year round, rather than only during the normal crop growing season. The Regional Water Quality Control Board has had data on the nitrate applications to the golf course. Again these data were not used.

What is the rationale for reducing the Agricultural acreage since the original draft from 237 acres to 100 acres? The cited reference does not support this. This does not even agree with Brown & Caldwell which allows 50% denitrification rather than 23% but the additional reduction of 20% for denitrification cannot be allowed, this is double entry. Lacking a justification for the change in acreage and not making an issue of the percentage of added fertilizer getting to the ground water: The agricultural contribution should be equal to 8,200 pounds per year. It should be noted that Resources Planning reserves 800 AF/yr for agriculture from this basin.

Chapter 3, Page 3-24, **Horticultural fertilizers**

{A 3.48 }The TAC believes that no data were collected to support any of the guesses made in this section. Several commercial greenhouse operations exist within the Los Osos area. Similar greenhouse operations in the Salinas Valley are known to be the nitrate hot spots for that Valley. The reference Snow, Jerry, Ted Mills, and Matt Zidar. 1988. Nitrates in groundwater Salinas Valley, California Salinas: Monterey County Flood Control & Water Conservation District. Salinas, CA. can be consulted for further information.

There is no reason to believe that resident gardeners who apply fertilizers for the pleasure of maintaining their limited landscaping will be any more conservative than farmers who must factor in the economic value of their fertilizer in terms of large acreage and sales price. The 10% figure for lawns (the only question asked in this category by the sanitary survey) in the residential does not take into consideration the horticultural use other than lawns and no allowance has been made in either the horticultural or agricultural categories for the intense use of fertilizers by the green houses in the area. Therefore the assumption of a lower figure per acre is certainly invalid. As a minimum the standard for agricultural use should be applied and the horticultural figure for the acreage shown should equal 12,000 #/yr.

Chapter 3, Page 3-24 Bullets 2, 3

{A 3.49 } The following factors used by M&E, although relatively minor, contain significant errors in approach. The assumption here of 77% used by plants is invalid. Horse stables by their nature have little if any vegetation and is more likely to be killed by the concentration of High TDS, especially chloride and high Nitrogen. No basis has been established for the 50% volatilization (of ammonia). Also no real basis has been established for the 30% loss due to denitrification Unless these factors can be established we will accept for this report the 50% volatilization of ammonia and the 30% loss to denitrification 50% of 22,000 = 11000; 11,000x .70 = 7,700 The same comments apply to dog and cat wastes but they are relatively minor factors compared to those cited above.

M&E makes the statement that"50% of the nitrogen in the waste is lost through volatilization [43], and 77% through plant uptake, the same as for fertilizer." The first clause is possibly correct in that horse manure is drier than most other forms of manure and this condition tends to accentuate the loss of ammonia gas to the atmosphere. The second clause is NOT true for Los Osos. Most of these horses are in stables and are fenced into a very limited area. Consequently, these areas are badly over-grazed. This results in the lack of vegetative cover. Thus, no plants are present appreciably to recover the nitrates which will leach into the ground water. The value of 77% as accounted for by plant uptake can NOT be anywhere near correct. The TAC believes that at best only 5% of the nitrogen would be taken up by plants in corrals with horse manure. *[M&E note: the figure has been changed to 40%.]* The effect of this change will increase the contribution of other nitrogen sources to ground water nitrates and to decrease the relative proportion (if any) coming from septic systems. Although horses are different from cattle, one cow is estimated to create the nitrogen waste loading of 16.5 people. This would then equate for 200 horses to about 3300 people equivalent waste loading of nitrogen if one made a straight equivalence of these two animals. If this number is compared to the 1990 Census (page 3-3 = 14,377) this represents 22.9% of the nitrogen from manure of horses if they are equal to cows with no loss. If one assumes a 50% loss as ammonia, then the horses represent about 11.5% of the total waste loading of nitrogen for this community.

Chapter 3, Page 3-24 last bullet

{A 3.50 } M&E statement, "Unlike onsite system effluent and like fertilizers, the soil is not always maintained in a saturated, anaerobic state" indicates a complete lack of understanding of the denitrification process which this subtopic refers to in previous paragraphs above. Denitrification is conducted by aerobic bacteria which encounter regions within the vadose zone or in ground water where oxygen gas becomes limiting. It does not mean that the soil or vadose zone has to be saturated with water. Also, it does not mean that the system has to be totally and completely anaerobic with absolutely no oxygen gas. It simply means that the amount of readily available oxygen gas is limiting and these aerobic organisms can and do switch their metabolism to available nitrate which they use as an alternate electron acceptor and convert this into elemental nitrogen gas which returns to the atmosphere in the process of denitrification. *[M&E note: this sentence has been revised to read "Unlike onsite system effluent and like fertilizers, the soil is not always maintained in a saturated, anaerobic state, <u>which is most conducive to denitrification</u>."]*

Chapter 3, Page 3-25 **Animal Waste - Dogs and Cats**

{A 3.51 } This section does not measure the number of dogs and cats directly. Also, it does NOT measure the waste production nitrogen generation for these animals. Again, the results of this section are guesses which are not clearly referred to in this report.

Chapter 3, Page 3-26 **Soil Disturbance**

{A 3.52 } This issue was indicated to be an important factor by James Kreissl from the US Environmental Protection Agency. Unfortunately, Metcalf & Eddy chose to ignore any reference to this report, even though they want to have him take credit under the Acknowledgements section on page v. The statement by Kreissl should be introduced at this point with references included.

Chapter 3, Page 3-27 **Mass Loading Calculations**

{A 3.53 } Table 3-3 ignores the continuing periodic disking of the southerly portion of the residential area to control chaparral, which is approximately 12 acres per year, or the more recently enacted practice of mowing the lots (cited in the supporting material) less than one year old. Prior to this, the perimeter of each lot (not included in the 12 acres above) was disked for fire control. This time frame is inadequate to show a reduction in effect. Neither citation seems to be applicable since reference [34] refers to nitrogen fixing plants in the chaparral, which certainly applies to these 12+ acres both from the standpoint of the plant community and the runoff to this area from the chaparral above.

However, simply including the additional 12 acres and using the figures from the table will add 800 #/yr.

> ****NOTE:** this is far less than the figures given in Kreissl's report which could well increase this contribution to a truly significant percentage rather than the 2% figure given in the table below.

Chapter 3, Page 3-27

{A 3.54 } "As shown in Table 3-3, over 60% of the nitrate in shallow ground water is supplied by onsite wastewater system effluent." This statement completely prostitutes the computer model which was developed for the mass loading. The mass loading only indicated the relative proportions of nitrogen from various sources in the community. It is based only upon guesses for every single parameter used in Table 3-3. None of the nitrate-nitrogen in the shallow ground water was tested for the proportion which came from any one of these sources. The statement made by Metcalf & Eddy is completely wrong as it is articulated. They should be much more careful in what they have actually tried to do and what they claim to have proven. *[M&E note: the sentence has been revised to read: "...over 60% of the nitrate in shallow groundwater <u>may be</u> derived from onsite wastewater system effluent as it percolates through the vadose zone."]*

Chapter 3, Page 3-27

{A 3.55 } "Although this mass loading calculation contains many uncertainties in the input parameter values, it does provide a quantitative assessment of nitrate contributions to shallow ground water." The first clause is accurate. One should go further to explain that the reason for the uncertainties in every one of the input parameters is that each represents a guess rather than an exactly measured value. The second clause is totally wrong. It can not represent an assessment because no data were collected on the magnitudes of either the total amounts of inputs or of the nitrogen concentrations of any of the total inputs. Thus, it can not be a valid quantitative assessment. It represents a computer-generated model. The model in no way is the real world. Metcalf & Eddy have tried to make it the best of all possible worlds. In fact, they have apparently deluded themselves into thinking that a computer model represents the real world. The space is too short to discuss all of the pitfalls and dangers of trying to use a computer model to be the real world. As indicated in the comments above, the model specifically underestimates the contributions from geological nitrogen sources and any biological nitrogen fixation. Both of these omissions significantly weaken any conclusions which may be able to be made from this computer model. Also, any statements regarding the contribution from any given source are at best only ball park figures and can not really be considered as quantitative. Had any of the actual inputs and their nitrogen contents been measured directly then the situation would have been different, but none were.

Chapter 3, Page 3-28 Table 3-3

{A 3.56 } This table consists entirely of a model based upon guesses for individual inputs. It can NOT be the real world. This must be the first note to be cited regarding this table. The Horticultural Fertilizers ignore major nitrate sources potentially from various greenhouse operations within Los Osos. Greenhouse operations can grow crops all year and use more than the normal amounts of nitrogen fertilizer. Depending upon the nature of the greenhouse operation, excessive leaching of nitrates from container plants and beds of plants is common. What these omissions mean from point 46 above and this point is that the percentage of each contribution for the total is off by some unknown but presumably measurable value most likely of several per cent or more. The Infiltration rate of natural rainfall and runoff is estimated to be 12 inches per year. Anyone watching the degree of water runoff along Los Osos Valley Road near the Library would be hard pressed to believe that with about 16 inches of annual rainfall in a few storms with appreciable water runoff directly to Morro Bay that even 12 inches can be infiltrating. The infiltration figure also ignores the evapotranspiration process which usually results in most of the infiltrated water being returned to the atmosphere through plants and evaporation from soil surfaces during the year. This will reduce the total amount of water from natural sources. Plants generally transpire about 99% of the water which enters the plant roots. What this does is to magnify the concentration of all natural nitrogen sources because the total amount of water is actually much smaller than calculated in this model. The values for Horse waste on page 3-29 seem to be underestimates by several fold, especially when one considers overgrazed corral sites where the 77% of applied nitrogen being utilized by plants can not possibly hold.

Chapter 3. page 2-28 **Metcalf and Eddy Table 3-3**

{A 3.57 } Metcalf and Eddy has used the U.S. Geological Survey Water (USGS) - Resources Investigation Report 88-4081(1988) to make various conclusions. It is unfortunate that they have failed to provide the additional insight in their data analysis that Figure 4 (left side) of this report shows clearly clay layers ranging from approximately 20 to 40 feet from the surface in the Los Osos sand dunes. The right side of Figure 4 indicates that the sands are thicker at the top of the hill before clay layers were encountered. Figure 5 indicates that the sand over the clay is the deepest near the shore of Morro Bay. Figure 6 indicates that the sands have nearly disappeared at the surface on the eastern edge of Los Osos. These shallow clay layers would be more effective as natural filters and serve to aid in the natural biological processing of the septic tank effluent within the general zone above the ground water.

Table 1 of the USGS report indicates that the total surface water subbasins cover an area of 13,217 acres. For the data years 1970-1977 the total acre-feet of water accounted for by surface runoff and underflow to the basin was reported as 3742 acre-feet with more than 91% of that water representing surface runoff to creeks and less than 9% (324 acre-feet of water as underflow to the ground water basin. The U.S. Geological Survey data [24] become quite interesting when one compares this with Metcalf and Eddy's Table 3-3 on Mass Loading calculations. The foot note under "natural" assumes "Infiltration rate from rainfall and runoff = 12 in./yr [24]. The reference [24] is using the very same U.S. Geological Survey report. If one uses the value of 324 acre-feet of underflow to the basin and divides this by 13,217 acres, the result is that on the average 0.0245 feet of water (or 0.29 inches) of water move through the basin each year. The USGS report on page 29 reports that "the average long-term deep percolation rate in the Lompoc area of 1.3 in./yr". Somehow, Metcalf and Eddy's value of 12 inches which they state is from rainfall and runoff is unclear. They use this value as if all of this water were moving as underflow to the basin.

The important point here is that the Metcalf and Eddy model is used for estimating the nitrogen mass loading calculation. Metcalf and Eddy used a value of 12 inches which is about 10 times higher than the apparent value of 0.29 to 1.3 inches for the true infiltration into this basin. Why does this make a difference? Any nitrogen mass balance effect reported by Metcalf and Eddy in their computer program will be magnified by this same factor of about 10 fold for all data related to the natural sources. Note that this will not necessarily change the numbers directly for the mass loading itself. However, the impact of the nitrogen mass loading upon the water quality of the community will be greatly altered in the real world situation when compared to the computer modeled results. All of the nitrogen from sources other than the onsite system effluent will be diluted in the 12 inches from Metcalf and Eddy or the 0.29 to 1.3 inches from the USGS data. The effect is that natural sources will result in nitrate-nitrogen concentrations from these natural sources which are about 10 times higher using the USGS data than will the nitrate-nitrogen values from the Metcalf and Eddy computer model.

Table 3-3 of Metcalf and Eddy indicate that onsite system effluent constitutes 63,000 pounds of N per year from 6610 DUE (Dwelling Unit Equivalents) which according to the footnote represent 189 gallons of water per DUE per day. One year has 365 days and one gallon of water weighs 8.345 pounds. Multiplying this out one obtains the following total water use:

$$\frac{189\ \text{gallons}}{\text{DUE day}} \times \frac{8.345\ \text{pounds}}{1\ \text{gallon}} \times \frac{365\ \text{days}}{1\ \text{year}} \times \frac{6610\ \text{DUE}}{\text{Los Osos}} = \frac{3{,}805{,}243{,}643\ \text{pounds water}}{\text{Los Osos yearly}}$$

Using Metcalf and Eddy's value of nitrogen loading provides an estimate of the nitrogen concentration in this septic tank effluent leaching water as indicated below:

$$\frac{63{,}000 \text{ pounds of nitrogen}}{3{,}805{,}243{,}643 \text{ pounds of water}} \times \frac{1{,}000{,}000}{1 \text{ million}} = \frac{16.56 \text{ pounds of N}}{1 \text{ million pounds of water}}$$

This value corresponds to 16.56 parts per million N in the water or 16.56 milligrams of N per liter or 16.56 mg N/L. Unfortunately, Metcalf and Eddy chose to confuse the situation by reporting the nitrogen values in Table 3-3 in units of N whereas the values for all of the well data were inflated to values of nitrate, which causes the values to seem larger than they actually are. The public health service limit for potable drinking water is 10 mg N/L or 45 mg nitrate/L. Using this conversion factor, one would obtain a value of 74.52 mg nitrate/L. The well data reported by Metcalf and Eddy in Table B-2 are considerably below this value. Table B-3 Detailed Database report that wells 13A1, 13A6, 13L1, 17F4, 17H2, 17L1, 17N4, 18A2, 18D2, 18J4, 18K5, 20B3, 20D1, 7F1, 7G3, 7J1, 7N1, 8M2, 8M3, and 20E1 have all reported values below this value of 72.864 mg nitrate/L. For the wells 13A2 has 2 of 8, 13A7 has 1 of 31, 13B2 has 1 of 10, 13G2 has 6 of 15, 13L5 has 17 of 32, 13Q1 has 25 of 32, 18J6 has 1 of 28, 18N1 has 1 of 3, 18R1 has 10 of 39, 7L3 has 4 of 32, 7Q1 has 2 of 58, and 7R1 has 1 of 3 data entries which exceed the value of 74.52 mg nitrate/L. This represents nearly 25 percent of the data points from this second group of wells reporting values above the estimated concentration of nitrates from Metcalf and Eddy's mass loading calculations.

What does this mean? If Metcalf and Eddy's mass loading computer program was correct, then one should expect all wells in the area to show values close to the calculated value of 72.864 mg nitrate/L if the septic tanks are the primary source of this nitrate. Twenty of the 32 monitored wells are below and many are considerably below this value. Metcalf and Eddy has not explained this inconsistency in their data. One can conclude from this simple analysis that the computer estimated value for the onsite system effluent nitrate loading must be in error. Since many wells have much lower values, one is compelled to consider that the Metcalf and Eddy estimated value must be higher than is the real world value.

Metcalf and Eddy report in Table 3-3 the following nitrate loading values: natural = 17,400, agricultural fertilizers = 2800, horticultural fertilizers = 5600, horse waste = 1800, dog waste = 1000, cat waste = 800, soil disturbance = 3200, and weed abatement = 2400 pounds of nitrate per year. This represents a total of 35,000 pounds of nitrate per year from non-onsite system effluent sources or 36% of the nitrate estimated by Metcalf and Eddy. On page 3-15 they used the value of "approximately 3500 acres" for the area of nitrate concern within the

Urban Reserve Line. Let us use this value and the assumed value of 12 inches of water infiltrating into every acre of land. One acre-inch of water contains 27,154 gallons of water. With each gallon of water weighing 8.345 pounds of water, then one acre-inch of water contains 226,600 pounds of water. This information from Metcalf and Eddy can be used to calculate the estimated infiltration of water down through the soil to the ground water as:

$$\frac{12 \text{ inches}}{\text{year}} \times \frac{3500 \text{ acres}}{\text{Los Osos}} \times \frac{226{,}600 \text{ pounds}}{1 \text{ acre-inch}} = \frac{9{,}517{,}200{,}000 \text{ pounds water}}{\text{Los Osos within Urban Reserve}}$$

Then if one assumes that all of the non-onsite system effluent nitrate is contained in this water, then one can calculate the nitrate concentration of this water as follows:

$$\frac{35{,}000 \text{ pounds nitrate}}{9{,}517{,}200{,}000 \text{ pounds water}} \times \frac{1{,}000{,}000}{1 \text{ million}} = \frac{3.678 \text{ pounds of nitrate}}{1 \text{ million pounds of water}}$$

Recalling that 10 mg N/L equals 45 mg nitrate/L, then this value corresponds to 16.55 mg nitrate/L. Note that this value agrees with many of the well values in the community. However, the assumption upon which this calculation has been based is that 12 inches of water infiltrates into this basin to reach the ground water.

The USGS report on page 3 states "Mean annual rainfall increases gradually from about 14.5 inches at the coast to about 16 inches at the inland end of the valley. Rainfall also increases towards the mountains. Mean annual rainfall is about 17 in/yr along Park Ridge and 30 in/yr at the upper end of the Los Osos Creek drainage basin in the Irish Hills (California Department of Water Resources, 1973)." To assume that 12 inches of water infiltrates and reaches ground water tends to ignore the high degree of water runoff which occurs in this community with the few by intense rain storms which deluge the area during the winter season. If one uses an average of 15 inches of rain and 12 inches infiltrates to ground water, then only 3 inches are reported as running off down Los Osos Valley Road and other areas where people can clearly see the amount of surface runoff. If the actual value of water infiltrating to the ground water is less that the 12 inches assumed by Metcalf and Eddy, then the concentration of nitrate from natural sources in the ground water will be higher by the extent to which Metcalf and Eddy's values are in error.

Again, the value of 0.0245 feet of water (or 0.29 inches) of water moving through the basin each year, or the USGS report of "the average long-term deep percolation rate in the Lompoc area of 1.3 in./yr" strongly suggest that this natural level of infiltration is closer to real world value, than is the value assumed by Metcalf and Eddy. A value of 0.29 inches substituted into the equation above provides a value of 229,999,000 pounds of water, and the value of 1.3 inches substituted into the same equation above provides a value of 1,031,030,000 pounds of water reaching the ground water annually. Using Metcalf and Eddy's computer estimated nitrate loading value, this results in the following concentrations in the ground water (as obtained by substituting the values into the same equation used previously to estimate the concentration). For the value of 0.29 inches of water the concentration would be 152.2 mg N/L, and for the 1.3 inches of water value the concentration would be 33.95 mg N/L.

What is the important point about these data? The U.S. Public Health Service nitrate limit for potable water is 10 mg N/L or 45 mg nitrate/L. The values just calculated from Metcalf and Eddy's computer estimations for nitrate loading from Table 3-3 and the U.S. Geological Survey data suggest that natural sources are greatly exceeding the public health limit of 10 mg N/L! The calculated value of 16.56 mg N/L from the onsite system effluent (as derived from Metcalf and Eddy's computer estimates) would actually mean that the onsite system effluent is diluting these very high natural concentrations of nitrate. This runs entirely contrary to what Metcalf and Eddy are suggesting in their report.

In fact, these calculated values for the natural conditions ignore several other nitrogen sources, such as biological nitrogen fixation and geological ammonium in the shales which is slowly being converted to nitrates. Thus, using Metcalf and Eddy's data the total of 35,000 pounds of nitrate loading from non-onsite system effluent would be an under estimate. This would simply accentuate the magnitude of the natural concentrations of water reaching the ground water from these natural sources.

What does all of this mean? Table 3-3 of Metcalf and Eddy is reported to be a mass loading of nitrate in Los Osos. In actuality, it is full of approximations, assumptions, and guesses. The computer did not do anything to improve upon the quality of the data. An old computer expression applies at this point. The saying is, "Garbage in, garbage out." In other words, if one enters wrong data, one can expect the computer to produce wrong results. Taken at face value Metcalf and Eddy's values seem interesting, but the real world is where we are. The calculations above strongly indicate that the nitrate mass loading values estimated by Metcalf and Eddy do not match real world values for either the concentration of the nitrate from the onsite system effluent or for the natural sources reaching the ground water. In fact, it is not at all clear what one can deduce from any of these values in the mass loading table 3-3.

Chapter 3, Page 3-27 last ¶

{A 3.58} The TAC believes that there are no known data to substantiate any depth to ground water association with the denitrification process.

Chapter 3, Page 3-30 1st bullet

{A 3.59 } "There is a statistically significant correlation between nitrate concentrations and population or time, suggesting a relationship between these variables." As explained in various points made above, the first clause is correct, but the second clause "...suggesting a relationship..." is completely in error from a statistical interpretation stand point.

Chapter 3, Page 3-30 3rd bullet

{A 3.60 } This entire paragraph is completely inaccurate as stated. The words " ...appear to be..." are based solely on a model developed entirely from guesses. The identification of 60% of the nitrates being from onsite wastewater systems is purely a fabrication of the model. It is important to indicate that no actual data were measured in the community to determine this approximation. Also, other major potential contributing sources have been ignored along with the magnitudes of other factors in Table 3-3 which will strongly affect the value of 60% even within the model itself. The phrase "...provide strong evidence of a relationship..." is really misrepresenting statistical interpretations. I am certain that this statement as it is represents what Metcalf & Eddy want to be able to say. However, the statements are scientifically and statistically incorrect as stated in the text.

Chapter 3, Page 3-30 4th bullet

{A 3.61 } This entire paragraph is highly questionable. All information relative to natural sources is very speculative and really only constitutes a computer model based entirely on guess work. The value of 18% is an artifact of the computer model and has no basis in reality. This is especially true when the potential nitrogen sources of biological nitrogen fixation and of geologic nitrogen as ammonium-nitrogen and/or organic nitrogen as buried soils or other deposits may be contributing to the overall natural loading. In addition, as indicated above, the concentration of the nitrogen in the water from natural sources would be expected to be much larger than this model predicts because the total water infiltration from rainfall seems to be over exaggerated.

Comments to Chapter 4

Lot Size/Density Analysis

Chapter 4, **General Comments**

The Metcalf and Eddy firm assured the representatives of the Technical Advisory Committee that they would examine the available data and draw their own conclusions. The citizens of the community volunteered their time to conduct a sanitary survey of the community. Metcalf and Eddy chose to double and triple count problems at one site and treat this one report as multiple site problems. Such double and triple counting and misrepresentation of the data hardly describes the promise Metcalf and Eddy made to the Technical Advisory Committee. The report has become more of a way of blaming the community for what is presumed to be the source of the problem, rather than to evaluate whether the data indicate that we really have a significant problem. We have long recognized that some home sites experience problems with their septic tanks. Many of these septic tanks were improperly installed in the first place and the problem was one of lack of appropriate supervision by the appropriate County agency.

Chapter 4, page 4-13, Table 4-3

{A 4.3 } Metcalf and Eddy has incorrectly interchanged the term for the commonly constructed Los Osos Leach Pit with the illegal and prohibited term Seepage Pit. Although Seepage Pit and Leach Pit both describe subsurface infiltration methods which perform fundamentally the same function, the Seepage Pit is a hollow chamber lined with brick or concrete block, is built on a foundation and covered with a domed concrete lid. The Leach Pit is a excavated hole, approximately 10 feet in diameter and 15 feet deep, is filled with 10 tons of river rock with a 4 inch diameter perforated drain line installed vertically in the center of the hole for delivery of the septic tank effluent. The important difference between the two systems is the surface area requirements or setback requirements for safe installation. The Seepage Pit is known for its potential for collapse or cave in while the Leach Pit is considered to be stable without any safety hazard potential. This means that the setback distances to structures, expansion pits or property lines should be considered to be less of a constraint for Leach Pits than for the Seepage Pits. *[M&E note: the term "seepage pit" has been changed to "leach pit" throughout the report.]*

Chapter 4, page 4-14.

{ A 4.4 } County Area Standard Number 27-Martin Tract, states that the Martin Tract is to be 1 area minimum unless a sewer system is installed. Since there is no sewer system, the zoning standard is 1 DU/acre. *[M&E note: the sentence on the Martin Tract zoning has been deleted.]*

Chapter 4, page 4-15.

{A 4.5 } Based upon the County of SLO subdivision tract map, the TAC has developed Table A-7 Average Lot Size for Los Osos Subdivisions. The reader can evaluate the specific lot size areas within the community's subdivisions for comparative purposes. The TAC believes that referencing lot size specific to the subdivision locations will enable the reader to understand that lot size constraints are applicable to only specific subdivisions within Los Osos (Cuesta by the Sea and Bush/Ferrell area) and must not be indiscriminately applied to the entire community.

Table A-7 Average Lot Size

SUBDIVISION	AVERAGE LOT SIZE
Morro Palisades	90 x 100
Redfield Woods	50 x 110
Sunset Terrace	70 x 90
Bay Oaks	75 x 90
Bayridge Estates	70 x 130
Martin Tract	1 Acre
Bayview Heights	1 Acre
Cuesta By The Sea	40 x 100
Town of El Moro	25 x 125 37.5 x 125 50 x 125 75 x 125

Chapter 4, page 4-13, 4-15

{A 4.6 }: Generally, in Los Osos, the placement of the septic/leach pit system is in the front yard setback. The County building setback ordinance prohibits the erection of any structure in the front setback. County ordnance 22.04.108 - Front Setbacks states that "All structures with a height greater than three feet shall be set back a minimum of 25 feet from the nearest point on the front property line." Adhering to this ordinance precludes any structural development in the area to be used for the Septic/leach pit system and enables these system layouts to be utilized in most of the Los Osos community.

****Note:**
The TAC has prepared site plans for the different subdivisions in Los Osos. M&E has agree to include these drawings as Figures H-3 through H-8 in report Appendix H. The reader can compare graphically the Septic/leach pit system layouts within the front setback area for all subdivision areas of Los Osos.

Table A-8 Leach Pit Area Requirements shows that leach pit area percentages of the different lot subdivision areas range from 12.8% to 21.8% of the total lot area. The limited area constraint imposed by the septic/leach system on the lot size is not "tight" as defined by Metcalf and Eddy and should not be considered a significant constraint for the retention of conventional onsite wastewater treatment systems. Based on these figures and tables, it can be concluded that the lot sizes are generally large enough for onsite septic/leach systems within the front setback and therefore does not adversely constrain the property owner from fully developing the lot.

Table A-8 Leach Pit Area Requirements

Subdivision Name	Lot Dimensions	Lot Area	Min. Leach Pit Area	Available Leach Pit Area	Leach Pit % of Lot
Morro Palisades	90 x 100	9000	1200	2250	13.33%
Redfield Woods	50 x 110	5500	1200	1250	21.82%
Sunset Terrace	70 x 90	6300	1200	2250	19.05%
Bay Oaks	75 x 90	6750	1200	1875	17.78%
Bayridge Estates	70 x 130	9100	community system	community system	N.A.
Martin Tract	1 acre	325830	1200	>1200	0.37%
Baywiew HTS	1 acre	325830	1200	>1200	0.37%
Town of El Morro	25 x 125	3125	Not suitable	Not suitable	Not suitable
	37.5 x 125	4688	Not suitable	Not suitable	Not suitable
	50 x 125	6250	1200	1250	19.20%
	75 x 125	9375	1200	1875	12.80%
Cuesta by the Sea	40 x 100	4000	Not suitable	Not suitable	Not suitable

All Areas in Square Feet
All Leach systems located between front property line and County's minimum structure setback of 25 feet.
Leach System based on San Luis Obispo County Guidlines for Seepage Pits

Chapter 4, page 4-17.

{A 4.7 } M&E's analysis is based upon the belief that there are large numbers of small lots throughout the community. The TAC believes that analysis of area subdivisions reveals a significant variability and an overall lower dwelling density per acre than M&E's "average density." Table A-9 Subdivision Density Comparison within the Assessment District compares the number of dwellings per acre with the number of total acres in the Assessment district. The reader is able to gain an understanding that different subdivision areas have different dwelling densities and consequently that each subdivision density will have a different impact upon the shallow groundwater quality. The TAC believes that density analysis should encompass both individual area subdivisions and clustering subdivision areas in order to evaluate the impact upon the shallow groundwater quality for specific areas of the community rather than a generalized analysis.

Table A-9 Subdivision Density

Subdivision	Homes	Lots Vacant	Lots %	Acreage	Acreage % of Assessment District*	Homes Per Acre	Units % of Assessment District**
Morro Palisades	262	5	1.9	79	3.9	3.3	5
Redfield Woods	591	17	2.8	77	3.8	7.7	11.5
Sunset Terrace	169	15	8.1	50	2.5	3.4	3.5
Bay Oaks	82	2	2.4	20	1.0	4.1	1.6
Bayridge Estates	154	7	4.3	52	2.6	3.0	3.0
Martin Tract	54	15	22.0	45	2.3	1.2	1.3
Bayview Heights	140	20	12.5	137	6.8	1.0	3.0
Total	**1452**	**81**	**5.3**	**460**	**23.0**	**3.2**	**28.9**

* 2000 Acres in Assessment District
** Based on County Assessment District (5286) Units

Chapter 4, page 4-19 **Soil Data**

{A 4.9 } M&E refers to the United States Soil Conservation Service (SCS) soil survey [48] describing "excessively drained soils" having "rapid permeability". Investigation of the cited report reveals that the study was limited to a single sampling for this area, at a site East of Broderson Ave. and south of the residences bordering Highland Dr. This sampling hole was approximately 30 inches deep.

The soil cores included in the two studies referred to here consist of multiple samples at each site. A total of 178 samples were taken to a depth of nearly 60 feet and tell a far different story. Laboratory data and detailed analysis is presented on pages 21-29 and in Tables 4, 5, 6 of Appendix A.

The moisture levels from these ground bore tests strongly suggest that the soil texture changes from dune sand at the surface to a loam clay mixture with depth. This change is indicated by the ability of the soil to retain water well above the ground water. Moisture contents of 10% to over 24 % simply do not occur in dune sands, at least not beyond 24 hours after a rainfall. Every soil core with the exception of 18B1 (which was only 11.5 feet deep(and 7R1 (which was just 16.5 feet deep) had one or more zones with moisture levels at the high end of this range. All of these zones were below 11 feet. so that it is probable that the dry holes simply weren't drilled deep enough. The zones where the apparent increase in clay content occurred were at 13L5/15.5 feet; 21D13 at 10.5 feet; at 17F4 at 15.5 extending to 41.5 feet; 18J6 at 3.5 feet extending to the end of the core at 16.5 feet; Bayridge Estates 10.5 feet. and John Wiese [24] states that under Bayridge is a solid clay layer which precludes any passage of septic effluent. On page 4-19 M&E make the statement that the SCS survey description of the soils is generally supported by references [19] and [24]. This is not valid. Hantzsche and Finnemore [19] did no original work in this area and the USGS [24] report does not support this concept of "excessively drained soils." *[M&E note: reference [19] should be changed to reference [15].]* Reference has been omitted to The Nitrate Study (35) which indicates infiltration rates from 13.3 min/in to 67 min/in with an average of 28.4 minutes per inch.

The data from the two sets of soil cores and the information cited from the United States Geological Survey for Los Osos indicate that dune sands are thin (about 20 feet or less) under most of the surface area. Near the margin of Morro Bay the depth may be somewhat greater.

Consequently the effluent from septic tank leachfields is not only passing through dune sands but is encountering and being modified by higher clay content soils at some depth between 10 and 20 feet in most parts of the community; so that biological transformations including denitrification are not only possible, but for the most part probable.

SANITARY SURVEY / BUILDING PERMITS AND COMPLAINT ANALYSIS

Chapter 4, Page 4-21

{A 4.10} The TAC believes that Maps, Figures 4-1 through 4-4, have been improperly constructed and that unjustified conclusions have been drawn from them. Based on the maps as drawn and interpreted, the report concludes that adverse conditions revealed by the Sanitary Survey and the study of Building Permits and Complaints are "<u>widespread</u>" and that there are no areas where the extent and concentration of adverse conditions suggest that further investigation is needed to deal specifically with the local problems. The TAC finds the continual use of the word 'widespread' rather than scattered for the relatively small number of incidents to be deliberatily inflamatory, tending to create alarm where no serious problem exists. *[M&E note: the word "widespread" has been removed and the sentence revised to read "data from the sanitary survey indicate that although such problems occur throughout the community, there are no specific areas with a higher or lower relative incidence of problems." A similar change has been made to the following paragraph on repair data.]*

The TAC believes that there are two types of situation that have lead to problems, complaints and building permits, as revealed in Appendix J. One category would be random situations, arising from poor construction of a particular system, or poor maintenance. These would account for the bulk of the lower level of occurrences per block.

The other category would be situations linked to the locality, where unusually high levels of occurrence per block are found, and in fact where in some instances several contiguous blocks have a high level of occurrence. In such instances soil and/or drainage problems deserve investigation.

In Figure 4-1, M&E has divided the 190 data blocks for sanitary survey problems into three categories: (1) 0.00 occurrences; (2) 0.01 to 0.22 occurrences per lot; and (3) over 0.22 occurrences per lot. In addition, there is a category for "no data, insufficient data or vacant," which comprises the other 50 blocks.

In Figure 4-2, M&E has divided the 240 data blocks for complaints and building permits into three categories again: (1) 0 to 0.15 occurrences per lot; (2) 0.16 to 0.25 occurrences per lot; and (3) over 0.25 occurrences per lot. Included within the 240 blocks are those for which there is "no data or vacant."

The TAC believes that the analysis has not been sufficiently detailed to reveal the nature of the problem. In Chapter 3, Mills, Frederick C, "Statistical Methods," Henry Holt and Company, New York, 1955, on frequency distributions, it is made clear that with the quantity and range of data involved in the present analysis, there should be eight to ten intervals, rather than only three. Of course such a number of data levels would make graphic presentation much more difficult. On the other hand, it would make possible the sorting out of the areas where there really is an unusually high incidence of adverse conditions.

In order to cut through the difficulties presented by the graphic presentation, we have limited ourselves to showing only those blocks in which the occurrence of adverse conditions was more than one standard deviation above the mean. The following tables compare our level of analysis with that of M&E:

TABLE A 10 : Sanitary Survey Data

Frequency Intervals (Occurrences per lot)	Frequency	Frequency Intervals (Occurrences per lot)	Frequency
M&E Analysis		**TAC Analysis**	
No data, Insufficient data or vacant	50	No data, Insufficient data or vacant	50
0.00	81	0.00-0.1647 (below the mean)	121
0.01-0.22	61	0.1648-0.3950 (mean to one standard deviation above the mean)	45
>0.22	48	0.3951-0.6253 (-to 2 S.D. above mean)	12
		0.6254-0.8556 (-to 3 S.D. above mean)	5
		0.8557-1.0859 (-to 4 S.D. above mean)	6
		>1.0860 (beyond 4 S.D. above mean)	1
Total	240		240

(Mean = 0.1647, Standard Deviation = 0.2303)

It must be obvious that the last 24 cases deserve the most attention, but with the M&E analysis they are lumped together with 24 other cases, and are presented graphically in such a way that they do not stand out. In a normal distribution curve, approximately 0.025 of the values are supposed to be found in each "tail" beyond 2 standard deviations from the mean. In the present case, we have 0.05 (12/240 = 0.05) of the cases beyond 2 standard deviations above the mean. Clearly, this is not a normal distribution; that is, the universe of data from which the values are drawn is not homogeneous. There is some factor at work other than random chance.

Chapter 4, Page 4-21

{ A 4.11 } Further analysis reveals that by compiling the values in Appendix J under the column "Sanitary Survey, Total problems/lots surveyed,"which amounts to an approximation of proportion of lots having problems, we find that 33 percent of all problems occur in blocks in the "greater than two standard deviations above the mean" group, and that over 51 percent of all problems occur in the group where the value exceeds one standard deviation above the mean. In other words, if we concentrate only on those blocks where the proportion of problems exceeds one standard deviation above the mean (the lots shaded for "Problems" on the attached map) we are dealing with more than one-half of all problems. One-tenth of the lots are the source of the preponderance of the problems. This situation is too clear to ignore.

TABLE A-11: Building permits and Complaints

Frequency Intervals (Occurrences per lot)	Frequency	Frequency Intervals (Occurrences per lot)	Frequency
M&E Analysis		**TAC Analysis**	
No data, Insufficient data or vacant	1	No data, Insufficient data or vacant	1
0.00-0.15	100	0.00-0.0569 (>one standard deviation below the mean)	32
		0.0570-0.1912 (one standard deviation below the mean to the mean)	106
0.16-0.25	68	0.1913-0.3255 (mean to one standard deviation above the mean)	72
>0.25	71	0.3256-0.4598 (-to 2 S.D. above mean)	19
		0.4599-0.5941 (-to 3 S.D. above mean)	7
		0.5942-0.7284 (-to 4 S.D. above mean)	2
		>0.7285 (beyond 4 S.D. above mean)	1
Total	240		240

(Mean = 0.1912, Standard Deviation = 0.1343)

Once again, it must be obvious that the last 29 cases deserve the preponderance of attention, but with the M&E analysis they are lumped together with 42 other cases, and are presented graphically in such a way that they do not stand out. In a normal distribution curve, approximately 0.025 of the values are supposed to be found in each "tail" beyond 2 standard deviations from the mean. In the present case, we have 0.041 (10/240 = 0.041) of the cases beyond 2 standard deviations above the mean. Clearly, this is not a normal distribution; that is, the universe of data from which the values are drawn is not homogeneous. There is some factor at work other than random chance.

Chapter 4, Page 4-22

{A 4.12 } The attached Figure A-2 shows the location of the 24 blocks with Sanitary Survey "problems" and the 29 blocks with Building Permits and Complaints, that exceed one standard deviation above the mean of their respective data. Those blocks with between one and two standard deviations from the mean are shown with light crosshatching, while those with in excess of two standard deviations from the mean are shown with heavier crosshatching. Crosshatching for the Sanitary Survey data runs northwest-southeast, while crosshatching for the Building Permit and Complaint data runs northeast-southwest. The crosshatching is superimposed on the M&E map showing depth to groundwater.

The TAC believes that the above description and the Figure A-2 show that the statements in the report to the effect that no clusters of problems can be found are inaccurate and that this situation deserves further investigation. Specifically, there appears to be a close relationship between the number of adverse conditions and the depth to groundwater.

[M&E note on A4.10, A4.11, and A4.12: footnotes have been added that recognize TAC's analysis of the data and the different conclusion drawn.]

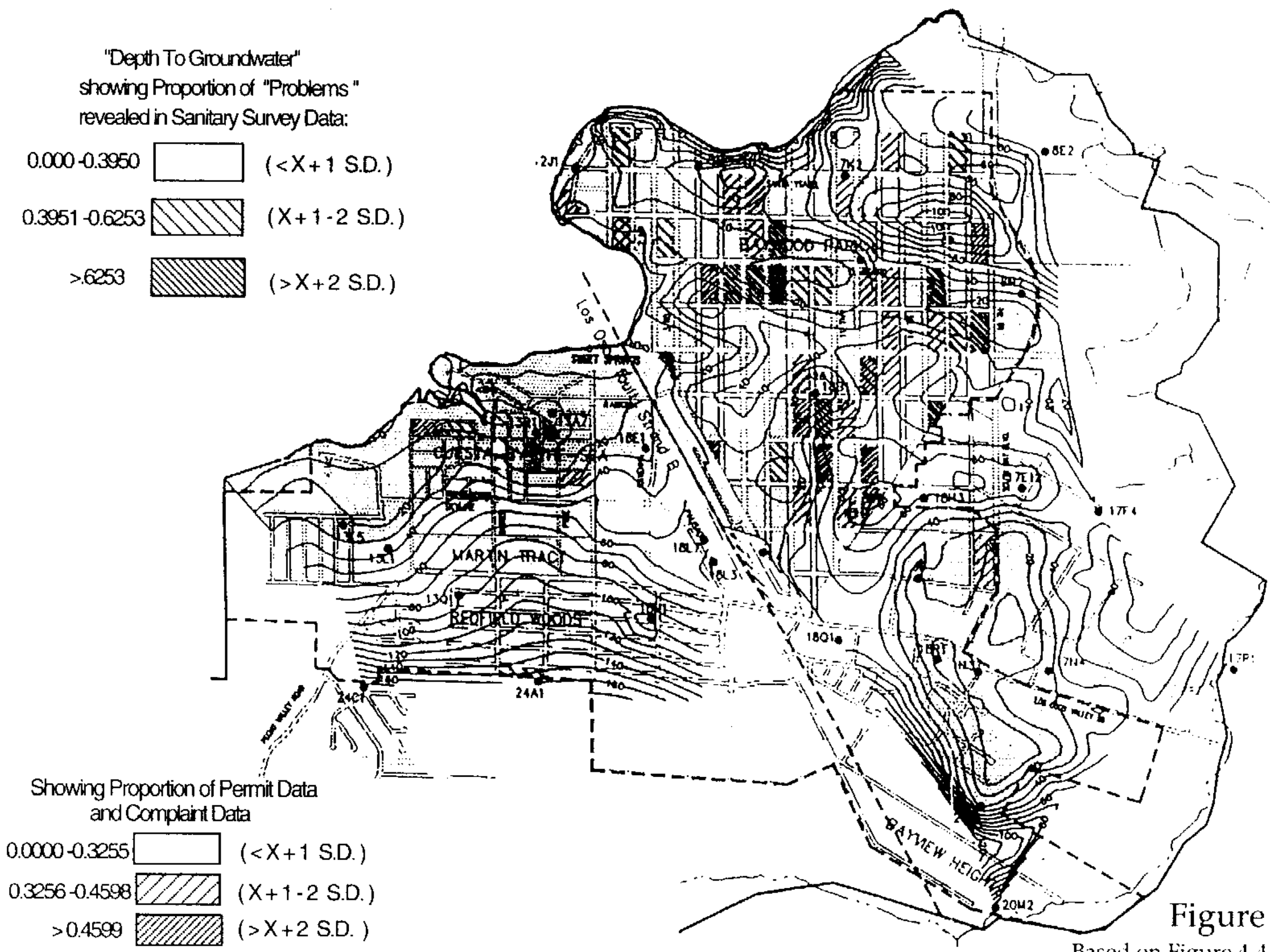


Figure A-2

Based on Figure 4-4 in Report,

Comments to Chapter 5

TAC's General Conclusion Page 5-1

{A 5.1 } Many of the problems of poor drainage of the existing septic tanks can be attributed to the County's failure to provide adequate water drainage for this community. It appears that the County is receptive to reports of poor drainage as an excuse to say that the problem is one of septic tank failures. Proper drainage would enhance septic tank functioning rather than detract from it. However, to what extent can the poor drainage be blamed for the failures of septic tanks? This question was never addressed by Metcalf and Eddy, apparently because the answer would have to conclude in part that the County has failed to provide adequate drainage for the community.

Chapter 5 (Page 5-1)

{A 5.2 } "Average annual nitrate concentrations in shallow ground water have increased since 1954." The TAC believes that no clear data indicate a consistent increase in nitrate concentration since 1954 has been demonstrated. We believe the data are too erratic, highly variable, and only represent a few sites in the community. Repeated sampling of one contaminated well does NOT mean that nitrates have increased as a trend, especially when many other wells have NOT been tested consistently over the same period. No statistical regression lines were presented to describe trends. Correlation coefficients are presented, but they are misinterpreted and misrepresented regarding their meaning. The TAC agrees with Metcalf and Eddy that "...such correlation does not establish a casual relationship between increasing nitrate and increasing population."

Chapter 5 (Page 5-1)

{A 5.3 } The TAC agrees that nitrate concentrations are highly variable, are inconsistent, and differ widely within the community. The TAC however believes that problems areas do appear in clusters and are not evenly distributed over the community but can be identified to area of high groundwater.

Chapter 5 (Page 5-1)

{A 5.4 } "Individual onsite waste water systems appear to be a major contributor of nitrate to shallow groundwater. Over 60% of the nitrate currently in shallow groundwater may be derived from onsite waste water system effluent. The data and calculations presented above provide strong evidence of a relationship between onsite waste water system effluent and groundwater nitrate." The TAC categorically disagrees with every statement in this Metcalf and Eddy conclusion. Their conclusion number 1 says that there is no cause and effect. Yet, they turn around to attribute a direct cause of high nitrate being due to onsite waste water systems in conclusion 3. The TAC believes that the wild guesses and approximations of Metcalf and Eddy's computer model and nitrogen mass loading conveniently show numbers of 60% of nitrate from on site waste water systems.

However, the TAC has provided several lines of argument and evidence that indicate that Metcalf and Eddy's numbers are guesses. No directly measured values of nitrogen mass loading are presented in this report. All of the values are guesses based upon various assumptions. The reality check of their data indicate that these guesses espoused in their nitrogen mass loading do NOT agree with the actual nitrate concentrations measured in the shallow ground water. It is extremely difficult to understand how Metcalf and Eddy's guesses could provide ANY evidence of a relationship when NO actual data have been measured on the nitrogen in the community.

Chapter 5 (Page 5-1)
{A 5.5 } The TAC denies that nitrate sources contribute only 8% of the nitrates in the shallow ground water. Metcalf and Eddy made NO actual measurements of natural nitrogen sources within the community. ALL of their nitrogen mass loading values are based upon guesses and assumptions. Several sources of nitrogen are dismissed as insignificant. However, these same sources were identified in the County's Los Osos/Baywood Park Nitrogen Study as potential nitrogen contributors to the ground water. Metcalf and Eddy made NO attempt to evaluate the actual magnitude of these sources. Instead, they chose to ignore them.

Chapter 5 (Page 5-2)
{A 5.6 } The TAC believes that problems as determined from the sanitary survey are NOT "wide spread". Problems seem to be sporadic. Although specific areas with problems are sporadic, some areas of the community with poor internal soil drainage and high ground water levels do appear to have some problems.

Chapter 5 (Page 5-2)
{A 5.7 } The TAC agrees that building permits indicate that sporadic repairs have been required for leach fields and leach pits in Los Osos. The TAC believes that the data do NOT indicate "...repairs are wide spread". Many of the leach fields and leach pits appear to have been improperly installed and inspected. George Gibson of County Engineering agreed at various meetings of the TAC that this was indeed the case. We know that tree roots often clog leach fields and this clogging often requires the installation of new leach lines. The TAC agrees that "...there are no clusters with relatively high incidence of repairs."

Chapter 5 (Page 5-2)
{A 5.8 } The TAC agrees that the County guidelines permit onsite systems in most areas of Los Osos. The TAC disagrees that a "very tight fit" exists on lots less than 15000 square feet. The TAC believes that Metcalf and Eddy has made these comments because the handbooks and guidelines written by Metcalf and Eddy prescribe lot sizes larger than those in Los Osos or those required by County Engineering or County Planning.

Chapter 5 (Page 5-2)

{A 5.9 } Metcalf and Eddy has miss-stated what they intended. The sentence starting with the word "Thus....." should read .... "30 feet or more...". The TAC agrees with this corrected statement. The TAC disagrees with the next sentence starting with "Where....". NO data support the idea that higher nitrate concentrations enter ground water when the depth to ground water is less than 30 feet. The TAC agrees that some areas of the community have a ground water table less than 30 feet from the soil surface. NO study has been made of these shallow ground water regions to justify whether or not nitrate concentrations are higher or lower where shallow depth to ground water exists in Los Osos. The County's Los Osos/Baywood Park Nitrogen Study TAC was prevented from studying the shallow ground water because the sampling site criteria assumed that a minimum depth to ground water was required for denitrification. That study pointed out that NO data have been put forth to prove or to disprove this contention. Comparison with similar biological systems suggest (but do not prove) that the nitrates should be denitrifying in the shallow ground water areas.

Table B-1. SUMMARY OF DATA AVAILABILITY AND SOURCES

Well no.	Sources & dates of available data (Note 1) SLO	DWR 73	2/1/77	RWQCB 81	1/3/79	No. of data points	Depth, ft (Note 2) Perfor-ations	Well	Included in database (Note 3)? Loca-tion	Depth	Noncon-tamination	Overall
7 B 1								143	Yes	No	Yes	No
7 F 1				81	79	2		12	Yes	Yes	Yes	Yes
7 G 1		61 70							Yes	No	Yes	No
7 G 2		61							Yes	No	Yes	No
7 G 3		61 67				9		62	Yes	Yes	Yes	Yes
7 J 1		57				1	80 80		Yes	Yes	Yes	Yes
7 L 3	82 94					32	42 45		Yes	Yes	Yes	Yes
7 N 1	82 94	54 72	54 76	81	78 79	44	61 83	84	Yes	Yes	Yes	Yes
7 Q 1	82 94	59 72	59 76			59	29 75	75	Yes	Yes	Yes	Yes
7 R 1	82 87					3	27 30		Yes	Yes	Yes	Yes
8 J 1		57 73	57 76		79			56	No	Yes	Yes	No
8 M 2		70 71				2		95	Yes	Yes	Yes	Yes
8 M 3			70 76	81	78	10	80 120	120	Yes	Yes	Yes	Yes
8 R 1		61 67	67 76		78			68	No	Yes	Yes	No
12 J 1	83 93	71 72	54 76				389 394		Yes	No	Yes	No
13 A 1		61 65				4		30	Yes	Yes	Yes	Yes
13 A 2		61 65	61 75			8		30	Yes	Yes	Yes	Yes
13 A 3		61							Yes	No	Yes	No
13 A 4		61							Yes	No	Yes	No
13 A 5		61							Yes	No	Yes	No
13 A 6		61 65				3		20	Yes	Yes	Yes	Yes
13 A 7	82 94					31	30 40		Yes	Yes	Yes	Yes
13 B 1		61							Yes	No	Yes	No
13 B 2		61 67				10		20	Yes	Yes	Yes	Yes
13 G 2		61 70	61 76	81	78	15		30	Yes	Yes	Yes	Yes
13 H 1	82 93		74 76		78		36 44	34	Yes	Yes	No (Note 4)	No
13 K 1			74 76		78			138	Yes	No	Yes	No
13 L 1	87	60 70			78 79	14	80 140		Yes	Yes	Yes	Yes
13 L 2		61 70			78		100 140		Yes	No	Yes	No
13 L 5	82 94					32	32 35		Yes	Yes	Yes	Yes
13 P 1		54 61	54 76	81			115 135	135	Yes	No	Yes	No
13 Q 1	82 94					32	97 100		Yes	Yes	Yes	Yes
17 A 2		70							No	No	Yes	No
17 B 1		61							Yes	No	Yes	No
17 E 1					78			282	Yes	No	Yes	No
17 E 4			74 76		78			250	Yes	No	Yes	No
17 F 2			74 76		78			200	Yes	No	Yes	No
17 F 4	82 94		74 76		78	40	48 72		Yes	Yes	Yes	Yes
17 F 6				81	78			118	Yes	No	Yes	No
17 H 2			74 76		78	3	67 102		Yes	Yes	Yes	Yes
17 L 1				81		1	90 110	110	Yes	Yes	Yes	Yes
17 L 4	83 87					7	80 85		Yes	Yes	Yes	Yes
17 M 1									Yes	No	Yes	No
17 M 2		73							Yes	No	Yes	No
17 M 6				81				134	Yes	No	Yes	No

Table B-1. SUMMARY OF DATA AVAILABILITY AND SOURCES

Well no.	Sources & dates of available data (Note 1): SLO	DWR 73	2/1/77	RWQCB 81	1/3/79	No. of data points	Depth, ft (Note 2): Perforations	Well	Included in database (Note 3)?: Location	Depth	Noncontamination	Overall
17 N 4				81		1	40 60	60	Yes	Yes	Yes	Yes
17 P 3				81			70 160	150	Yes	Yes	Yes	Yes
17 Q 1			74						Yes	No	Yes	No
17 R 1	82 87						45 65		No	Yes	Yes	No
18 A 2				81		1		75	Yes	Yes	Yes	Yes
18 B 1	82 87						29 32		Yes	Yes	No (Note 4)	No
18 D 1S		70 73							Yes	No	Yes	No
18 D 2				81		1	73 88	90	Yes	Yes	Yes	Yes
18 F 1			72 76		78 79		183 345	361	Yes	No	Yes	No
18 F 2			76		78 79			645	Yes	No	Yes	No
18 H 1	87	59 72	59 76		78 79		113 231	232	Yes	No	Yes	No
18 H 2			74 76		78				Yes	No	Yes	No
18 H 5			73 76		78				Yes	No	Yes	No
18 J 1		61			78		130 210		Yes	No	Yes	No
18 J 2		61	61 76		78				Yes	No	Yes	No
18 J 3		61	61 76		78			185	Yes	No	Yes	No
18 J 4			74 75			5		60	Yes	Yes	Yes	Yes
18 J 6	82 94					28	22 25		Yes	Yes	Yes	Yes
18 K 1		65 72	65 76		78		170 254	234	Yes	No	Yes	No
18 K 3		69	75		79		148 232		Yes	No	Yes	No
18 K 5				81		1	76 92	92	Yes	Yes	Yes	Yes
18 L 1							183 346		Yes	No	Yes	No
18 L 7	87						180 220		Yes	No	Yes	No
18 N 1	82 87					3	87 90		Yes	Yes	Yes	Yes
18 P 1							170 230		Yes	No	Yes	No
18 Q 1	82 90	54 69					76 86		Yes	Yes	No (Note 4)	No
18 Q 2		62 66							Yes	No	Yes	No
18 R 1	82 94	65		81		39	40 50	50	Yes	Yes	Yes	Yes
20 A 1			74 76		78		67 105		No	Yes	Yes	No
20 A 2			74 76		78		45 65	66	No	Yes	Yes	No
20 A 4			76		78 79		30 50		No	Yes	Yes	No
20 B 1		72	72 76		78 79		100 183	183	Yes	No	Yes	No
20 B 3			74			1	60 120		Yes	Yes	Yes	Yes
20 D 1		70		81		2	47 57	57	Yes	Yes	Yes	Yes
20 E 1	94					1		80	Yes	Yes	Yes	Yes
20 L 1		70						119	Yes	No	Yes	No
21 D 2	89						85 175		No	Yes	Yes	No
21 D 4		73					40 160		No	Yes	Yes	No
21 D 9	89 93								No	No	Yes	No
21 D 12				81				125	No	No	Yes	No
21 D 13	84 87			81			35 100	100	No	Yes	Yes	No
21 E 1		70	65 75				100 143		No	No	Yes	No
21 E 3			73 76		78		60 100		No	Yes	Yes	No

Table B-1. SUMMARY OF DATA AVAILABILITY AND SOURCES

Well no.	Sources & dates of available data (Note 1) SLO	DWR 73	2/1/77	RWQCB 81	1/3/79	No. of data points	Depth, ft (Note 2) Perfor-ations	Well	Included in database (Note 3)? Loca-tion	Depth	Noncon-tamination	Overall
22 L 1		54							Yes	No	Yes	No
23 H 1		61 70						143	Yes	No	Yes	No
24 A 1		63 72					172 248		Yes	No	Yes	No
Total						445						

NOTES:

1. Range of years for which data is available from the following sources.

   SLO: Baywood Park Grundwater Study. Fourth Quarter Report. San Luis Obispo County Engineering Department. Water Quality Laboratory. 1993. Also, other unpublished County Engineering Department data.

   DWR 73: California Department of Water Resources. Southern District. Los Osos-Baywood Park Groundwater Protection Study. October 1973.

   2/1/77: Protopapas, G.C. Letter to Advisory Group. County Service Area No. 9. February 1, 1977.

   RWQCB 81: Aleshire, R. and Coray, C. Report on Nitrate Contamination in Shallow Wells. California Regional Water Quality Control Board, Central Coast Region. March 24-26, 1981.

   1/3/79: Protopapas, G.C. Letter to Advisory Group. County Service Area No. 9. January 3, 1979. and attachment thereto.

2. Depth of performations is from San Luis Obispo County Service Area No. 9. Los Osos Baywood Park Phase 1 Water Quality Management Study. Volume 1 – Project Report. Brown and Caldwell. April 1983. Pages 5-9 to 5-13.

   Depth of wells is from sources in Note 1.

3. Criteria for including in database:

	Location	Depth	Noncontamination
"Yes"	Within the Urban Reserve Line, i.e., Sections 7, 8 (except J1 and R1), 12, 13, 17 (except R1 and A2), 18, 19, 20 (except A1, A2, and A4), 23, and 24.	Highest perforation less than or equal to 100 ft.	No contamination from ground surface suspected.
"No"	Other Sections, i.e., 16 and 21; Wells 8J1, 8R1, 17A2, 17R1, 20A1, 20A2, and 20A4.	Lowest perforation greater than 100 ft or no depth data.	Direct contamination from ground surface suspected.

4. Source: Baywood Park Groundwater Study. Fourth Quarter Report. San Luis Obispo County Engineering Department. Water Quality Laboratory. 1993; and unpublished data for 1994.

Table B-2. ANNUAL AVERAGES				
	Nitrate, mg/L as NO3		No. of ob-	Population
Year	Mean	Median	servations	URL*
1950				600
1954	6.5	6.5	2	
1957	10.3	12.0	4	
1958	13.0	13.0	2	
1959	2.4	2.0	3	
1960	16.2	16.2	2	1,480
1961	17.3	14.0	10	
1962	25.6	15.5	10	
1963	24.1	7.4	3	
1964	20.8	17.0	6	
1965	13.6	6.0	7	
1966	13.4	13.0	8	
1967	11.9	7.5	9	
1968	0.1	0.1	1	
1969	10.0	10.0	2	
1970	24.9	21.0	7	3,487
1971	19.1	21.0	9	
1972	15.7	22.0	9	
1973	18.0	18.0	2	
1974	40.7	36.3	17	
1975	51.0	41.9	10	
1976	27.2	33.7	7	
1977	21.0	13.7	7	
1978	15.7	14.7	6	
1979	18.5	15.5	3	
1980			0	10,933
1981	32.1	33.0	11	
1982	39.5	36.1	10	
1983	45.8	50.4	10	
1984	44.1	38.7	30	
1987	45.9	55.4	40	
1988	56.5	58.3	19	
1989	51.8	57.2	35	
1990	58.8	62.0	30	14,377
1991	49.0	59.0	35	
1992	43.8	41.8	34	
1993	47.4	49.7	35	
1994	48.7	55.7	10	**
Total			445	

* Urban Reserve Line; from U.S. Census.
** Through March.

Table B–3. DETAILED DATABASE		
Well	Date	Nitrate, mg/L as NO3
13A1	Aug–61	27.0
13A1	Jul–62	34.0
13A1	Jul–64	41.0
13A1	Aug–65	45.0
13A2	Aug–61	21.0
13A2	Jul–64	21.0
13A2	Aug–65	21.0
13A2	May–74	77.5
13A2	Jul–74	38.1
13A2	Dec–74	44.3
13A2	May–75	29.2
13A2	Dec–75	86.4
13A6	Jul–61	53.0
13A6	Jul–64	42.0
13A6	Aug–65	2.0
13A7	Oct–83	52.4
13A7	Jan–84	38.7
13A7	Jul–84	32.1
13A7	Oct–84	38.7
13A7	Mar–87	39.6
13A7	Jul–87	37.8
13A7	Oct–87	39.6
13A7	Dec–87	36.5
13A7	Oct–88	42.2
13A7	Dec–88	35.6
13A7	Mar–89	38.7
13A7	Jul–89	47.1
13A7	Oct–89	46.6
13A7	Dec–89	48.8
13A7	Mar–90	54.1
13A7	Jul–90	45.3
13A7	Oct–90	70.8
13A7	Dec–90	75.7
13A7	Mar–91	60.7
13A7	Jul–91	54.1
13A7	Oct–91	62.9
13A7	Dec–91	50.6
13A7	Mar–92	49.7
13A7	Jul–92	37.4
13A7	Oct–92	49.3
13A7	Dec–92	49.7
13A7	Mar–93	52.8
13A7	Jul–93	44.0
13A7	Oct–93	49.7
13A7	Dec–93	52.8
13A7	Mar–94	61.6
13B2	Aug–61	34.0
13B2	Jul–62	70.0
13B2	Oct–62	80.0
13B2	Jul–63	62.0
13B2	Jul–64	5.0

Table B-3. DETAILED DATABASE

Well	Date	Nitrate, mg/L as NO3
13B2	Aug-65	5.0
13B2	Jul-66	23.0
13B2	Oct-66	25.0
13B2	May-67	35.0
13B2	Dec-67	2.0
13G2	Aug-61	4.0
13G2	Jul-62	18.0
13G2	Oct-62	14.0
13G2	Mar-70	92.0
13G2	May-74	97.5
13G2	Jul-74	85.1
13G2	Dec-74	69.1
13G2	Dec-74	79.7
13G2	May-75	101.9
13G2	Dec-75	113.0
13G2	Dec-76	35.0
13G2	Dec-76	55.8
13G2	Oct-77	55.4
13G2	Dec-78	35.9
13G2	Mar-81	42.0
13L1	Aug-61	0.0
13L1	Jul-62	6.0
13L1	Oct-62	7.0
13L1	Jul-63	7.4
13L1	Aug-65	6.0
13L1	Jul-66	7.0
13L1	Oct-66	5.4
13L1	May-67	7.0
13L1	Dec-67	6.0
13L1	Mar-70	10.0
13L1	Oct-77	13.7
13L1	Dec-78	11.2
13L1	Jan-79	15.5
13L1	Aug-87	41.2
13L5	Jul-82	35.2
13L5	Oct-83	76.1
13L5	Jan-84	86.2
13L5	May-84	110.4
13L5	Aug-84	176.0
13L5	Mar-87	74.8
13L5	May-87	64.2
13L5	Oct-87	79.6
13L5	Jan-88	75.7
13L5	Oct-88	108.2
13L5	Dec-88	117.9
13L5	Mar-89	114.8
13L5	Jul-89	117.0
13L5	Oct-89	124.1
13L5	Dec-89	99.0
13L5	Mar-90	97.7

Table B−3. DETAILED DATABASE		
Well	Date	Nitrate, mg/L as NO3
13L5	Jul−90	98.1
13L5	Oct−90	95.0
13L5	Dec−90	95.5
13L5	Mar−91	69.5
13L5	Jul−91	70.4
13L5	Oct−91	62.5
13L5	Dec−91	59.8
13L5	Mar−92	41.8
13L5	Jul−92	26.4
13L5	Oct−92	26.0
13L5	Dec−92	30.4
13L5	Mar−93	37.8
13L5	Jul−93	25.5
13L5	Oct−93	29.5
13L5	Dec−93	31.2
13L5	Mar−94	48.4
13Q1	Jul−82	46.6
13Q1	Oct−83	87.6
13Q1	Jan−84	77.0
13Q1	May−84	72.6
13Q1	Aug−84	74.4
13Q1	Mar−87	70.8
13Q1	May−87	64.2
13Q1	Oct−87	71.3
13Q1	Dec−87	71.7
13Q1	Oct−88	86.7
13Q1	Dec−88	84.0
13Q1	Mar−89	79.2
13Q1	Jul−89	73.9
13Q1	Oct−89	73.9
13Q1	Dec−89	84.5
13Q1	Mar−90	101.2
13Q1	Jul−90	69.5
13Q1	Oct−90	78.8
13Q1	Dec−90	106.5
13Q1	Mar−91	93.3
13Q1	Jul−91	92.4
13Q1	Oct−91	97.2
13Q1	Dec−91	103.0
13Q1	Mar−92	95.5
13Q1	Jul−92	93.3
13Q1	Oct−92	94.2
13Q1	Dec−92	105.6
13Q1	Mar−93	101.2
13Q1	Jul−93	92.4
13Q1	Oct−93	89.3
13Q1	Dec−93	105.6
13Q1	Mar−94	101.2
17F4	May−74	3.1
17F4	Dec−74	2.1

Table B-3. DETAILED DATABASE		
Well	Date	Nitrate, mg/L as NO3
17F4	May-75	1.8
17F4	Dec-75	8.4
17F4	Dec-76	0.9
17F4	Dec-76	2.7
17F4	Oct-77	0.9
17F4	Dec-78	1.5
17F4	Mar-82	0.4
17F4	Oct-83	19.4
17F4	Mar-84	1.3
17F4	May-84	0.0
17F4	Aug-84	1.8
17F4	Mar-87	10.6
17F4	Jul-87	18.9
17F4	Aug-87	13.6
17F4	Dec-87	5.3
17F4	Aug-88	9.7
17F4	Jan-89	2.2
17F4	Mar-89	4.8
17F4	Jul-89	5.7
17F4	Aug-89	5.3
17F4	Dec-89	1.3
17F4	Mar-90	3.3
17F4	Jul-90	6.6
17F4	Oct-90	6.6
17F4	Dec-90	3.5
17F4	Mar-91	1.7
17F4	Jul-91	2.8
17F4	Oct-91	2.9
17F4	Dec-91	2.8
17F4	Mar-92	2.4
17F4	Jul-92	5.7
17F4	Aug-92	2.9
17F4	Dec-92	3.5
17F4	Mar-93	2.9
17F4	Jul-93	3.2
17F4	Aug-93	5.3
17F4	Dec-93	4.0
17F4	Mar-94	2.6
17H2	Dec-74	9.5
17H2	Dec-76	46.5
17H2	Nov-78	19.9
17L1	Mar-81	9.0
17L4	Oct-83	19.4
17L4	Jan-84	19.4
17L4	May-84	19.2
17L4	Aug-84	19.4
17L4	Jul-87	18.0
17L4	Oct-87	16.7
17L4	Dec-87	15.8
17N4	Mar-81	33.0
18A2	Mar-81	44.0
18D2	Mar-81	39.0

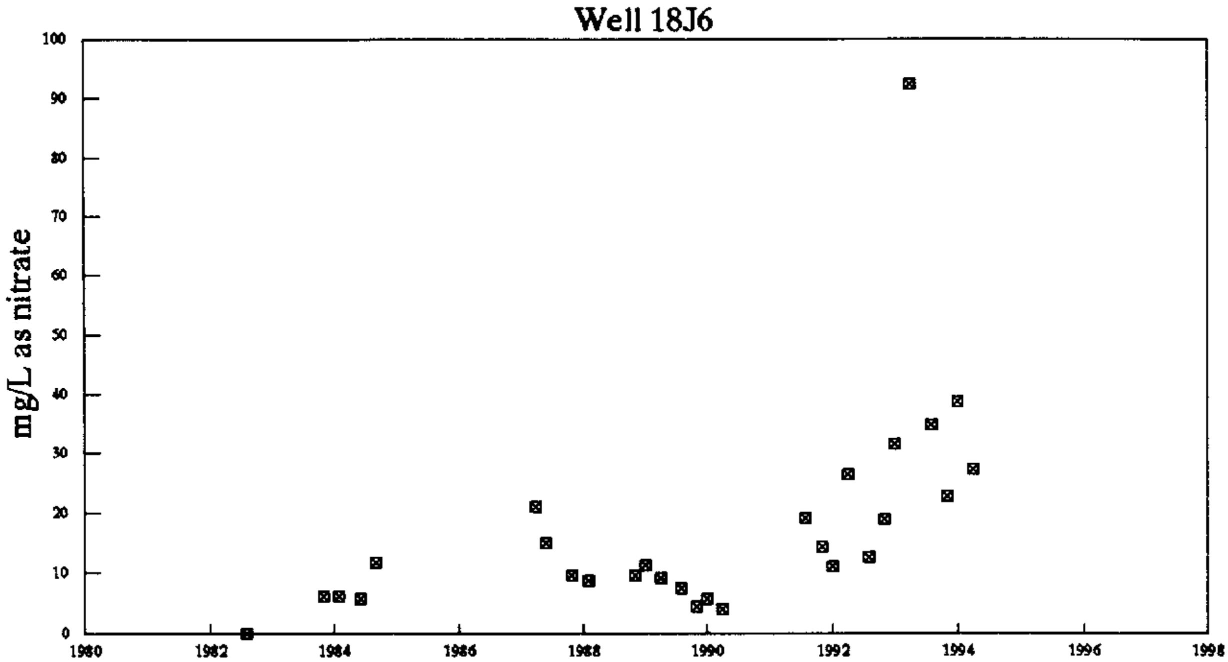
Table B-3. DETAILED DATABASE		
Well	Date	Nitrate, mg/L as NO3
18J4	May-74	43.4
18J4	Jul-74	36.3
18J4	Dec-74	32.8
18J4	May-75	23.5
18J4	Dec-75	61.6
18J6	Jul-82	0.0
18J6	Oct-83	6.2
18J6	Jan-84	6.2
18J6	May-84	5.7
18J6	Aug-84	11.9
18J6	Mar-87	21.1
18J6	May-87	15.0
18J6	Oct-87	9.7
18J6	Jan-88	8.8
18J6	Oct-88	9.7
18J6	Dec-88	11.4
18J6	Mar-89	9.2
18J6	Jul-89	7.5
18J6	Oct-89	4.4
18J6	Dec-89	5.7
18J6	Mar-90	4.0
18J6	Jul-91	19.2
18J6	Oct-91	14.3
18J6	Dec-91	11.2
18J6	Mar-92	26.4
18J6	Jul-92	12.8
18J6	Oct-92	18.9
18J6	Dec-92	31.7
18J6	Mar-93	92.4
18J6	Jul-93	34.8
18J6	Oct-93	22.9
18J6	Dec-93	38.7
18J6	Mar-94	27.3
18K5	Mar-81	27.0
18N1	Jul-82	93.7
18N1	Jul-87	70.4
18N1	Oct-87	66.9
18R1	Jul-54	8.7
18R1	Aug-57	11.0
18R1	Oct-58	26.0
18R1	Jul-59	4.0
18R1	Oct-60	27.0
18R1	Aug-65	3.0
18R1	Oct-77	0.0
18R1	Mar-81	31.0
18R1	Mar-82	37.0
18R1	Oct-83	52.4
18R1	Jan-84	48.4
18R1	Jul-84	58.5
18R1	Aug-84	60.3
18R1	Mar-87	66.0

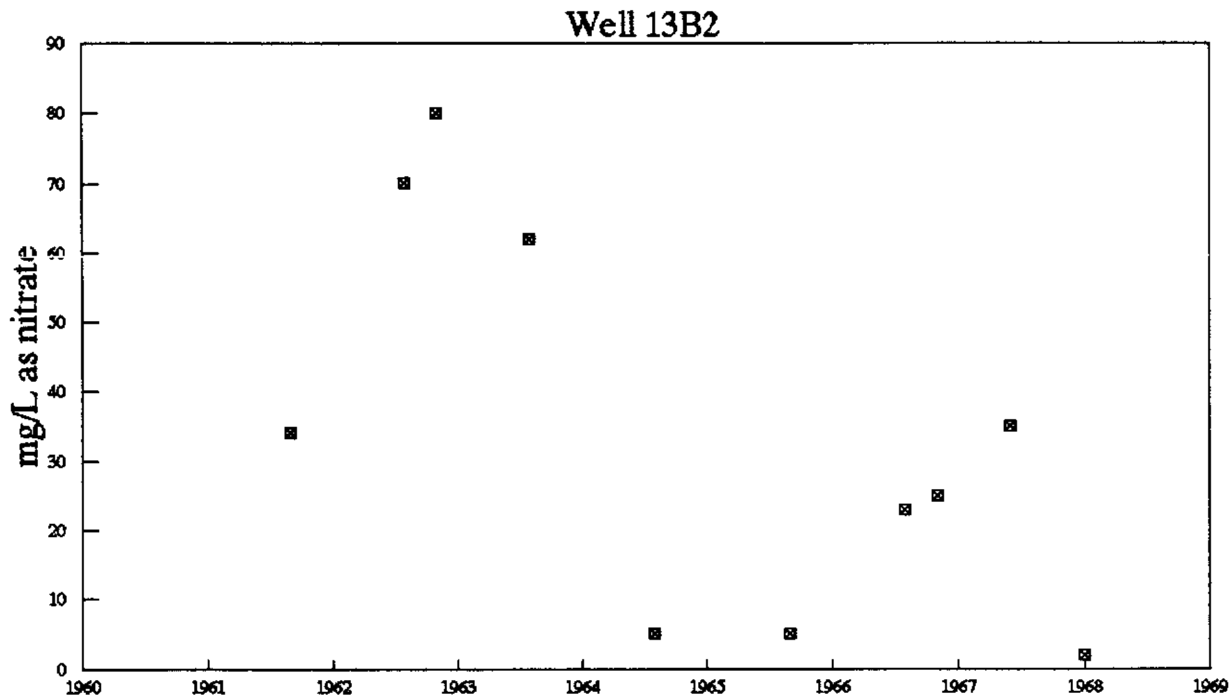
Table B-3. DETAILED DATABASE		
Well	Date	Nitrate, mg/L as NO3
18R1	May-87	59.4
18R1	Oct-87	64.2
18R1	Jan-88	66.9
18R1	Oct-88	79.6
18R1	Dec-88	80.5
18R1	Mar-89	81.0
18R1	Jul-89	86.7
18R1	Oct-89	78.3
18R1	Dec-89	81.0
18R1	Jul-90	80.5
18R1	Oct-90	57.2
18R1	Dec-90	87.6
18R1	Mar-91	76.1
18R1	Jul-91	83.6
18R1	Oct-91	55.0
18R1	Dec-91	61.2
18R1	Mar-92	63.4
18R1	Jul-92	61.6
18R1	Oct-92	37.8
18R1	Dec-92	42.7
18R1	Mar-93	52.8
18R1	Jul-93	52.8
18R1	Oct-93	40.5
18R1	Dec-93	48.4
18R1	Mar-94	57.2
20B3	Jul-74	8.9
20D1	Mar-70	6.0
20D1	Mar-81	53.0
7F1	Mar-81	31.0
7F1	May-79	31.0
7G3	Aug-61	13.0
7G3	Jul-62	8.0
7G3	Jul-64	13.0
7G3	Aug-65	13.0
7G3	Jul-66	12.0
7G3	Oct-66	14.0
7G3	Jan-67	14.0
7G3	May-67	11.0
7G3	Dec-67	8.0
7J1	Mar-57	13.0
7L3	Jul-82	18.9
7L3	Oct-83	84.9
7L3	Jan-84	90.2
7L3	May-84	42.7
7L3	Aug-84	35.6
7L3	Mar-87	82.3
7L3	May-87	69.5
7L3	Oct-87	49.7
7L3	Dec-87	55.4
7L3	Oct-88	54.6

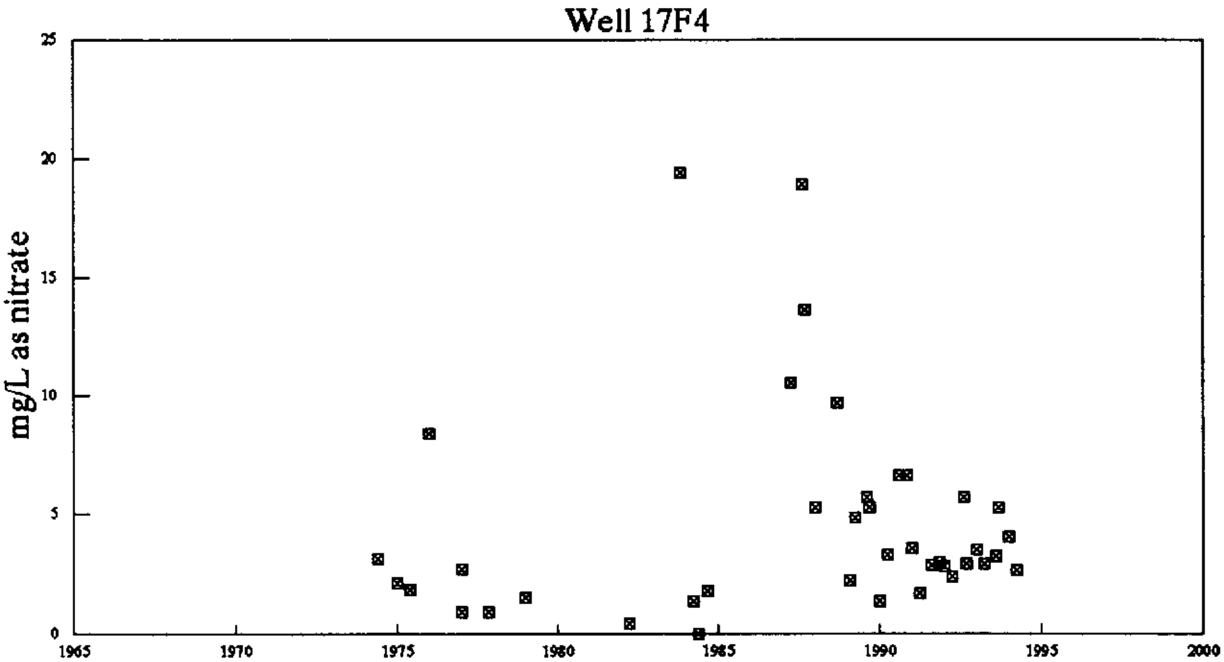
Table B-3. DETAILED DATABASE		
Well	Date	Nitrate, mg/L as NO3
7L3	Dec-88	59.0
7L3	Mar-89	72.6
7L3	Jul-89	59.4
7L3	Oct-89	57.2
7L3	Dec-89	49.7
7L3	Mar-90	60.7
7L3	Jul-90	62.0
7L3	Oct-90	57.6
7L3	Dec-90	70.4
7L3	Mar-91	60.7
7L3	Jul-91	57.6
7L3	Oct-91	70.0
7L3	Dec-91	47.1
7L3	Mar-92	60.7
7L3	Jul-92	68.6
7L3	Oct-92	77.4
7L3	Dec-92	66.4
7L3	Mar-93	57.2
7L3	Jul-93	61.6
7L3	Oct-93	56.8
7L3	Dec-93	57.2
7L3	Mar-94	61.6
7N1	Oct-54	4.3
7N1	Aug-57	13.0
7N1	Oct-57	4.3
7N1	Oct-58	0.0
7N1	Jul-59	2.0
7N1	Aug-61	2.3
7N1	Dec-61	3.9
7N1	Oct-62	2.0
7N1	Oct-63	3.0
7N1	Oct-64	3.0
7N1	Oct-66	2.8
7N1	Dec-67	3.0
7N1	Dec-69	2.0
7N1	Dec-70	2.0
7N1	Aug-71	1.1
7N1	Mar-72	1.0
7N1	Jul-73	6.0
7N1	Oct-74	3.8
7N1	Oct-77	8.2
7N1	Dec-78	7.4
7N1	Mar-82	22.0
7N1	Jan-79	8.9
7N1	Mar-81	9.0
7N1	Oct-83	11.0
7N1	Jan-84	12.8
7N1	May-84	6.2
7N1	Aug-84	9.2
7N1	May-87	7.5

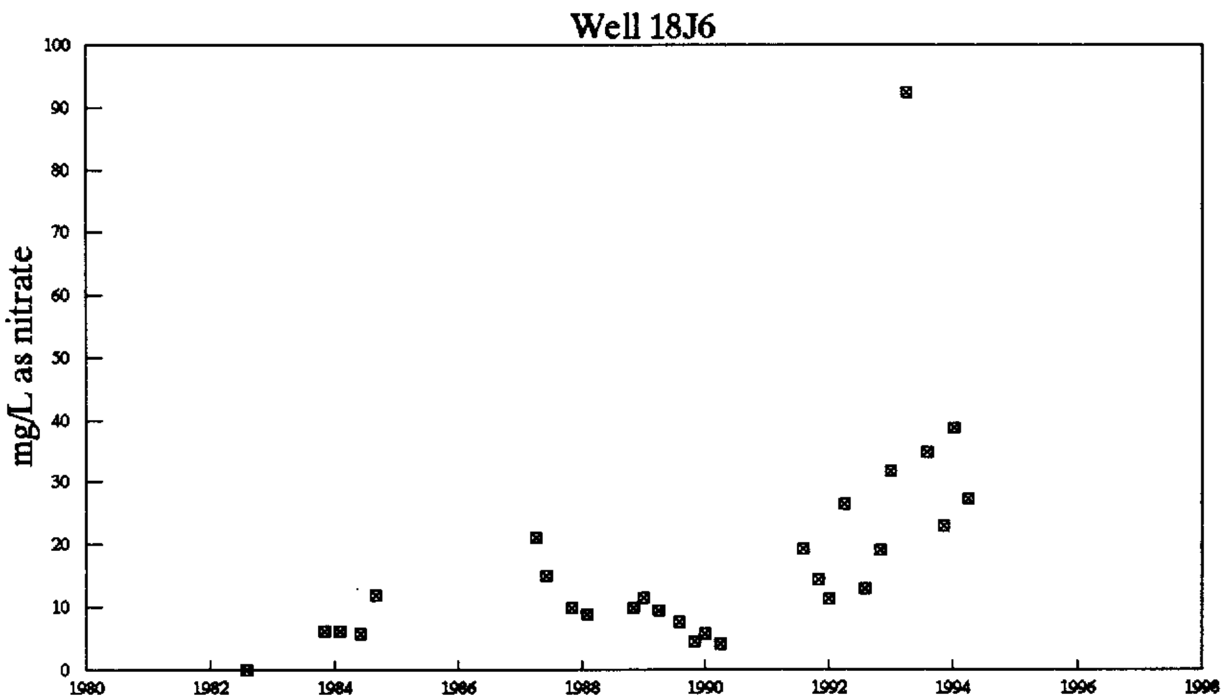
Table B-3. DETAILED DATABASE		
Well	Date	Nitrate, mg/L as NO3
7N1	Oct-87	8.8
7N1	Dec-87	7.5
7N1	Dec-88	8.4
7N1	Jul-89	9.7
7N1	Dec-89	11.0
7N1	Jul-90	11.9
7N1	Dec-90	11.4
7N1	Jul-91	9.6
7N1	Aug-91	10.8
7N1	Dec-91	10.0
7N1	Jul-92	11.0
7N1	Dec-92	11.0
7N1	Jul-93	12.8
7N1	Oct-93	11.4
7N1	Dec-93	12.8
7N1	Mar-94	11.0
7Q1	Dec-59	1.3
7Q1	Aug-60	5.3
7Q1	Aug-61	15.0
7Q1	Oct-62	17.0
7Q1	Oct-66	18.0
7Q1	Dec-67	21.0
7Q1	Jan-68	0.1
7Q1	Dec-69	18.0
7Q1	Mar-70	22.0
7Q1	May-71	24.0
7Q1	Jul-71	21.0
7Q1	Aug-71	22.0
7Q1	Oct-71	22.0
7Q1	Oct-71	20.0
7Q1	Dec-71	28.0
7Q1	Jan-72	22.0
7Q1	Mar-72	24.0
7Q1	Mar-72	23.0
7Q1	May-72	22.0
7Q1	May-72	2.3
7Q1	Jul-72	21.0
7Q1	Aug-72	2.2
7Q1	Oct-72	24.0
7Q1	Jul-73	30.0
7Q1	Oct-74	28.8
7Q1	Oct-77	42.0
7Q1	Mar-82	54.1
7Q1	Oct-83	48.4
7Q1	Mar-84	52.8
7Q1	May-84	60.3
7Q1	Aug-84	55.0
7Q1	Mar-87	61.6
7Q1	May-87	60.7
7Q1	Oct-87	59.0

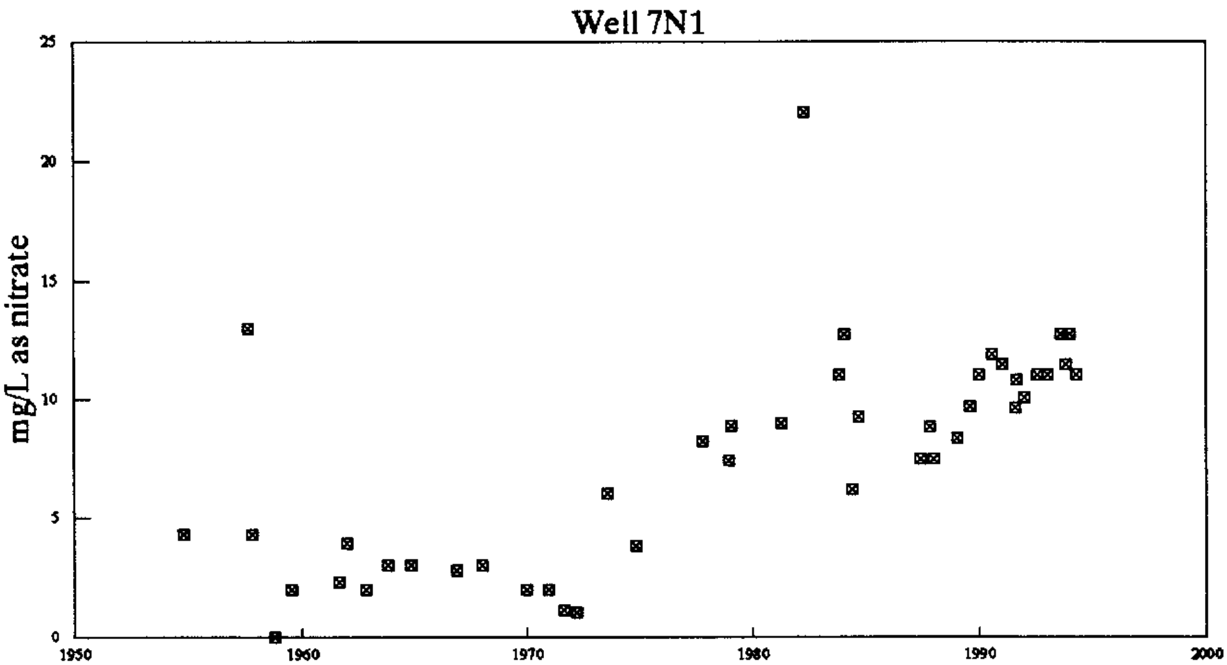
Table B-3. DETAILED DATABASE		
Well	Date	Nitrate, mg/L as NO3
7Q1	Dec-87	54.1
7Q1	Oct-88	59.4
7Q1	Dec-88	57.6
7Q1	Mar-89	58.5
7Q1	Jul-89	57.6
7Q1	Oct-89	63.8
7Q1	Dec-89	53.2
7Q1	Mar-90	73.5
7Q1	Jul-90	49.7
7Q1	Oct-90	36.1
7Q1	Dec-90	59.0
7Q1	Mar-91	52.4
7Q1	Jul-91	61.6
7Q1	Oct-91	70.4
7Q1	Dec-91	59.0
7Q1	Mar-92	41.8
7Q1	Jul-92	19.8
7Q1	Oct-92	60.3
7Q1	Dec-92	61.6
7Q1	Mar-93	61.6
7Q1	Jul-93	70.4
7Q1	Oct-93	79.2
7Q1	Dec-93	66.0
7Q1	Mar-94	61.6
7R1	Jul-82	86.7
7R1	May-87	70.4
7R1	Aug-87	71.7
8M2	Mar-70	21.0
8M2	May-71	17.0
8M3	Mar-70	21.0
8M3	May-71	17.0
8M3	Dec-74	31.1
8M3	May-75	29.2
8M3	Dec-75	54.5
8M3	Dec-76	16.0
8M3	Dec-76	33.7
8M3	Oct-77	26.8
8M3	Dec-78	18.2
8M3	Mar-81	35.0
20E1	Jun-94	54.1

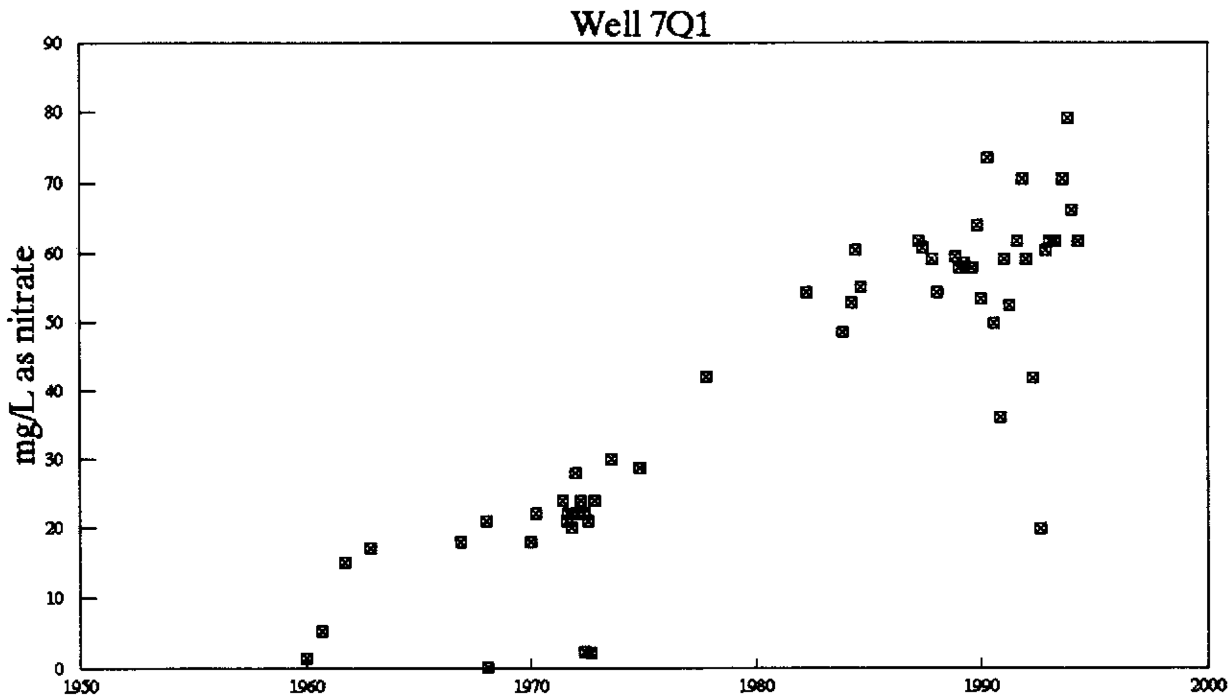

Well 18J6
mg/L as nitrate
100
90
80
70
60
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998

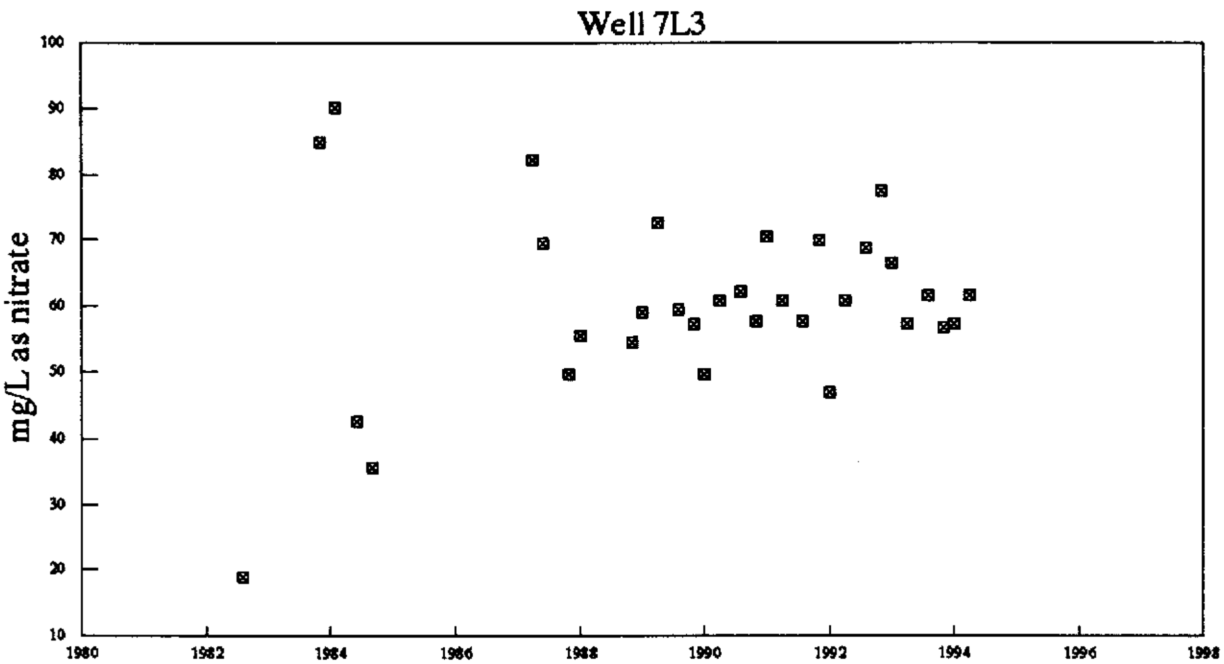

Well 13B2
mg/L as nitrate
90
80
70
60
50
40
30
20
10
0
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969

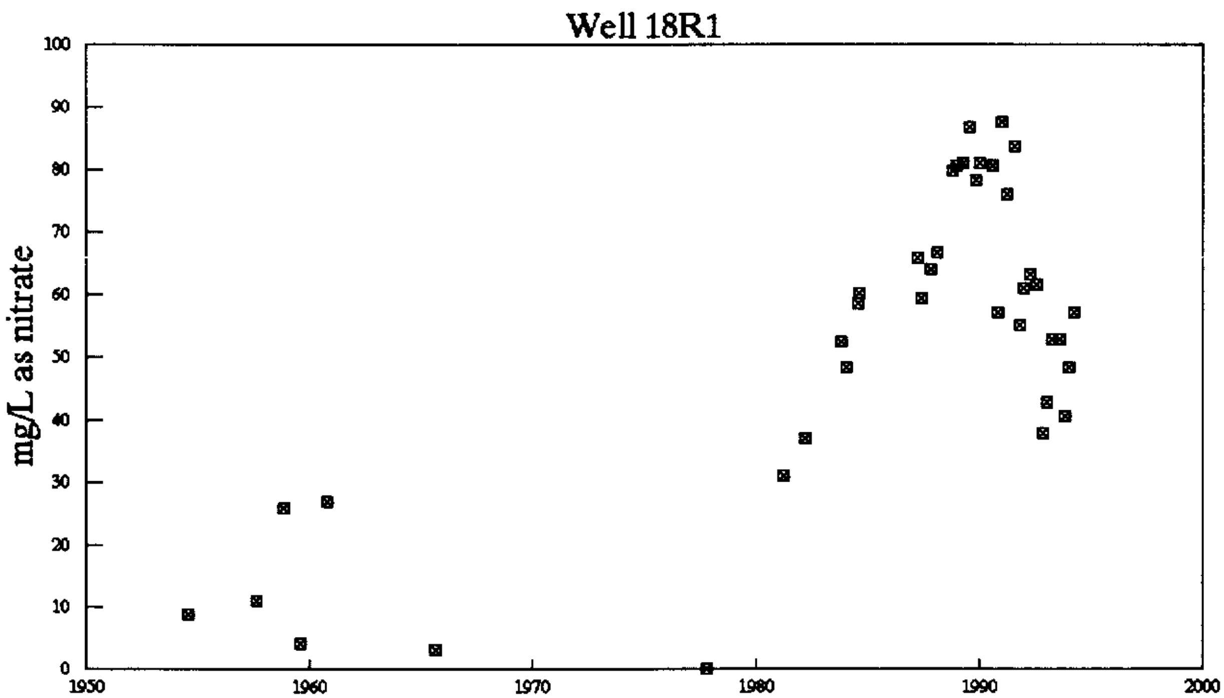

Well 17F4
mg/L as nitrate
0
5
10
15
20
25
1965
1970
1975
1980
1985
1990
1995
2000

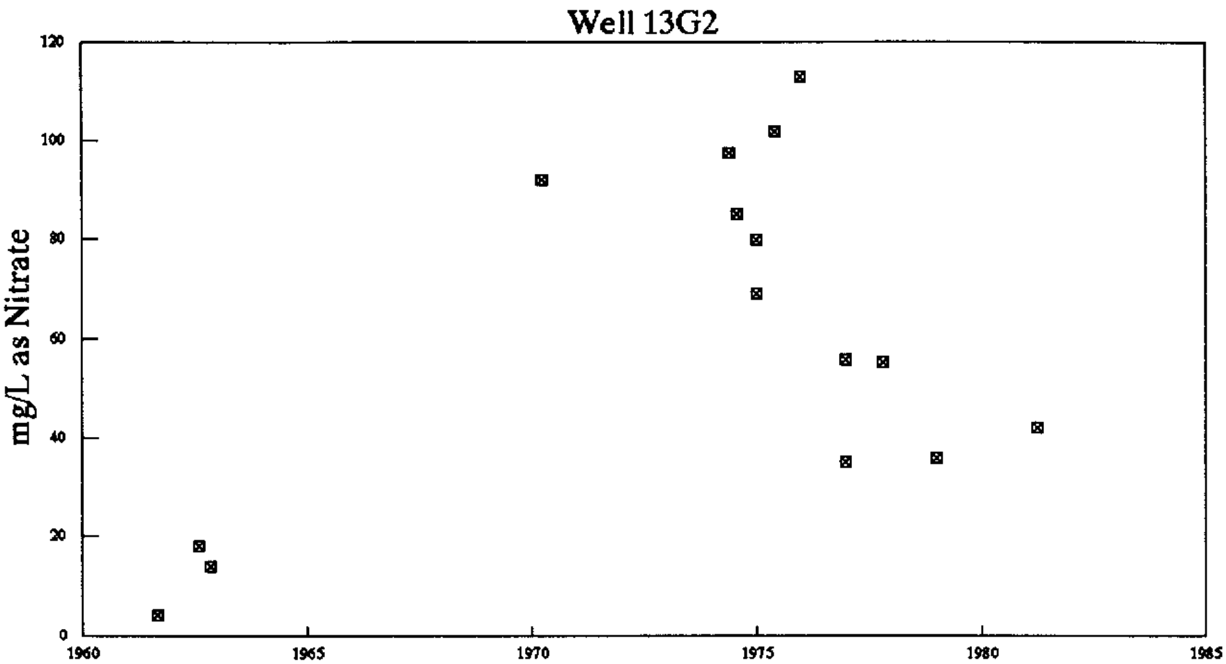

Well 18J6
mg/L as nitrate
0
10
20
30
40
50
60
70
80
90
100
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998

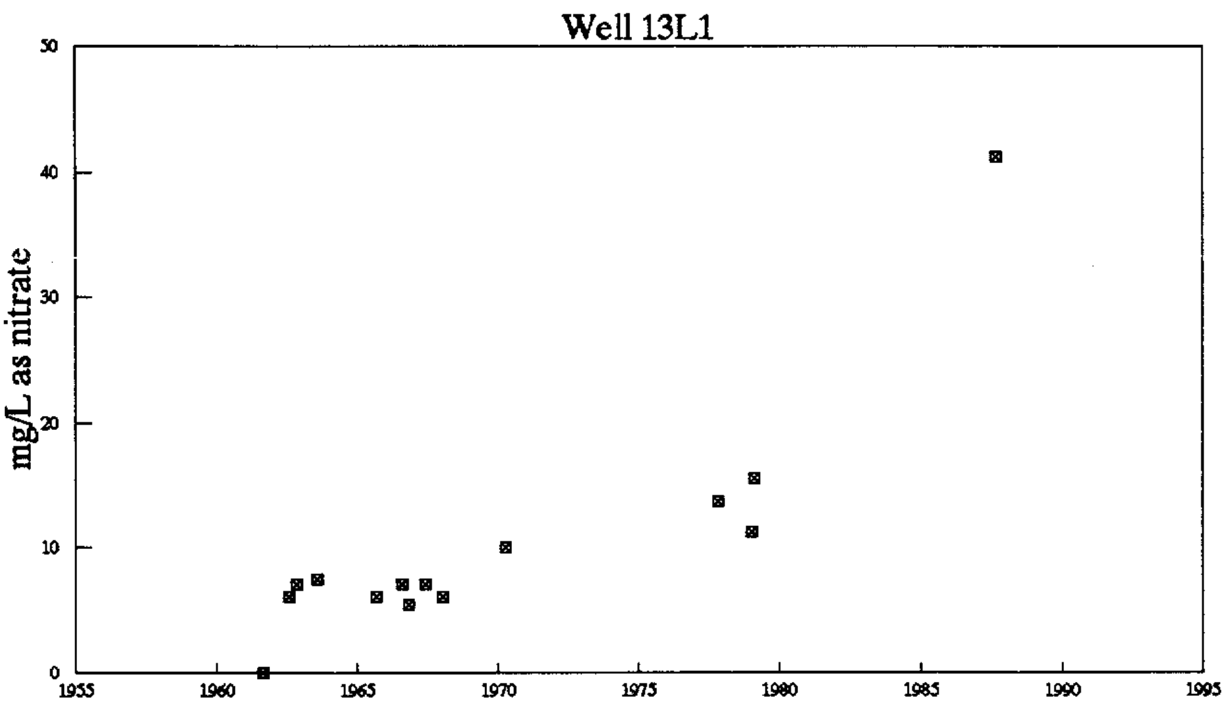

Well 7N1
mg/L as nitrate
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000


Well 7Q1
mg/L as nitrate
90
80
70
60
50
40
30
20
10
0
1950
1960
1970
1980
1990
2000

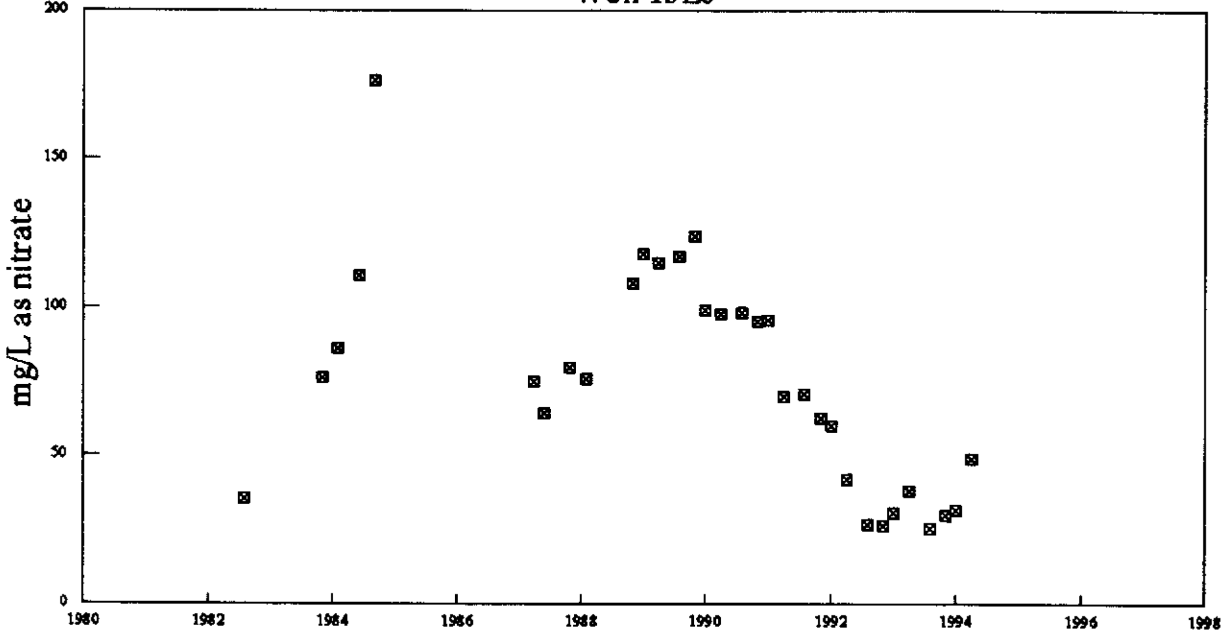

Well 7L3
mg/L as nitrate
100
90
80
70
60
50
40
30
20
10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998


Well 18R1
mg/L as nitrate
100
90
80
70
60
50
40
30
20
10
0
1950
1960
1970
1980
1990
2000

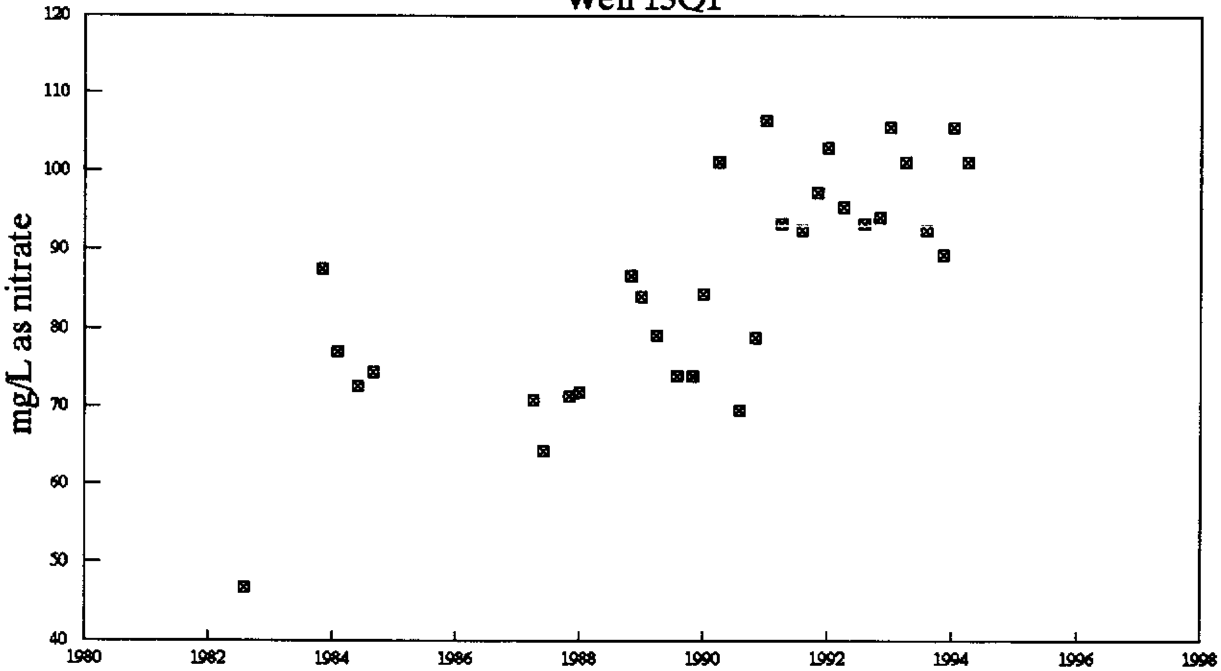

Well 13G2
mg/L as Nitrate
120
100
80
60
40
20
0
1960
1965
1970
1975
1980
1985


Well 13L1
mg/L as nitrate
50
40
30
20
10
0
1955
1960
1965
1970
1975
1980
1985
1990
1995

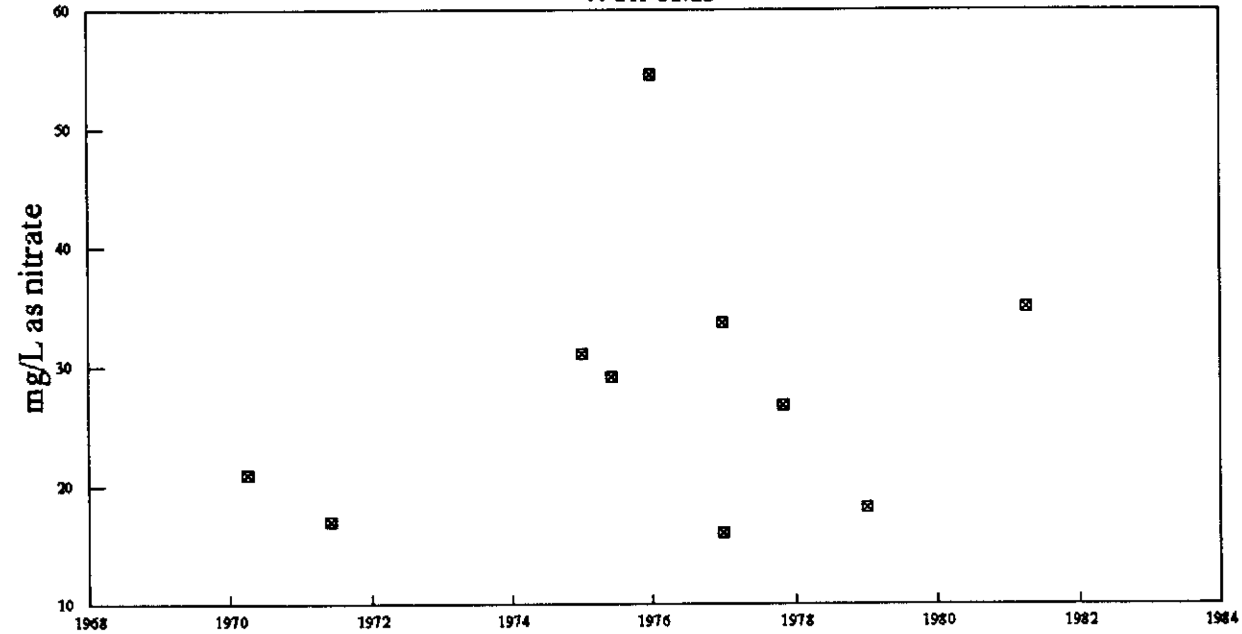
Well 13L5



Well 13Q1



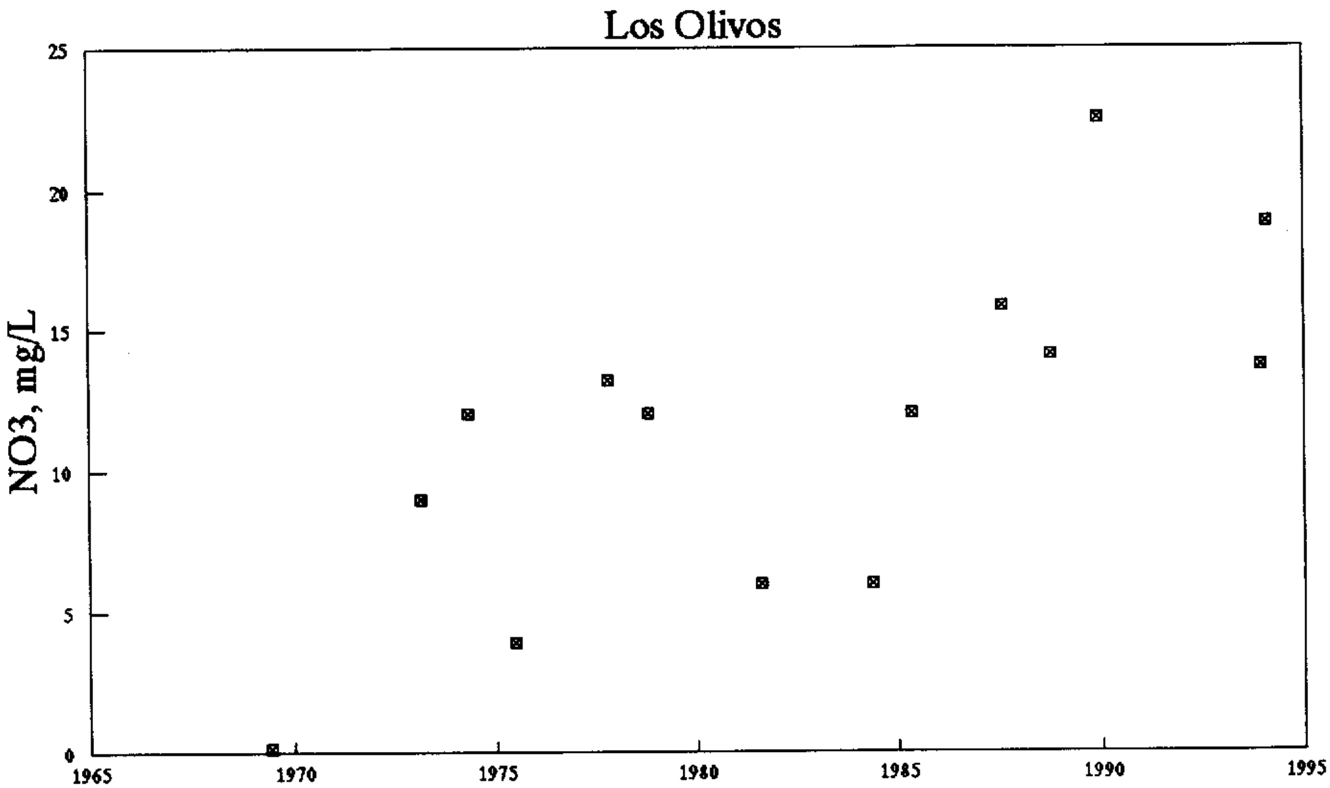
Well 8M3

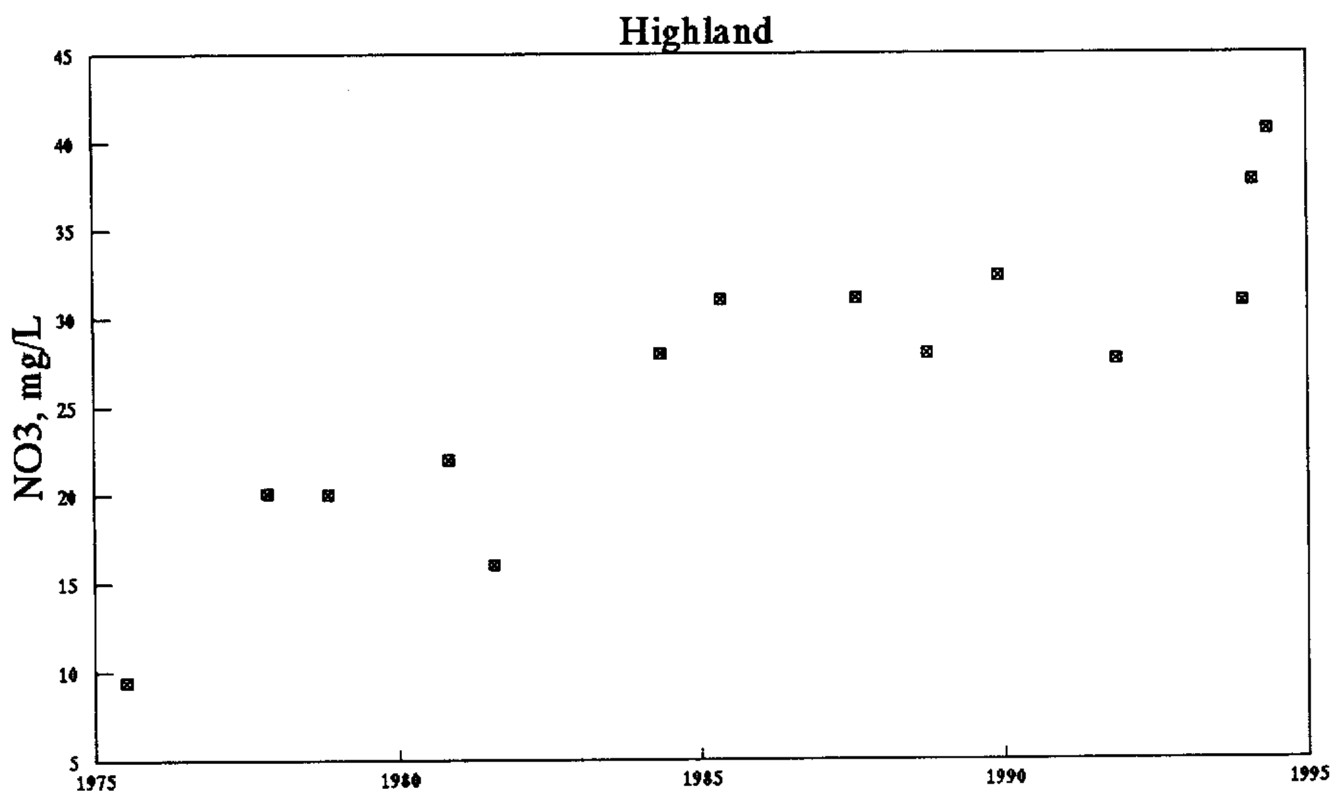


60
50
40
30
20
10
mg/L as nitrate
1968
1970
1972
1974
1976
1978
1980
1982
1984

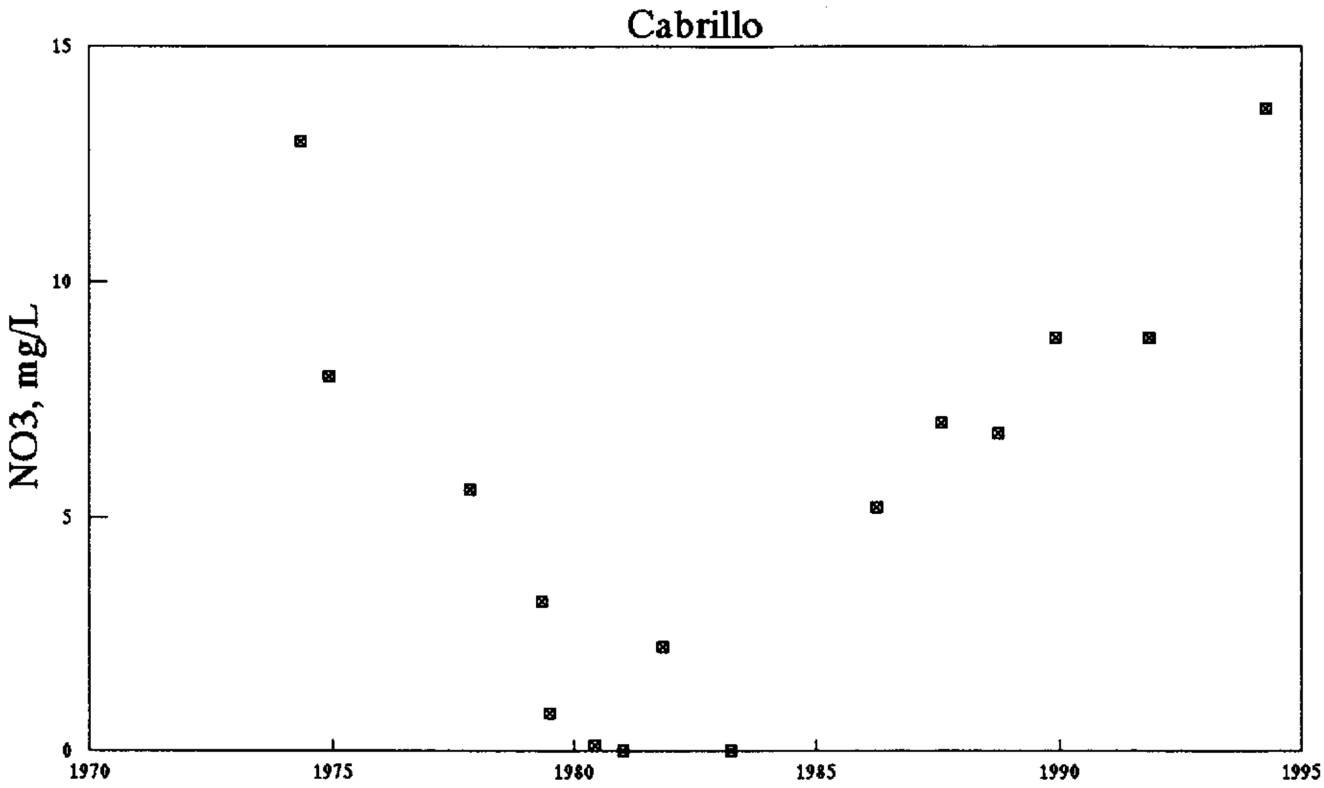
Table B-4. NITRATE DATA FOR
CAL CITES PRODUCTION WELLS, mg/L as NO3

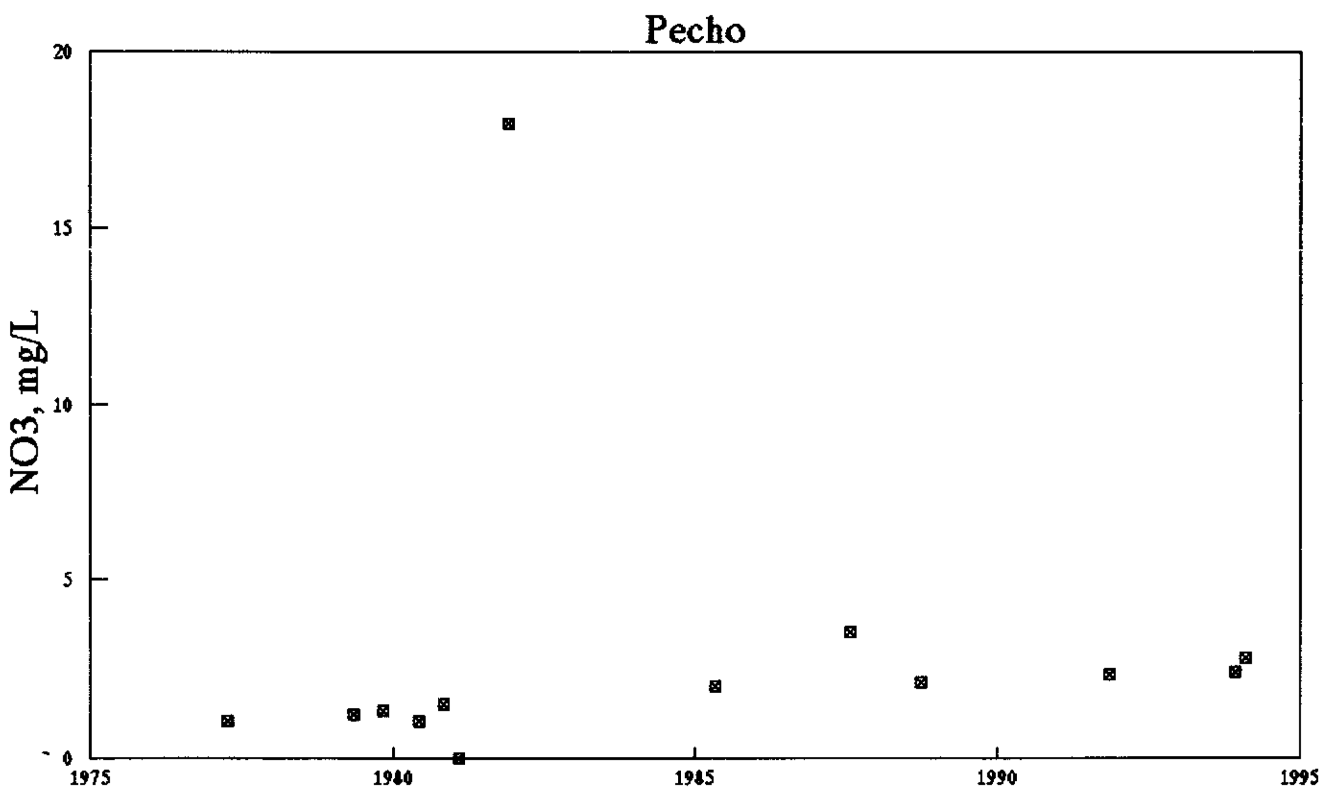
Date	Los Olivos	Highland	Skyline	Cabrillo	Pecho	Rosina
May-69	0.15					
Feb-73	9					
Apr-74	12					
Nov-74				8		
Jun-75	3.9	9.4				
Mar-77					1	
Oct-77	13.2	20.1		5.6		
Oct-78	12	20				
Apr-79				3.2	1.2	
Jun-79				0.8		
Oct-79					1.28	
May-80				0.1	1	6
Oct-80		22			1.46	
Dec-80						1
Jan-81						
Jul-81	6	16				
Oct-81				2.2		
Nov-81					18	
Mar-83						
Apr-84	6	28				
Apr-85	12	31			2	4
Mar-86				5.2		
Jul-87	15.8	31.1		7	3.5	4.3
Sep-88	14.1	28		6.8	2.1	3
Nov-89	22.5	32.3	33.2	8.8		4.1
Sep-91						5.1
Oct-91		27.6	23.6	8.8	2.3	6.3
Nov-93	13.7	30.9	33		2.4	2.4
Jan-94	18.8	37.7	38.6		2.8	5.7
Mar-94				13.7		
Apr-94		40.6	39.6			



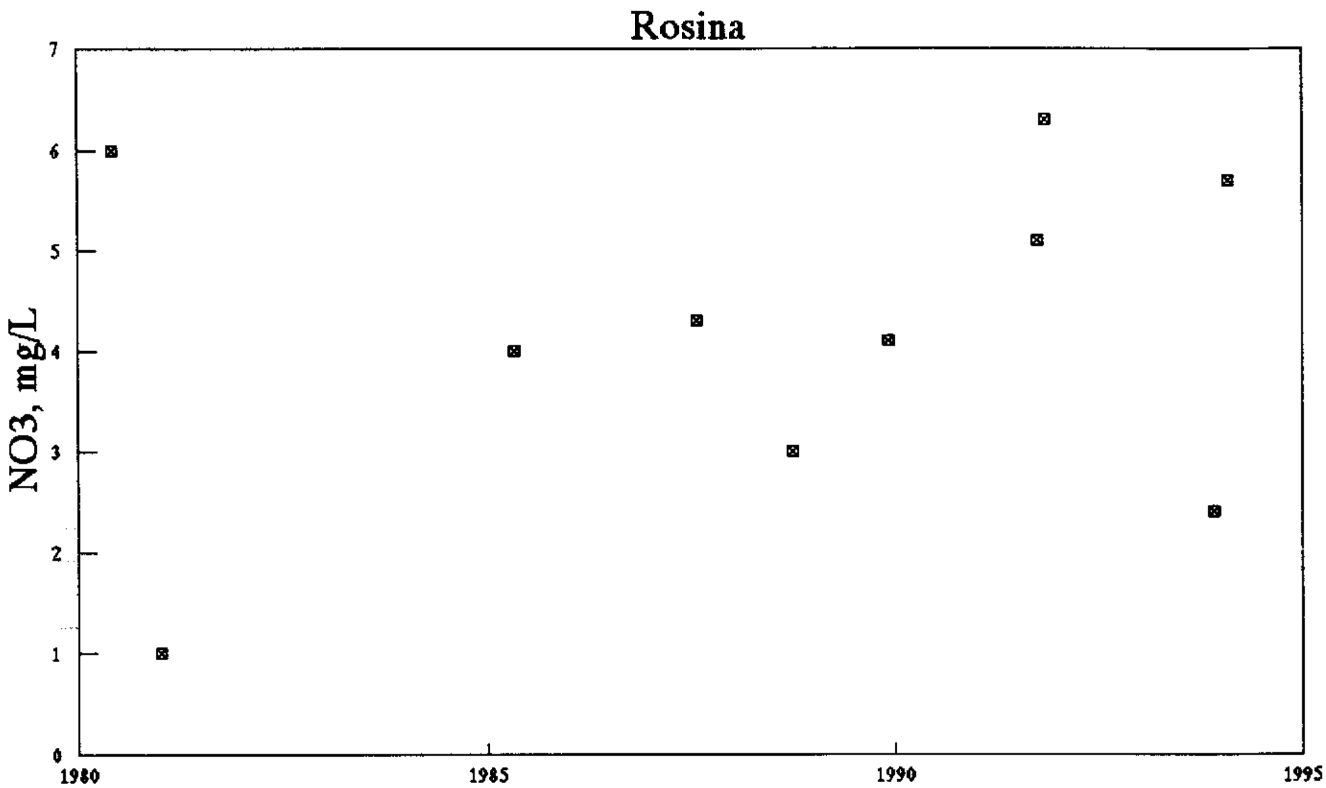


DEEPWELL.WK3

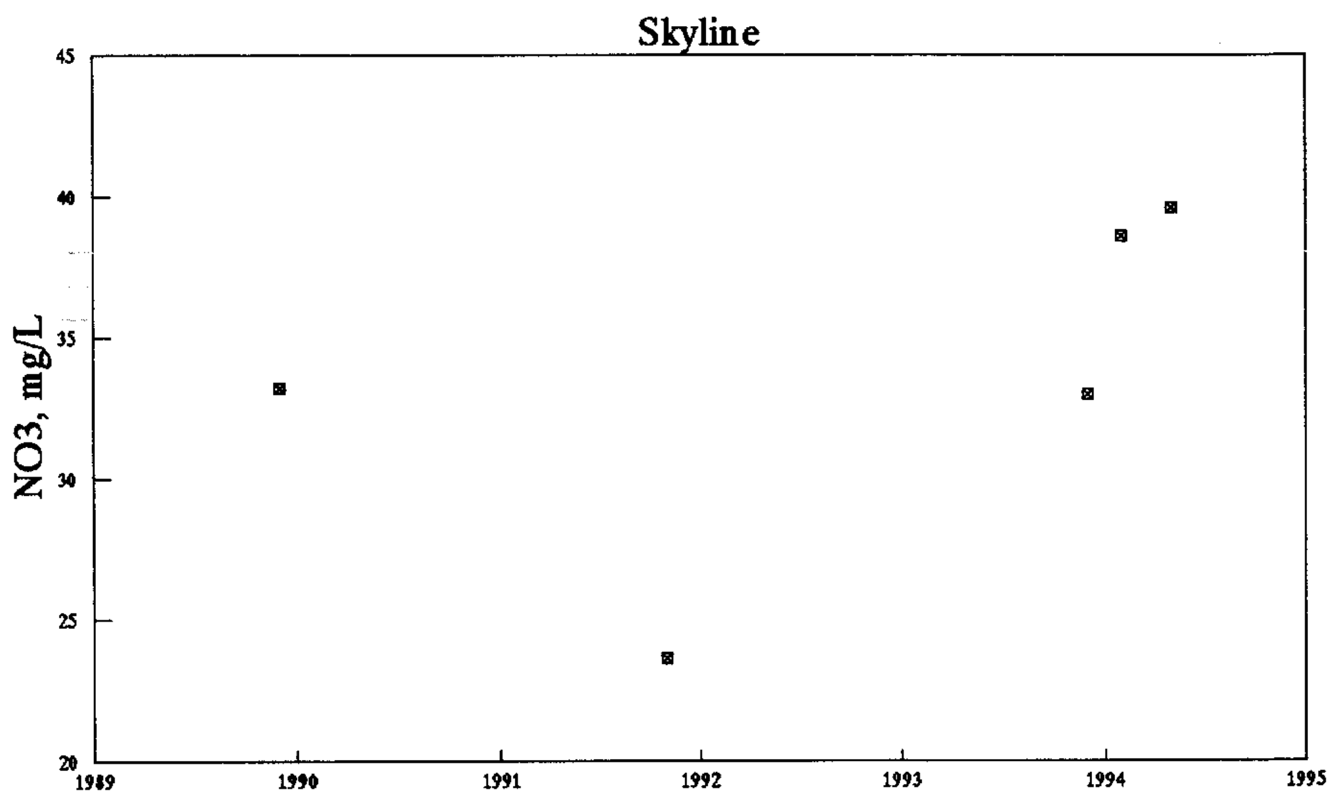




DEEPWELL.WK3



Rosina
NO3, mg/L
0
1
2
3
4
5
6
7
1980
1985
1990
1995



Skyline
NO3, mg/L
20
25
30
35
40
45
1989
1990
1991
1992
1993
1994
1995

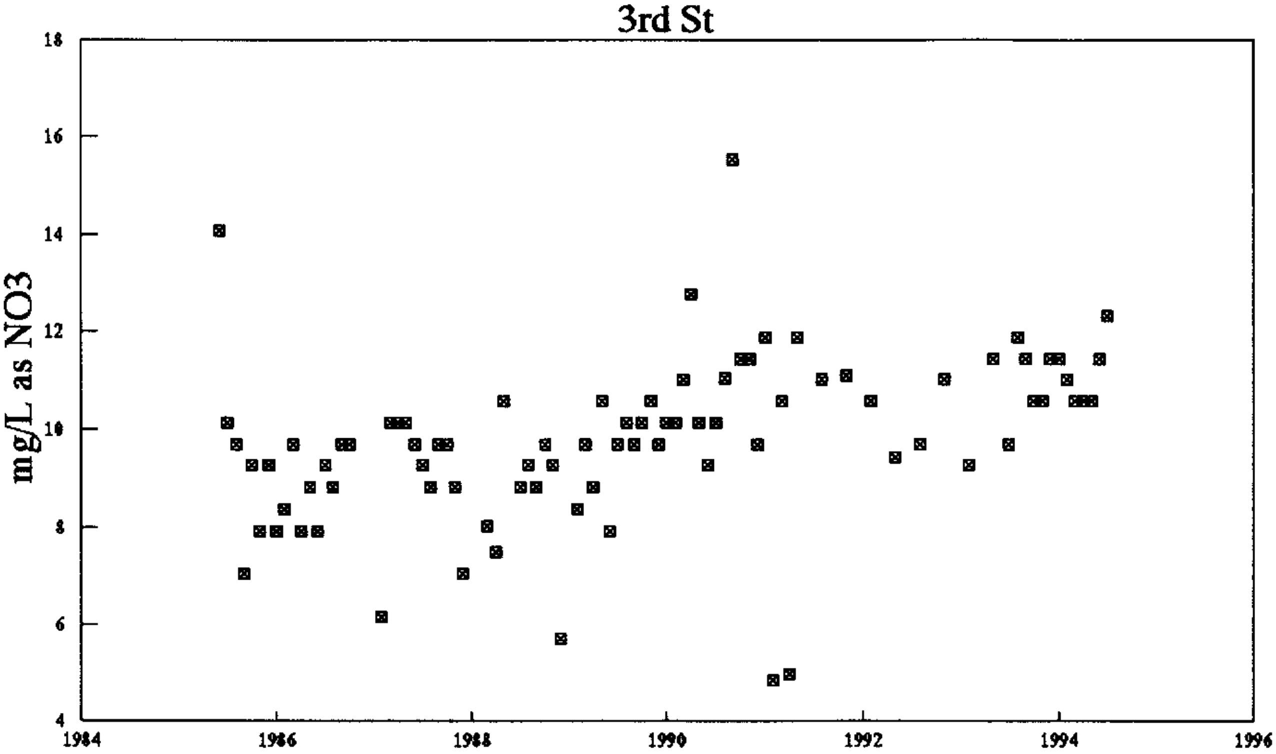
Table B–5. NITRATE DATA FOR
CSA 9 PRODUCTION WELLS, mg/L as NO3

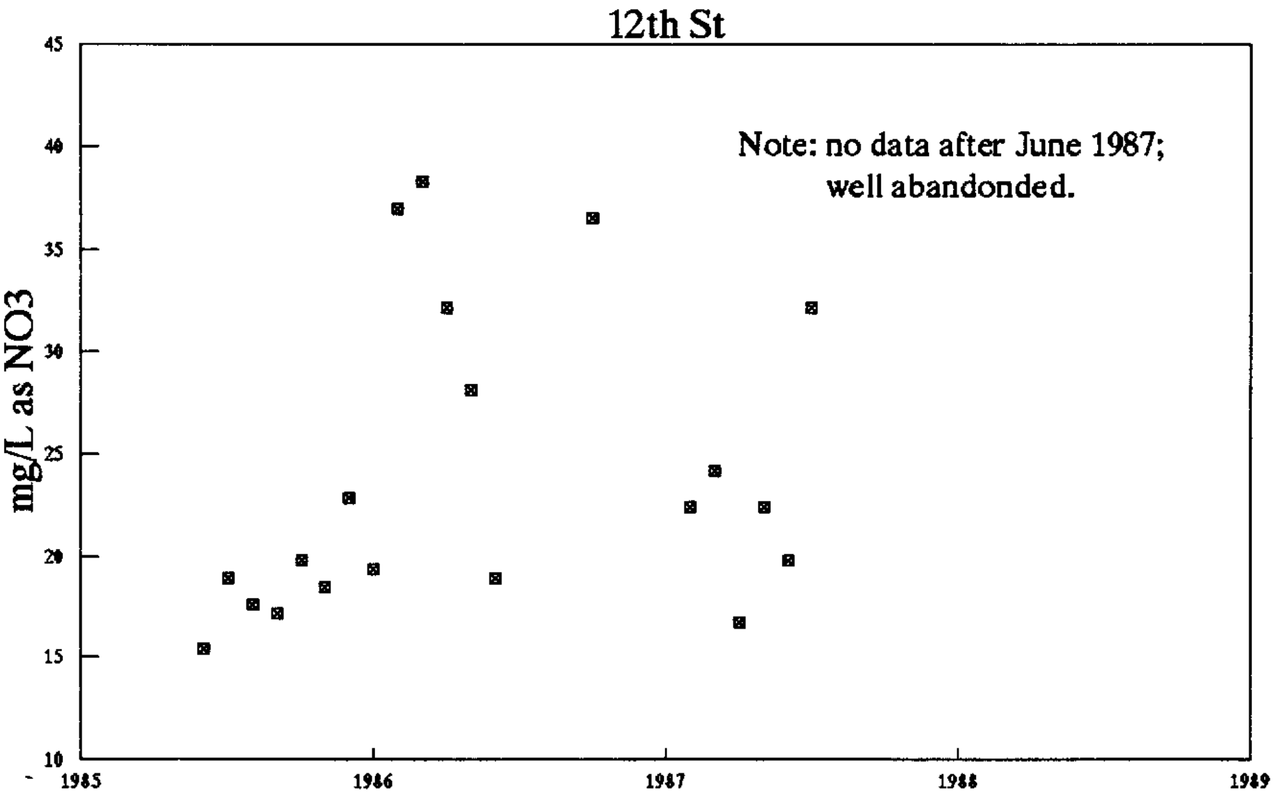
Date	3rd St	10th St	12th St*	New Ferrell*	Palisades	8th St
May–85	14.1		15.4	0.9	0.4	
Jun–85	10.1		18.9	0.4	0.4	
Jul–85	9.7		17.6	0.4	0.4	
Aug–85	7.0		17.2	0.4	0.4	
Sep–85	9.2		19.8	1.8	2.6	
Oct–85	7.9		18.5	0.4	0.4	
Nov–85	9.2		22.9	0.4	0.9	
Dec–85	7.9		19.4	0.9	0.4	
Jan–86	8.4		37.0	0.9	1.3	
Feb–86	9.7		38.3	0.9	1.3	
Mar–86	7.9		32.1	0.4	2.2	
Apr–86	8.8		28.2	0.9	0.4	
May–86	7.9		18.9	0.4	0.4	
Jun–86	9.2			0.4	0.4	
Jul–86	8.8			0.4	0.4	
Aug–86	9.7			0.4	0.4	
Sep–86	9.7		36.5	0.4	0.0	
Oct–86				0.4	0.4	
Nov–86				0.4	0.4	
Jan–87	6.2		22.4		0.4	0.4
Feb–87	10.1		24.2	0.4	0.9	
Mar–87	10.1		16.7	0.4	0.6	0.5
Apr–87	10.1		22.4	1.3	1.3	0.9
May–87	9.7		19.8	1.8	0.9	0.9
Jun–87	9.2		32.1	3.1	0.4	0.4
Jul–87	8.8			0.4	1.8	1.8
Aug–87	9.7			0.4	0.9	0.9
Sep–87	9.7			1.3	0.9	0.4
Oct–87	8.8			0.4	0.4	0.4
Nov–87	7.0			1.3	0.4	0.4
Dec–87					0.9	
Jan–88					0.0	0.4
Feb–88	8.0			0.4	0.4	0.4
Mar–88	7.5			1.3	1.3	
Apr–88	10.6			2.6	2.6	
Jun–88	8.8			0.4	0.4	0.4
Jul–88	9.2			0.9	1.3	0.4
Aug–88	8.8			1.3	0.4	0.4
Sep–88	9.7			0.9	2.2	0.4
Oct–88	9.2			0.4	1.3	0.4
Nov–88	5.7			0.9	0.4	0.4
Jan–89	8.4			0.4	0.4	0.4
Feb–89	9.7			1.3	0.9	0.4
Mar–89	8.8			0.9	0.4	0.4
Apr–89	10.6				0.9	0.4

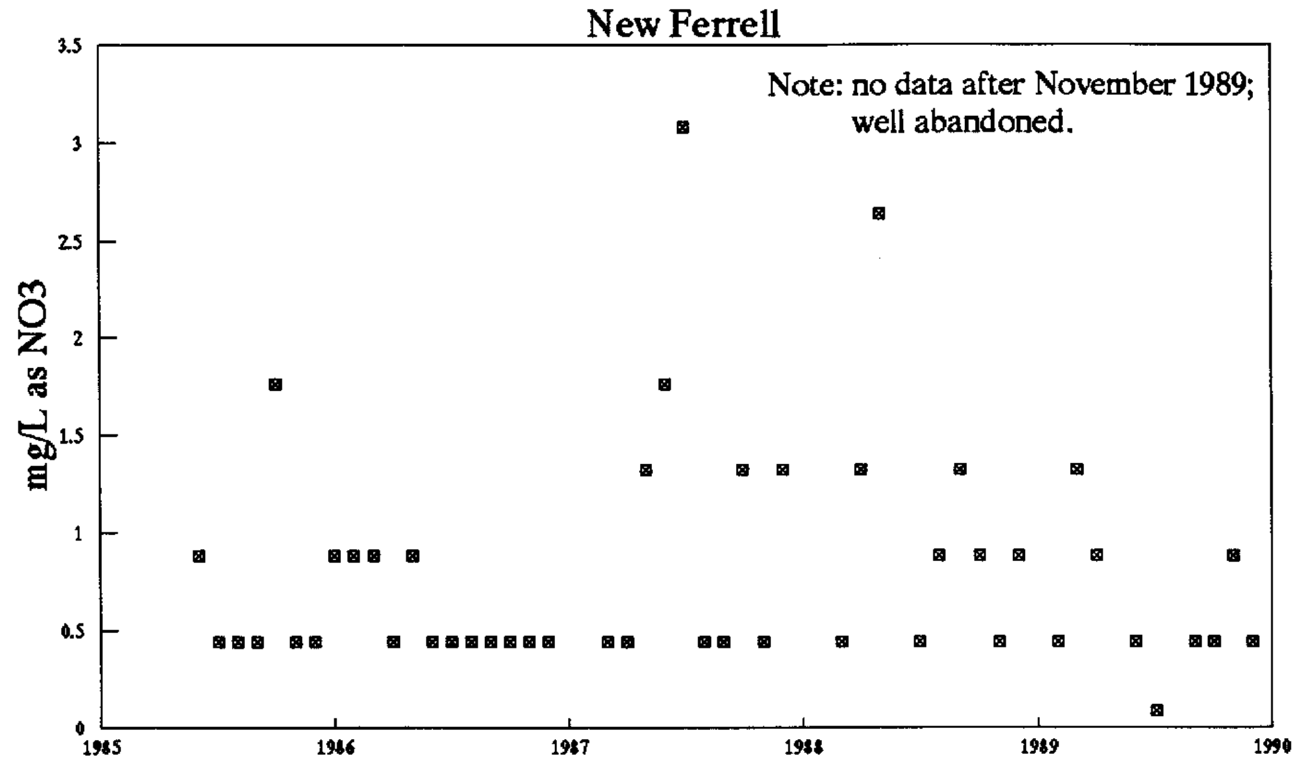
Table B–5. NITRATE DATA FOR CSA 9 PRODUCTION WELLS, mg/L as NO3

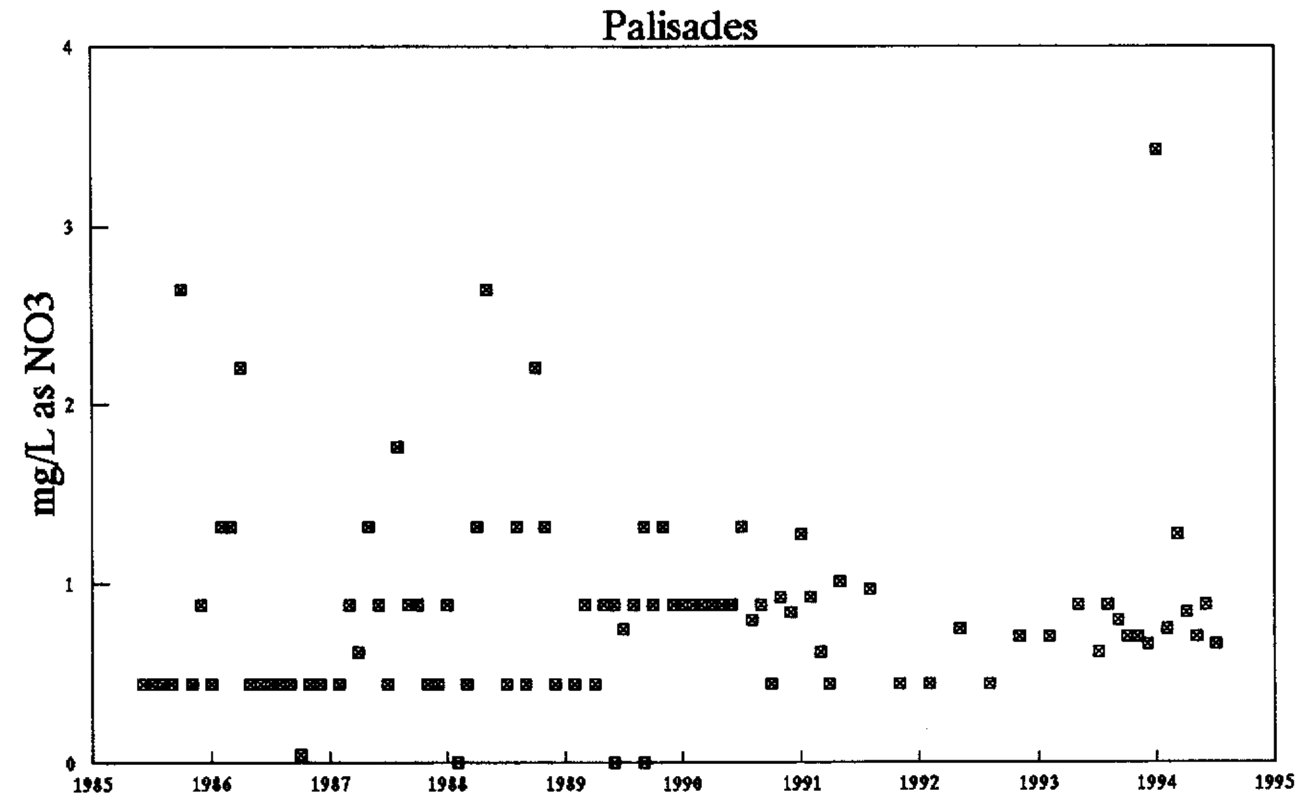
Date	3rd St	10th St	12th St*	New Ferrell*	Palisades	8th St
May–89	7.9			0.4	0.0	1.3
May–89					0.9	
Jun–89	9.7			0.1	0.7	0.1
Jul–89	10.1				0.9	0.4
Aug–89	9.7				1.3	1.3
Aug–89				0.4	0.0	
Sep–89	10.1			0.4	0.9	0.4
Oct–89	10.6			0.9	1.3	5.3
Nov–89	9.7			0.4	0.9	0.4
Dec–89	10.1				0.9	0.4
Jan–90	10.1				0.9	0.4
Feb–90	11.0				0.9	0.4
Mar–90	12.8				0.9	0.4
Apr–90	10.1				0.9	0.4
May–90	9.2				0.9	0.4
Jun–90	10.1				1.3	0.9
Jul–90	11.0				0.8	0.4
Aug–90	15.5				0.9	0.4
Sep–90	11.4				0.4	0.4
Oct–90	11.4				0.9	0.4
Nov–90	9.7				0.8	0.4
Dec–90	11.9				1.3	0.4
Jan–91	4.8				0.9	0.4
Feb–91	10.6				0.6	0.4
Mar–91	5.0				0.4	0.1
Apr–91	11.9				1.0	0.4
Jul–91	11.0				1.0	0.4
Oct–91	11.1		0.4		0.4	0.4
Jan–92	10.6				0.4	1.0
Apr–92	9.4				0.7	0.4
Jul–92	9.7				0.4	0.4
Oct–92	11.0				0.7	0.4
Jan–93	9.2				0.7	0.4
Apr–93	11.4				0.9	0.4
Jun–93	9.7	3.3			0.6	0.4
Jul–93	11.9	2.9			0.9	0.4
Aug–93	11.4	2.8			0.8	0.4
Sep–93	10.6	2.6			0.7	0.4
Oct–93	10.6	12.8			0.7	0.4
Nov–93	11.4	1.7			0.7	0.7
Dec–93	11.4	2.6			3.4	0.4
Jan–94	11.0	2.4			0.7	0.4
Feb–94	10.6	2.6			1.3	0.4
Mar–94	10.6	2.3			0.8	
Apr–94	10.6	2.2			0.7	
May–94	11.4	2.9			0.9	
Jun–94	12.3	2.2			0.7	

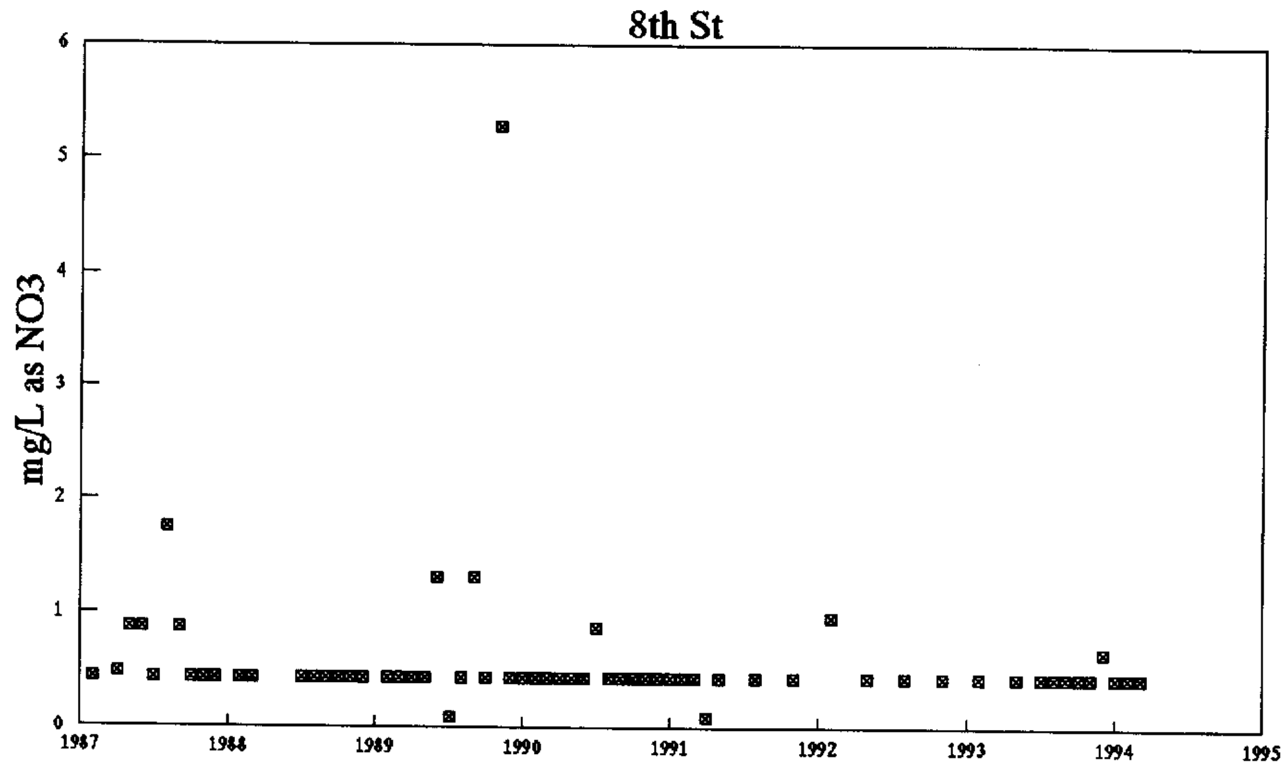
* Abandoned.


3rd St
mg/L as NO3
18
16
14
12
10
8
6
4
1984
1986
1988
1990
1992
1994
1996


12th St
mg/L as NO3
Note: no data after June 1987;
well abandonded.
45
40
35
30
25
20
15
10
1985
1986
1987
1988
1989


New Ferrell
Note: no data after November 1989; well abandoned.
mg/L as NO3
3.5
3
2.5
2
1.5
1
0.5
0
1985
1986
1987
1988
1989
1990


Palisades
mg/L as NO3
4
3
2
1
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995


8th St
mg/L as NO3
0
1
2
3
4
5
6
1987
1988
1989
1990
1991
1992
1993
1994
1995

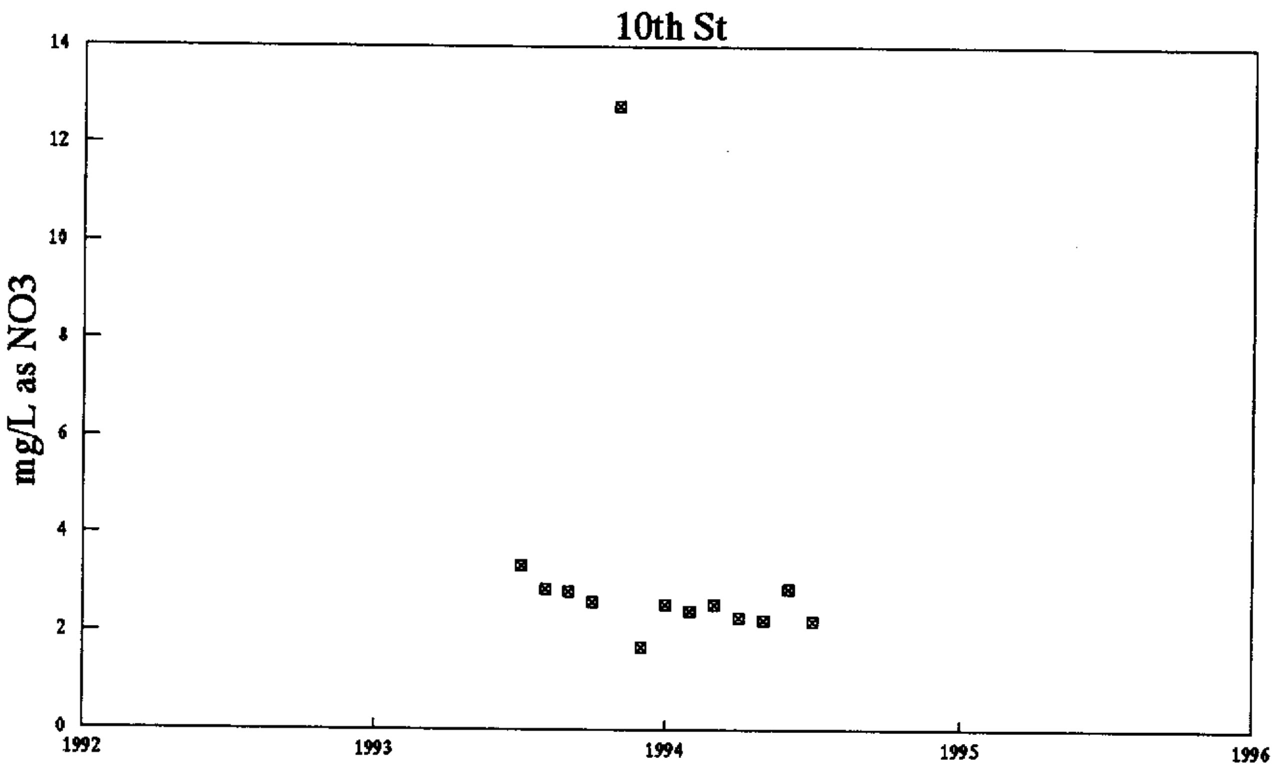

10th St
mg/L as NO3
0
2
4
6
8
10
12
14
1992
1993
1994
1995
1996

Table B-6
NITRATE DATA FOR S&T WELLS

Date	mg/L as NO3	
Jun-76	33	Wells 1 and 2
Jun-76	35	|
Jul-76	31	|
Dec-76	11	|
Jul-78	24	|
Jun-79	22	|
Jun-80	27	|
Oct-80	13.8	|
Sep-83	31	V
Mar-85	18	Wells 1 and 3
Dec-86	31	|
Aug-87	32	|
Aug-88	36	|
1989	36 *	|
1990	43 *	V
Feb-93	32	Wells 1, 3, and 4

NOTE: samples are from discharge manifold and include water from wells indicated.

* No date given.

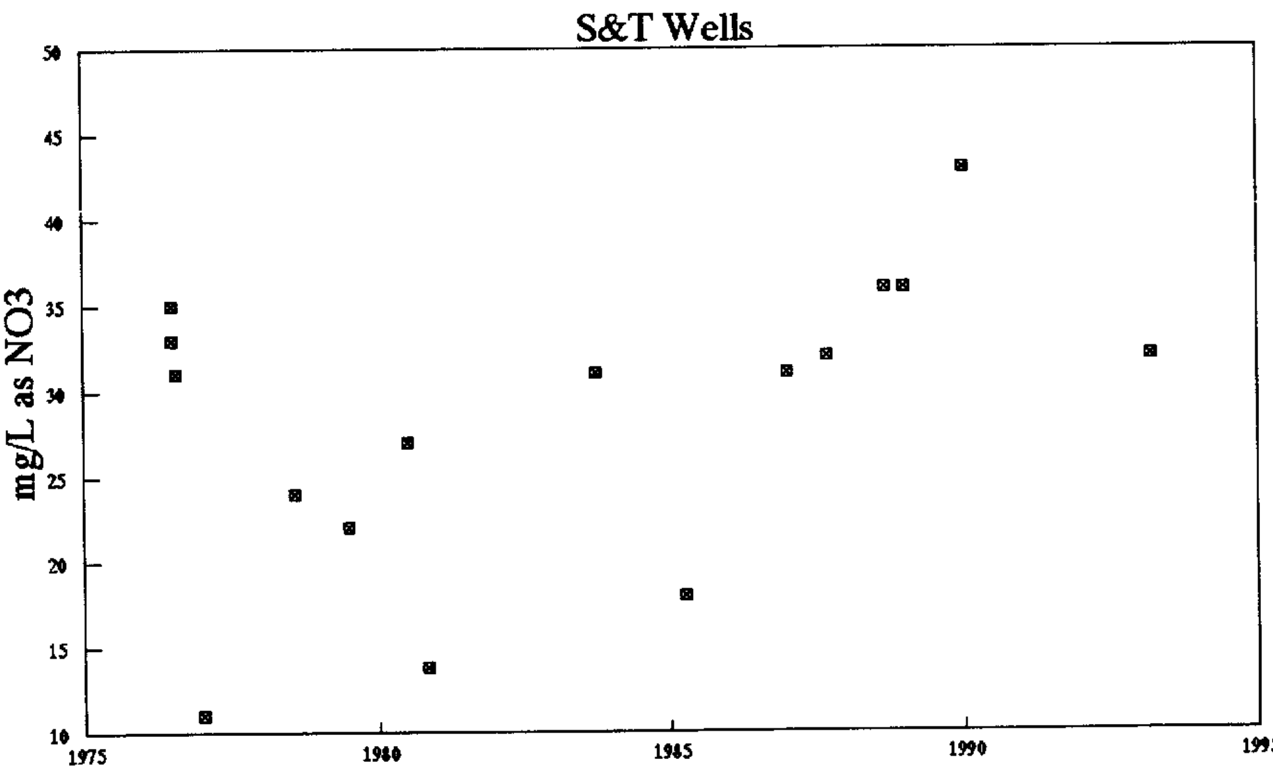


TABLE C-1. CALCULATION OF PERCENT AREA WITH FERTILIZED LANDSCAPING

Zone	Total area, ac	% of zone in study area[a]	Area of zone in study area, acre	% landscaped		Landscaped area, acre
1	1,162	100	1,162	20		232
2	271	100	271	25		68
3	73	100	73	25		18
4	367	100	367	10		37
5	51	100	51	0		0
6	1,142	75	857	0		0
7	384	100	384	0		0
8	92	100	92	0		0
9-17,19	1,638	0	0	0		0
18	35	100	35	0[b]		0
Total	5,214	--	3,291	11	(say 10%)	354
Total based on 35% of sanitary survey respondents fertilizing their lawns.[c]				4		124

Source: Yates, E.B. and Wiese, J.H. Hydrogeological and Water Resources of the Los Osos Valley Ground-Water Basin, San Luis Obispo County, California. U.S. Geological Survey Water-Resources Investigations Report 88-4081. Sacramento, 1988. Pp.24-25.

a. Urban Reserve Line.

b. Golf course -- covered under agriculture.

c. Appendix F.

TABLE C-2. CALCULATION OF AGRICULTURAL AREA

Zone	Total area, acre	% of zone in study area	Area of zone in study area, acre	% agriculture	Area with agriculture, acre
1	1,162	100	1,162	0	0
2	271	100	271	0	0
3	73	100	73	0	0
4	367	100	367	0	0
5	51	100	51	100	51
6	1,142	75	857	0	0
7	384	100	384	0	0
8	92	100	92	0	0
9	77	0	0	0	0
10,11	360	0	0	100	0
12,13	317	0	0	0	0
14	45	0	0	100	0
15-17	713	0	0	0	0
18	35	100	35	100	35
19	126	0	0	0	0
Total	5,213	--	3,290	--	84 (say) 100

Source: Yates, E.B. and Wiese, J.H. Hydrogeological and Water Resources of the Los Osos Valley Ground-Water Basin, San Luis Obispo County, California. U.S. Geological Survey Water-Resources Investigations Report 88-4081. Sacramento, 1988. Pp.24-25.

APPENDIX D

WASTEWATER FLOW

Table D-1. DWELLING UNIT EQUIVALENTS			
Land use designation	No. dwelling units[a]	No. commercial establishments	No. dwelling unit equivalents
Residential	6,100	--	6,100
Nonresidential	--	199[b]	199[c]
Total	6,100	199	6,299

a. Data for Urban Reserve Line in Estero Area Plan Update. Land Use Survey & Buildout Projections. Draft Background Report. San Luis Obispo County Planning Department. June 1994. Table K.
b. Backup parcel data for note a, from John Hofschroer, San Luis Obispo County Planning Department.
c. On average, each commercial establishment is equal to one dwelling unit in terms of nitrogen concentration in wastewater effluent.

Table D-2. UNIT WASTEWATER FLOW CALCULATION								
	February 1993			February 1994			Average, 1993-94	
	No. of services	Metered water use, ccf	Unit use, gpd/ service	No. of services	Metered water use, ccf	Unit use, gpd/ service	gpd/ service	gpd/ person
CSA 9	2,683	45,664	216	2,685	47,795	247	--	--
Cal Cities	2,257	32,712	178	2,219	33,022	183	--	--
S&T	206	--	302[a]	206	--	233[a]	--	--
Total	5,146	--	203	5,110	--	218	211	84[b]
Outdoor water use[c]	--	--	22	--	--	22	22	--
Wastewater flow	--	--	181	--	--	196	189	75[b]

a. Based on production records.
b. Based on 2.5 persons/service.
c. Based on irrigation once per week of 0.25 in. over 1,000 sq ft.

Table D-3. SUMMARY OF UNIT WASTEWATER FLOWS FROM OTHER AREAS		
City, location[a]	Population (1990 unless noted)	Average wastewater flow, gpd/person[b]
Cotati (medium- to low-density suburban residential and commercial)	5,736	94
Lindsay (medium density residential and commercial)	8,625	104
Morgan Hill (medium density suburban residential areas only)	22,400 (1992)	80-115
El Cerrito (medium- to high-density urban residential)	35,000	146-153[c]
Hemet (medium- to low-density suburban residential, including trailer parks and commercial)	45,700	45-100
11 rural homes[d]	51	42
Novato (16 suburban homes)[e]	53	78
10 areas in San Lorenzo, Oakland, and San Diego area (medium density residential)[f]	6,000 (1963-65)	41-127 (average = 67)

a. Unless noted, all are from recent (since 1991) Metcalf & Eddy reports on sewer and/or water master plans for the cities indicated.
b. Unless noted, all data are based on metered sewer flows and may include infiltration from groundwater and inflow from storm runoff.
c. Based on winter water consumption.
d. Metered indoor water use from USEPA. Management of Small Waste Flows. EPA-600/2-78-173. September 1978.
e. Winneberger, J.H.T. Septic Tank Systems: A Consultant's Toolkit. Butterworth Publishers. 1984.
f. Lineweaver, F.P. Jr., Geyer, J.C., Wolff, J.B. A Study of Residential Water Use. U.S. Department of Housing and Urban Development. Federal Housing Administration. HUD TS-12. February 1967. Data are metered nonsprinkling (i.e., indoor or domestic) water use for ten small, homogeneous residential areas; average housing density is 3.6/acre.

APPENDIX E

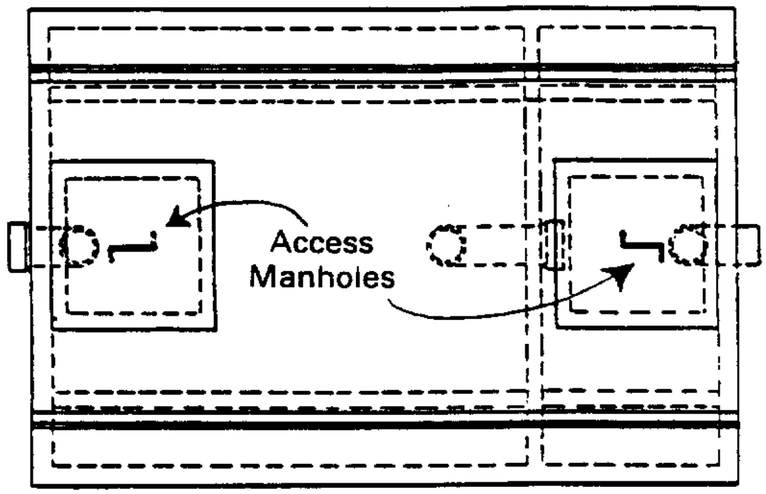
CONVENTIONAL ONSITE WASTEWATER TREATMENT MECHANISMS

Conventional onsite wastewater disposal systems commonly consist of a septic tank with a subsurface soil absorption system (leachfields, leach pits, or seepage pits). The following sections are brief descriptions of the processes that take place within each unit and the important soil-effluent interactions that result in wastewater treatment.

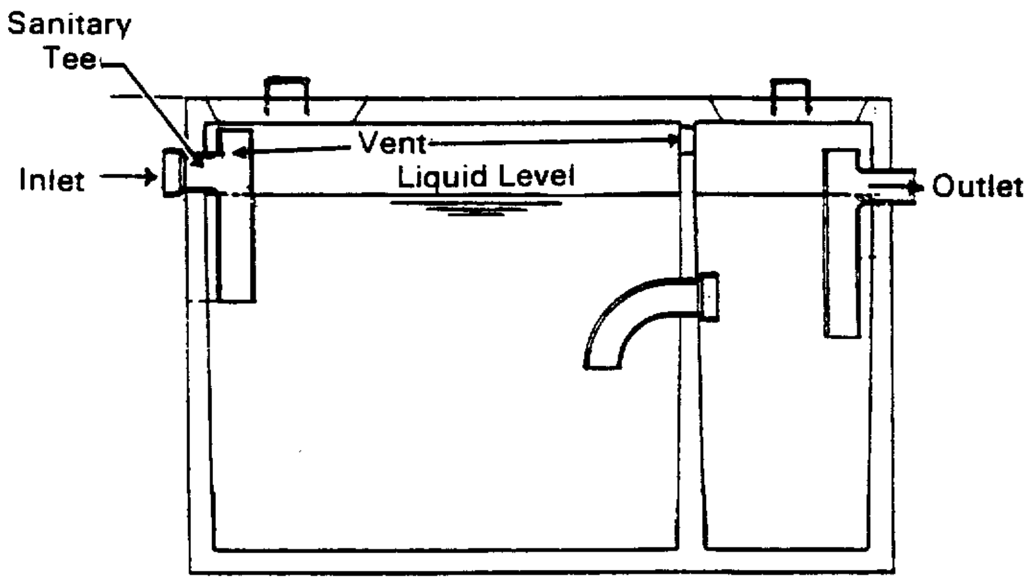
SEPTIC TANK

A typical septic tank is shown in Figure E-1. Raw sewage entering the septic tank undergoes physical and biological treatment. Solids separation occurs by sedimentation (forming a sludge layer on the tank bottom) and flotation (forming a scum or grease layer at the liquid surface). After separation, the solids undergo anaerobic biological decomposition, which reduces sludge and scum volume and produces methane, carbon dioxide, ammonium, and soluble organic compounds. Similar biochemical processes occur in the liquid phase in the clear space between the sludge and scum layers.

Although anaerobic digestion of solids reduces sludge and scum volume, septic tanks have only a finite storage capacity. Therefore, septic tanks should be pumped periodically (typically every 3 to 10 years) before too much sludge and scum (septage) accumulate. Unless this is done, solids removal efficiency will decrease. The solids will pass through the septic tank, clog all but the most porous of gravel formations, and reduce the hydraulic and treatment efficiency of the soil absorption system.



Plan



Longitudinal Section

Los Osos Wastewater Study	**Figure**
Typical Two-Compartment Septic Tank	**E-1**
Metcalf & Eddy	Date: August 1994

SUBSURFACE SOIL ABSORPTION SYSTEM

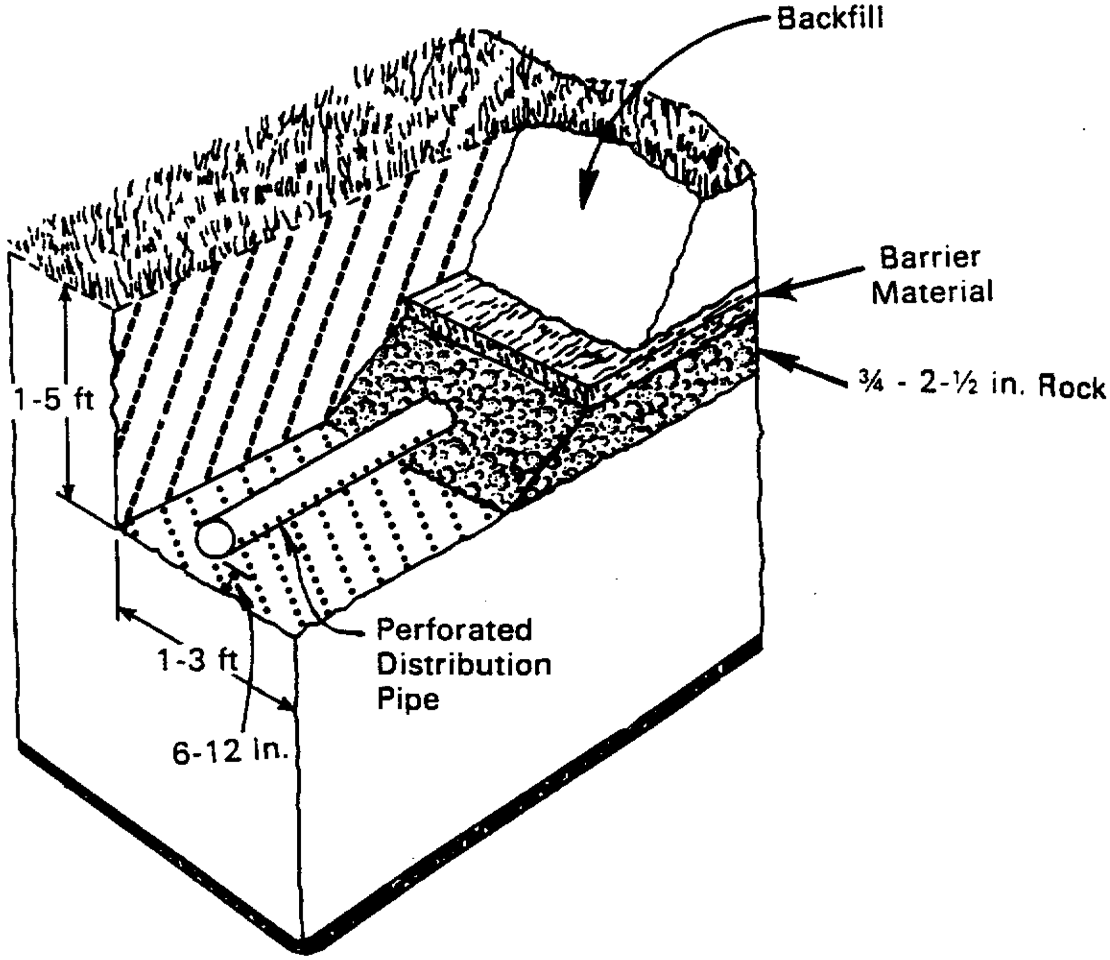
Wastewater effluent passes out of the septic tank into a leachfield or seepage pit for ultimate disposal in the subsurface soil environment.

Leachfield

In a conventional leachfield system, a pipeline connects the septic tank to a distribution box. This box distributes flow to two or more leach lines. The leach lines consist of a series of drain tiles laid in relatively shallow trenches (18 to 36 in. below ground surface) within an envelope of coarse aggregate. The drain tiles are covered with soil and the area is generally planted with grass. The effluent is carried through the drain tile to all points of the leachfield where it is absorbed and filtered by the surrounding soil. Initially, effluent passes into the surrounding soil primarily through the bottom and lower sidewalls. With advancing system age, the middle and upper sidewalls are utilized increasingly for seepage. A typical leachfield trench is shown in Figure E-2.

The overall area of leachfield trenches or beds is generally based on infiltrative capacity of the soil. The area may include both trench bottom and sidewall below the distribution pipe. The actual length and cross-sectional area are usually determined from site considerations such as available area and lot shape.

Continuous subsurface application of wastewater results in clogging at the trench bottom and side surfaces. Over time, the infiltrative capacity of the soil may be reduced by this clogging mat so that system hydraulic performance is adversely affected. The trench length may be modified to account for the reduction in infiltration by designing for a long-term application rate (LTAR) generally lower than for soil alone. Two separate leachfields, each with half



Los Osos Wastewater Study	Figure
Typical Trench System	E-2
Metcalf & Eddy	Date: August 1994

the total required length, are then built. Use of each field is alternated over time. Designing for dual, alternating leachfields is a desirable practice for two reasons:

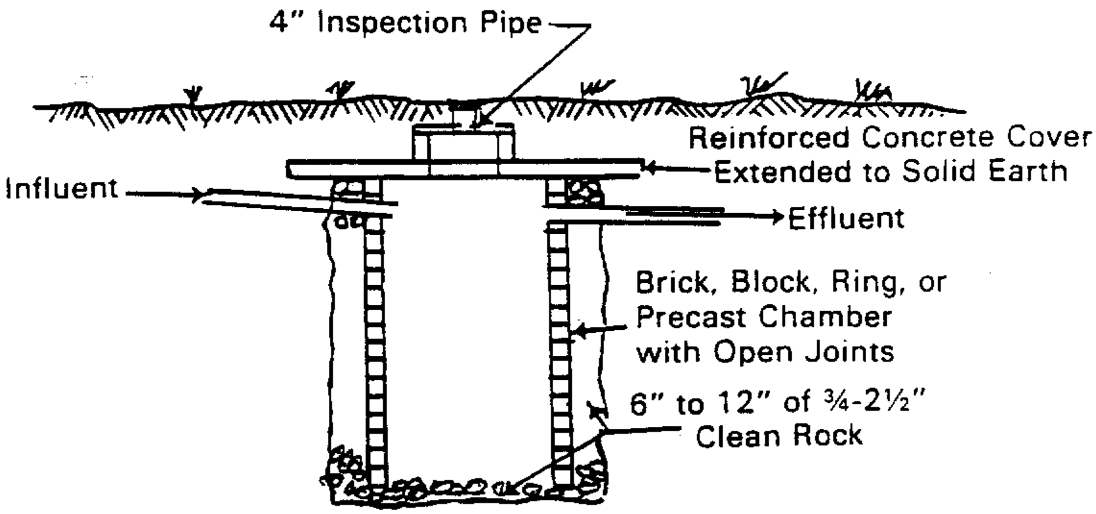
- Alternate use of each field allows the clogging mat to biodegrade so that soil can return to near its original infiltrative capacity. By having each field "rest" and dry out for a period of time, the life of an onsite system can be extended.
- The field not in use also can act as a standby in case of failure of the operating field.

Leach Pit or Seepage Pit

An alternative method of effluent disposal is the seepage pit or leach pit. These terms are often used interchangeably. A seepage pit is typically lined while a leach pit may be lined or unlined. However, they perform fundamentally the same function. In this system, septic tank effluent flows into a normally circular pit through which effluent seeps into the surrounding soil. Leach pits are generally used where there is not enough area on a lot for a leachfield system. Because pits are deeper than trenches or beds, there is less separation between the point of disposal and the underlying groundwater. Furthermore, in deeper pits more wastewater will eventually infiltrate through sidewalls than the bottom. This is important because there may be several layers of soil with different infiltrative capacities throughout the depth of the pit. A typical pit is shown in Figure E-3.

TREATMENT MECHANISMS

Numerous studies have demonstrated that a properly functioning soil disposal system can substantially remove total suspended solids (TSS), biochemical oxygen demand (BOD_5), pathogens, nitrogen, and phosphorus from domestic wastewater. Typical treatment efficiencies are summarized Table E-1.



Los Osos Alternatives Study	Figure
Typical Seepage Pit	E-3
Metcalf & Eddy	Date: March 1995

Table E-1. TREATMENT EFFICIENCIES[a]			
Parameter	Raw wastewater	Septic tank effluent	Leachfield or pit - typical removal, %
BOD_5, mg/L	200-300	140-200	>95
TSS, mg/L	200-500	50-90	75
Fecal coliforms, MPN/100 ml	10^6-10^{10}	1 x 10^3-1 x 10^6	>99.99
Viruses, PFU/ml	-	1 x 10^5- 1 x 10^7	>99.99
Nitrogen (as N)			
Total, mg/L	40-80	50-60	0-40
NH_4, mg/L	10-40	30-60	-
NO_3, mg/L	<1	<1	-

a. Domestic wastewater

BOD and TSS

Suspended solids are generally removed from percolating wastewater by filtration. The general association of BOD with suspended solids results in a simultaneous reduction in BOD. Further BOD reduction takes place by biological decomposition.

Pathogens

Pathogenic organisms represent the constituent of greatest concern to public health authorities. Bacteria, viruses, and other pathogenic organisms are removed by filtration, adsorption, and sedimentation within the soil. Factors offering pathogenic removal (or survival) in soils include moisture content, temperature, pH, organic matter, as well as soil type. In general, pathogen removal is greatest in fine textured, unsaturated soils.

Nitrogen

Nitrogen in septic tank effluent exists primarily as ammonium ions with the remainder in organic form. In general, nitrification--conversion of organic and ammonia nitrogen to nitrate--occurs under aerobic conditions in the first few feet of soil below the bottom of the leachfield or seepage pit. Aiding this process is the tendency of positively-charged ammonium ions to adsorb onto negatively-charged soil particles. A limited amount of nitrate may be removed by the uptake of nutrients by plants growing adjacent to the leach line, but most is available to be transported with percolating effluent.

Denitrification--conversion of nitrate to nitrogen gas--occurs at a greater depth under anaerobic conditions in the unsaturated zone above the water table. The rate at which denitrification occurs depends on an variety of factors including soil type, thickness of the vadose zone, and presence or absence of local reducing conditions. The denitrification process is biological, so certain types of bacteria that can survive in an anaerobic environment must be present. To sustain these bacteria, a source of energy must also be present, i.e., a source of carbon, usually in the wastewater, soil, or decayed vegetation.

Unlike the ammonium ion, the nitrate ion is negative and not attracted to soil particles. The charge and solubility of the nitrate ion makes it very mobile in unsaturated and saturated soils. The rate of denitrification generally ranges from 0% to 40% and can theoretically be 100% given enough energy. For total denitrification, the carbon-nitrogen ratio must be at least 2 to 1. However, the rate cannot be predicted in a given situation without empirical data.

Once the wastewater plume enters the water table, denitrification may continue, but a much reduced rate because the reduced availability of bacteria and an energy source. In effect, after the nitrate ion enters the groundwater, nitrate concentrations in groundwater depend more on dilution than on denitrification.

Other

Constituents such as chlorides and sulfates, also exhibit high mobility because of their relatively high solubility and low chemical reactivity in an environment of low anion exchange capacity. Like nitrates, the principal mechanism of concentration reduction is groundwater dilution during downgradient migration.

BIBLIOGRAPHY

1. U.S. Environmental Protection Agency. Design Manual. Onsite Wastewater Treatment and Disposal Systems. October 1980.

2. Metcalf & Eddy. Wastewater Engineering. Treatment, Disposal, and Reuse. Third Edition. McGraw-Hill, 1991.

3. Natural Systems for Wastewater Treatment. Manual of Practice FD-16. Water Pollution Control Federation. 1990.

4. Eastburn, R. P. and W. F. Ritter. Denitrification in On-Site Wastewater Treatment Systems - A Review. In: On-Site Waste Water Treatment. Proceedings of the Fourth National Symposium on Individual and Small Community Sewage System. American Society of Agricultural Engineers. 1984. Pages 305-313.

5. Canter, W. and C. Knox. Septic Tank System Effects on Ground Water Quality. Lewis Publishers. Chelsea, MI. 1985.

6. Bitton, C. and Gerba, C., eds. Groundwater Pollution Microbiology. New York, John Wiley & Sons. 1984.

Appendix F

Blue Ribbon Committee
Sanitary Survey
Residential

1. Name & address

____

____

2. Owner (if different)

1,532 Owners	(75%)
500 Renters	(25%)

3. How long have you lived here?

1. One year or less	280	(14%)
2. 1 to 5 years	610	(30%)
3. 5 to 10 years	522	(26%)
4. More than 10 years	602	(30%)

4. How many people live here?

1. One	256	(13%)
2. Two	787	(39%)
3. Three	379	(19%)
4. Four	359	(18%)
5. More than four	232	(12%)

5. When was this home built?

1. Before 1950	56	(3%)
2. 1950 - 1960	118	(6%)
3. 1960 - 1970	274	(14%)
4. 1970 - 1980	804	(40%)
5. 1980 - 1990	509	(25%)
6. After 1990	11	(1%)
7. Don't know	245	(12%)

6. How many bedrooms?

1. One	76	(4%)
2. Two	579	(29%)
3. Three	1,182	(58%)
4. Four	159	(8%)
5. More than four	35	(2%)

7. What is the size of this lot?

1. 2,000 sq ft	119	(6%)
2. 5,000 sq ft	1,294	(68%)
3. 10,000 sq ft	430	(22%)
4. 20,000 sq ft	52	(3%)
5. More than 20,000 sq ft	20	(1%)

8. Who supplies your water?

1. Have own well	21	(1%)
2. CSA-9	1,334	(67%)
3. Cal. Cities	519	(26%)
4. S & T	127	(6%)

9. Is your wastewater system -

1. Septic Tank	1,964	(98%)
2. Aerobic Unit	7	(0%)
3. Don't know	37	(2%)

10. Is your septic tank -

1. Concrete	1,105	(55%)
2. Steel	34	(2%)
3. Fiberglass	74	(4%)
4. Redwood	24	(1%)
5. Don't know	770	(38%)

11. What is your leach system?

1. Leach field	848	(42%)
2. Seepage pit or leach pit	673	(34%)
3. Cesspool	5	(0%)
4. Discharge to ditch	2	(0%)
5. Don't know	473	(24%)

12. What is the size of your septic tank?

1. Less than 1,000 gallons	74	(4%)
2. 1,000 gallons	430	(22%)
3. 1,500 gallons	193	(10%)
4. 2,000 gallons	44	(2%)
5. Don't know, no response	1,237	(63%)

13. When was your septic system built?

1. Before 1950	21	(1%)
2. 1950 - 1960	82	(5%)
3. 1960 - 1970	249	(14%)
4. 1970 - 1980	786	(45%)
5. 1980 - 1990	521	(30%)
6. After 1990	50	(3%)
7. Don't know	45	(3%)

14. If wet spots appear in your yard, how long do they persist?

1. Only in wet weather	286	(82%)
2. Less than a month	20	(1%)
3. More than a month	12	(1%)
4. Never go away	31	(2%)
No response	1,626	--

15. How often do you have your septic tank pumped?

1. Never	727	(41%)
2. Every other year	189	(11%)
3. Every 3 to 5 years	460	(26%)
4. Every 5 to 19 years	361	(20%)
5. Less than every 2 years	47	(3%)

16. Does your yard flood after heavy rains?

1. Yes	120	(6%)
2. No	1913	(94%)

17. Does your septic system have problems after heavy rains?

1. Yes	66	(3%)
2. No	1966	(97%)

18. Does your septic system have problems after you have visitors, due to the increased load?

1. Yes	76	(4%)
2. No	1956	(96%)

19. Does your septic system back up or have odors?

1. Yes	155	(8%)
2. No	1877	(92%)

20. Which water using appliances do you use?

1. Washing machine	1,852	(91%)
2. Dish washer	1,452	(71%)
3. Garbage disposal	1,225	(60%)
4. All of the above	1,195	(59%)
5. None of the above	65	(3%)

21. Do you divert grey water from your septic system for use in landscaping?

1. Yes	513	(25%)
2. No	1520	(75%)

22. Do you have a water softener?

1. Yes	154	(8%)
2. No	1879	(92%)

23. If 22 is yes, do you back flush it into septic system?

1. Yes	66	(43%)
2. No	88	(57%)

24. Do you have a dual leach system?

1. Yes	332	(16%)
2. No	1701	(84%)

25. Are tree roots a problem for your septic system?

1. Yes	152	(7%)
2. No	1881	(83%)

26. Where is your septic tank and leach system located?

1. In front of house	1255	(69%)
2. In back of house	420	(23%
3. At side of house	132	(7%)

27. Are there any water wells on this property?

1. Yes	16	(1%)
2. No	2017	(99%)

28. If 27 is yes, is this water used for drinking?

1. Yes	7	(44%)
2. No	9	(56%)

29. Are there any abandoned wells on this property?

1. Yes	30	(1%)
2. No	2003	(99%)

30. Do you use chemical or biological additives in your septic system?

1. Yes	51	(3%)
2. No	1982	(97%)

31. Has your septic system been modified or repaired?

1. Yes	452	(22%)
2. No	1581	(78%)

32. Do you fertilize your lawn?

1. Yes	714	(35%)
2. No	1319	(65%)

33. If 32 is yes, what do you use?

____

34. If 32 & 33 are yes, how often?

____

____

____

APPENDIX G

SANITARY SURVEY RELIABILITY AND VALIDITY

The sanitary survey reached 2,033 households, or only about 40% of the population of Los Osos. In this appendix, the sanitary survey data are compared to other data to determine if this sample was representative of the entire community and to evaluated the validity of the responses. The results of the comparison are shown in Tables G-1 through G-6.

Table G-1. WATER SUPPLIER

Water purveyor	Sanitary survey (question 8)		Actual[a]		1990 US Census of Housing
Own well	21	1%	--	--	4%
CSA 9	1,334	67%	2,875	55%	96%
California Cities	519	26%	2,120	41%	
S&T	127	6%	206	4%	
Total	1,992	100%	5,201	100%	100%

a. Gregory, Jerry. Personal communication. March 1994.

Table G-2. SEPTIC TANK PUMPING VOLUMES gallons			
Year	Sanitary survey (questions 12,15)	San Luis Obispo County Environmental Health Department records[a]	Pumpers' records[b]
1990		556,000	
1991		727,780	588,600
1992		633,000	582,700
1993		614,160	558,320
Average	1,348,000[c]	632,735	576,540

a. Based on data reported by pumpers.
b. Ross, Glen. Personal communication. February 3, 1994.
c. Based on 271,500 gal/yr for 1,007 usable records extrapolated to approximately 5,000 existing septic tanks (Appendix D).

Table G-3. OWNER VS RENTER		
	Sanitary survey (question 2)[a]	1990 U.S. Census of Housing[b]
Owner	75%	67%
Renter	25%	33%

a. Total responses = 2,032.
b. For Baywood-Los Osos census tract, 5,769 occupied housing units.

Table G-4. NUMBER OF PEOPLE LIVING IN UNIT		
	Sanitary survey (question 4)[a]	1990 U.S. Census of Housing[b]
One	13%	23%
Two	39%	40%
Three	19%	16%
Four	18%	14%
More than four	12%	8%
Total	101%	101%

NOTE: figures may not add to 100% due to rounding.
a. Total responses = 2,013.
b. For Baywood-Los Osos census tract, 5,769 occupied housing units.

Table G-5. YEAR HOUSE WAS BUILT		
	Sanitary survey (question 5)[a]	1990 U.S. Census of Housing[b]
Before 1950	3%	4%
1950-59	7%	6%
1960-69	15%	14%
1970-79	45%	47%
1980-89	29%	28%
After 1990	1%	0%[c]
Total	100%	99%

NOTE: Figures may not add to 100% due to rounding.
a. Total responses = 1,722.
b. For Baywood-Los Osos census tract, 6,019 total housing units.
c. Less than 0.5%.

Table G-6. NUMBER OF BEDROOMS		
	Sanitary survey (question 6)[a]	1990 U.S. Census of Housing[b]
One	4%	10%
Two	29%	39%
Three	58%	43%
Four	8%	7%
More than four	2%	1%
Total	101%	100%

NOTE: figures may not add to 100% due to rounding.
a. Total responses = 2,031.
b. For Baywood-Los Osos census tract, 6,019 total housing units.

Table H-1
LEACH FIELD SIZING
Case 1:
18 in. bottom trench width and
24 in. depth below distribution pipe

	San Luis Obispo County guidelines [a]	"Most Conservative Criterion" [b]
Infiltrative surface	3 bedroom house @ 125 sq ft/bedroom 375 sq ft infiltrative surface area required.	For criterion of 0.2 gpd/sq ft and 189 gpd/service (Appendix D), 945 sq ft infiltrative surface area required.
Length of leach lines	For: 18 in. bottom trench width and 24 in. depth below pipe, 107 ft length required [c].	For: 18 in. bottom trench width and 24 in. depth below pipe, 236 ft based on sidewall area only.
Total area required without setbacks	214 ft length, including replacement area, or 6 trenches @ 36 ft each and 4 ft between trenches (edge-to-edge) Dimensions are 37.5 ft x 29 ft. Area, including septic tank (Figure H-1) = 1,148 sq ft.	236 ft length, or 7 trenches @ 34 ft each. 4 ft between trenches (edge-to-edge) Dimensions are 35.5 ft x 34.5 ft. Area, including septic tank (Figure H-1) = 1,285 sq ft.
Total area required including setbacks	5 ft from property line and 8 ft from structure Area, including septic tank (Figure H-1) = 1,922 sq ft.	5 ft from property line and 8 ft from structure Area, including septic tank (Figure H-1) = 2,066 sq ft.

NOTE: these are minimum areas required; with different orientation of facilities on Figure H-1, area could be larger.

a. Private Sewage Disposal System. Information Bulletin. San Luis Obispo County Department of Planning and Building. January 1989.

International Association of Plumbing and Mechanical Officials. Uniform Plumbing Code. 1991 Edition. September 1990.

b. Metcalf & Eddy. Wastewater Engineering: Treatment, Disposal, Reuse. Third Edition. McGraw-Hill, 1991. Pp. 1060 ff. Also Winneberger, J.H.T. Septic-Tank Systems. A Consultant's Toolkit. Boston, Ann Arbor Science. 1984. Pp. 67-90.

c. Based on bottom and sidewall areas with the top 12 in. of trench not counted; a maximum of 36 in. depth credited for sidewall area; and 36 in. maximum trench width.

Table H-2
LEACH FIELD SIZING
Case 2:
24 in. bottom trench width and
36 in. depth below distribution pipe

	San Luis Obispo County guidelines [a]	"Most Conservative Criterion" [b]
Infiltrative surface	3 bedroom house @ 125 sq ft/bedroom 375 sq ft infiltrative surface area required.	For criterion of 0.20 gpd/sq ft and 189 gpd/service (Appendix D), 945 sq ft infiltrative surface area required.
Length of leach lines	For: 24 in. bottom trench width and 36 in. depth below pipe, 63 ft length required [c].	For: 24 in. bottom trench width and 36 in. depth below pipe, 158 ft based on sidewall area only.
Total area required setbacks	125 ft length, including replacement area, or 4 trenches @ 32 ft ea. 4 ft between trenches (edge-to-edge) Dimensions are 34.0 ft x 20.0 ft. Area, including septic tank (Figure H-1) = 741 sq ft.	158 ft length, or 5 trenches @ 32 ft ea. 4 ft between trenches (edge-to-edge) Dimensions are 34.0 ft x 26.0 ft. Area, including septic tank (Figure H-1) = 945 sq ft.
Total area required including setbacks	5 ft from property line and 8 ft from structure Area, including septic tank (Figure H-1) = 1,434 sq ft.	5 ft from property line and 8 ft from structure Area, including septic tank (Figure H-1) = 1,668 sq ft.

NOTE: these are minimum areas required; with different orientation of facilities on Figure H-1, area could be larger.

a. Private Sewage Disposal System. Information Bulletin. San Luis Obispo County Department of Planning and Building. January 1989.

International Association of Plumbing and Mechanical Officials. Uniform Plumbing Code. 1991 Edition. September 1990.

b. Metcalf & Eddy. Wastewater Engineering: Treatment, Disposal, Reuse. Third Edition. McGraw-Hill, 1991. Pp. 1060 ff. Also Winneberger, J.H.T. Septic-Tank Systems. A Consultant's Toolkit. Boston, Ann Arbor Science. 1984. Pp. 67-90.

c. Based on bottom and sidewall areas with the top
12 in. of trench not counted; a maximum of
36 in. depth credited for sidewall area; and
36 in. maximum trench width.

Table H-3
LEACH FIELD SIZING
Case 3:
36 in. bottom trench width and
48 in. depth below distribution pipe

	San Luis Obispo County guidelines [a]	"Most Conservative Criterion" [b]
Infiltrative surface	3 bedroom house @ 125 sq ft/bedroom 375 sq ft infiltrative surface area required.	For criterion of 0.2 gpd/sq ft and 189 gpd/service (Appendix D), 945 sq ft infiltrative surface area required.
Length of leach lines	For: 36 in. bottom trench width and 48 in. depth below pipe, 41.7 ft length required [c].	For: 36 in. bottom trench width and 48 in. depth below pipe, 118 ft based on sidewall area only.
Total area required without setbacks	83 ft length, including replacement area, or 4 trenches @ 21 ft ea. 4 ft between trenches (edge-to-edge) Dimensions are 24 ft x 24 ft. Area, including septic tank (Figure H-1) = 637 sq ft.	118 ft length, or 4 trenches @ 30 ft ea. 4 ft between trenches (edge-to-edge) Dimensions are 33 ft x 24 ft. Area, including septic tank (Figure H-1) = 853 sq ft.
Total area required including setbacks	5 ft from property line and 8 ft from structure Area, including septic tank (Figure H-1) = 1,250 sq ft.	5 ft from property line and 8 ft from structure Area, including septic tank (Figure H-1) = 1,556 sq ft.

NOTE: **these are minimum areas required; with different orientation of facilities on Figure H-1, area could be larger.**

a. Private Sewage Disposal System. Information Bulletin. San Luis Obispo County Department of Planning and Building. January 1989.

International Association of Plumbing and Mechanical Officials. Uniform Plumbing Code. 1991 Edition. September 1990.

b. Metcalf & Eddy. Wastewater Engineering: Treatment, Disposal, Reuse. Third Edition. McGraw-Hill, 1991. Pp. 1060 ff. Also Winneberger, J.H.T. Septic-Tank Systems. A Consultant's Toolkit. Boston, Ann Arbor Science. 1984. Pp. 67-90.

c. Based on bottom and sidewall areas with the top
12 in. of trench not counted; a maximum of
36 in. depth credited for sidewall area; and
36 in. maximum trench width.

Table H-4
LEACH OR SEEPAGE PIT SIZING
Case 1: 10 ft pit depth

	San Luis Obispo County guidelines [a]	"Most Conservative Criterion" [b]
Infiltrative surface	3 bedroom house @ 125 sq ft/bedroom 375 sq ft infiltrative surface area required.	For criterion of 0.40 gpd/sq ft and 189 gpd/service (Appendix D), 473 sq ft infiltrative surface area required.
Diameter of pit	For pit depth of 10 ft, diameter required = 11.9 ft.	For pit depth of 10 ft, diameter required = 15.0 ft.
Total area required without setbacks	441 sq ft, including septic tank (Figure H-2)	633 sq ft, including septic tank (Figure H-2)
Total area required including setbacks	8 ft from property line and from structures 12 ft between pits 5 ft for septic tank Area, including septic tank (Figure H-2) = 1,640 sq ft.	8 ft from property line and from structures 12 ft between pits 5 ft for septic tank Area, including septic tank (Figure H-2) = 1,993 sq ft.

NOTE: **these are minimum areas required; with different orientation of facilities on Figure H-2, area could be larger.**

a. Private Sewage Disposal System. Information Bulletin. San Luis Obispo County Department of Planning and Building. January 1989. It is assumed that the basic criterion of 125 sq ft/bedroom does not include a replacement pit.

International Association of Plumbing and Mechanical Officials. Uniform Plumbing Code. 1991 Edition. September 1990.

b. Metcalf & Eddy. Wastewater Engineering: Treatment, Disposal, Reuse. Third Edition. McGraw-Hill, 1991. Pp. 1060 ff.

Kaplan, O.B. Septic Tank Systems Handbook. Second Edition. Chelsea, Michigan, Lewis Publishers. 1991. P. 116. It is assumed that the basic criterion of 0.4 gpd/sq ft does not include a replacement pit.

Table H-5 LEACH OR SEEPAGE PIT SIZING **Case 2: 15 ft pit depth**		
	San Luis Obispo County guidelines [a]	"Most Conservative Criterion" [b]
Infiltrative surface	3 bedroom house @ 125 sq ft/bedroom 375 sq ft infiltrative surface area required.	For criterion of 0.40 gpd/sq ft and 189 gpd/service (Appendix D), 473 sq ft infiltrative surface area required.
Diameter of pit	For pit depth of 15 ft, diameter required = 8.0 ft.	For pit depth of 15 ft, diameter required = 10.0 ft.
Total area required without setbacks	251 sq ft, including septic tank (Figure H-2)	342 sq ft, including septic tank (Figure H-2)
Total area required including setbacks	8 ft from property line and from structures 12 ft between pits 5 ft for septic tank Area, including septic tank (Figure H-2) = 1,243 sq ft.	8 ft from property line and from structures 12 ft between pits 5 ft for septic tank Area, including septic tank (Figure H-2) = 1,441 sq ft.

NOTE: **these are minimum areas required; with different orientation of facilities on Figure H-2, area could be larger.**

a. Private Sewage Disposal System. Information Bulletin. San Luis Obispo County Department of Planning and Building. January 1989. It is assumed that the basic criterion of 125 sq ft/bedroom does not include a replacement pit.

International Association of Plumbing and Mechanical Officials. Uniform Plumbing Code. 1991 Edition. September 1990.

b. Metcalf & Eddy. Wastewater Engineering: Treatment, Disposal, Reuse. Third Edition. McGraw-Hill, 1991. Pp. 1060 ff.

Kaplan, O.B. Septic Tank Systems Handbook. Second Edition. Chelsea, Michigan, Lewis Publishers. 1991. P. 116. It is assumed that the basic criterion of 0.4 gpd/sq ft does not include a replacement pit.

Table H-6
LEACH OR SEEPAGE PIT SIZING
Case 3: 20 ft pit depth

	San Luis Obispo County guidelines [a]	"Most Conservative Criterion" [b]
Infiltrative surface	3 bedroom house @ 125 sq ft/bedroom 375 sq ft infiltrative surface area required.	For criterion of 0.40 gpd/sq ft and 189 gpd/service (Appendix D), 473 sq ft infiltrative surface area required.
Diameter of pit	For pit depth of 20 ft, diameter required = 6.0 ft.	For pit depth of 20 ft, diameter required = 7.5 ft.
Total area required without setbacks	180 sq ft, including septic tank (Figure H-2)	234 sq ft, including septic tank (Figure H-2)
Total area required including setbacks	8 ft from property line and from structures 12 ft between pits 5 ft for septic tank Area, including septic tank (Figure H-2) = 1,068 sq ft.	8 ft from property line and from structures 12 ft between pits 5 ft for septic tank Area, including septic tank (Figure H-2) = 1,203 sq ft.

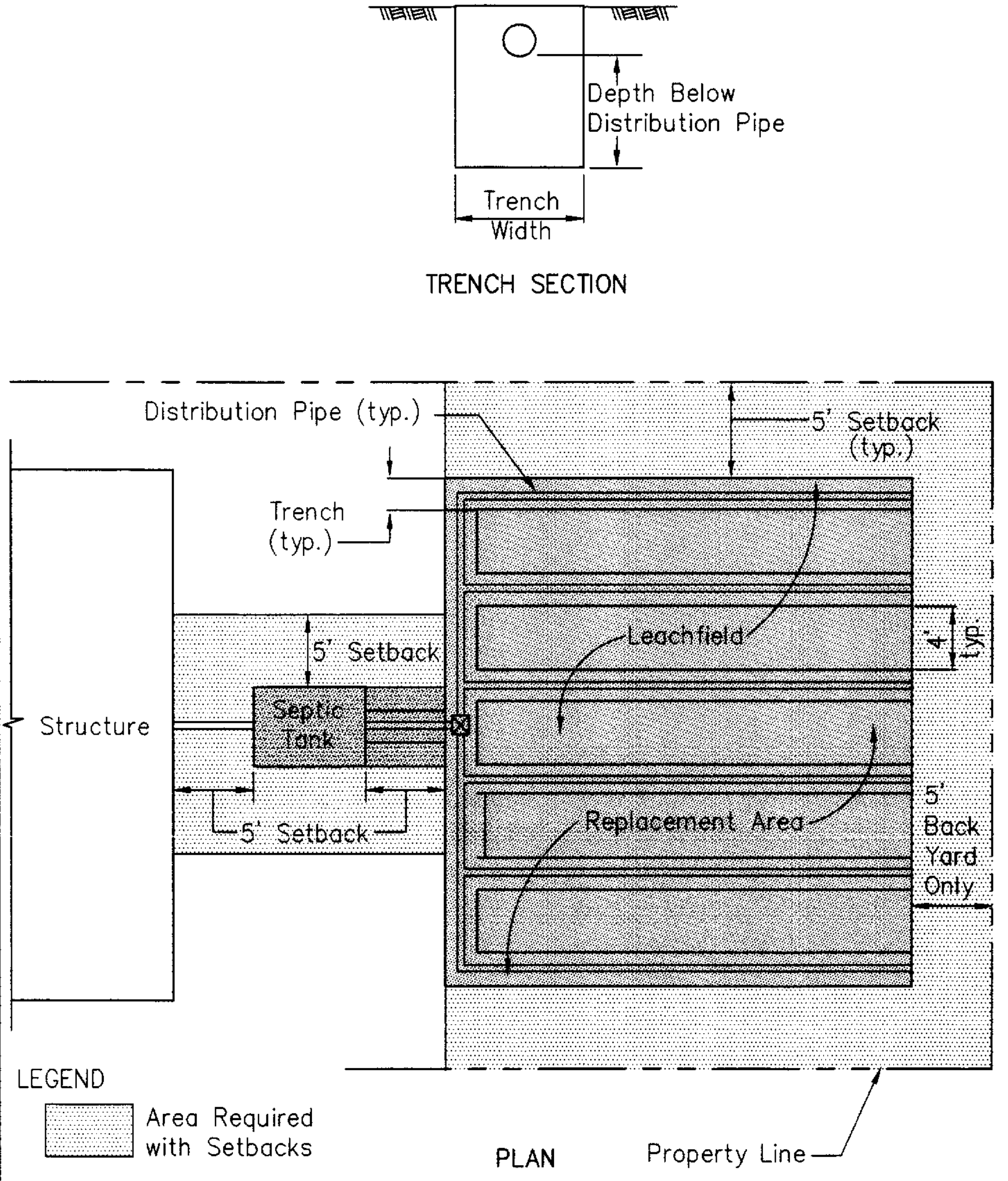
NOTE: **these are minimum areas required; with different orientation of facilities on Figure H-2, area could be larger.**

a. Private Sewage Disposal System. Information Bulletin. San Luis Obispo County Department of Planning and Building. January 1989. It is assumed that the basic criterion of 125 sq ft/bedroom does not include a replacement pit.

International Association of Plumbing and Mechanical Officials. Uniform Plumbing Code. 1991 Edition. September 1990.

b. Metcalf & Eddy. Wastewater Engineering: Treatment, Disposal, Reuse. Third Edition. McGraw-Hill, 1991. Pp. 1060 ff.

Kaplan, O.B. Septic Tank Systems Handbook. Second Edition. Chelsea, Michigan, Lewis Publishers. 1991. P. 116. It is assumed that the basic criterion of 0.4 gpd/sq ft does not include a replacement pit.



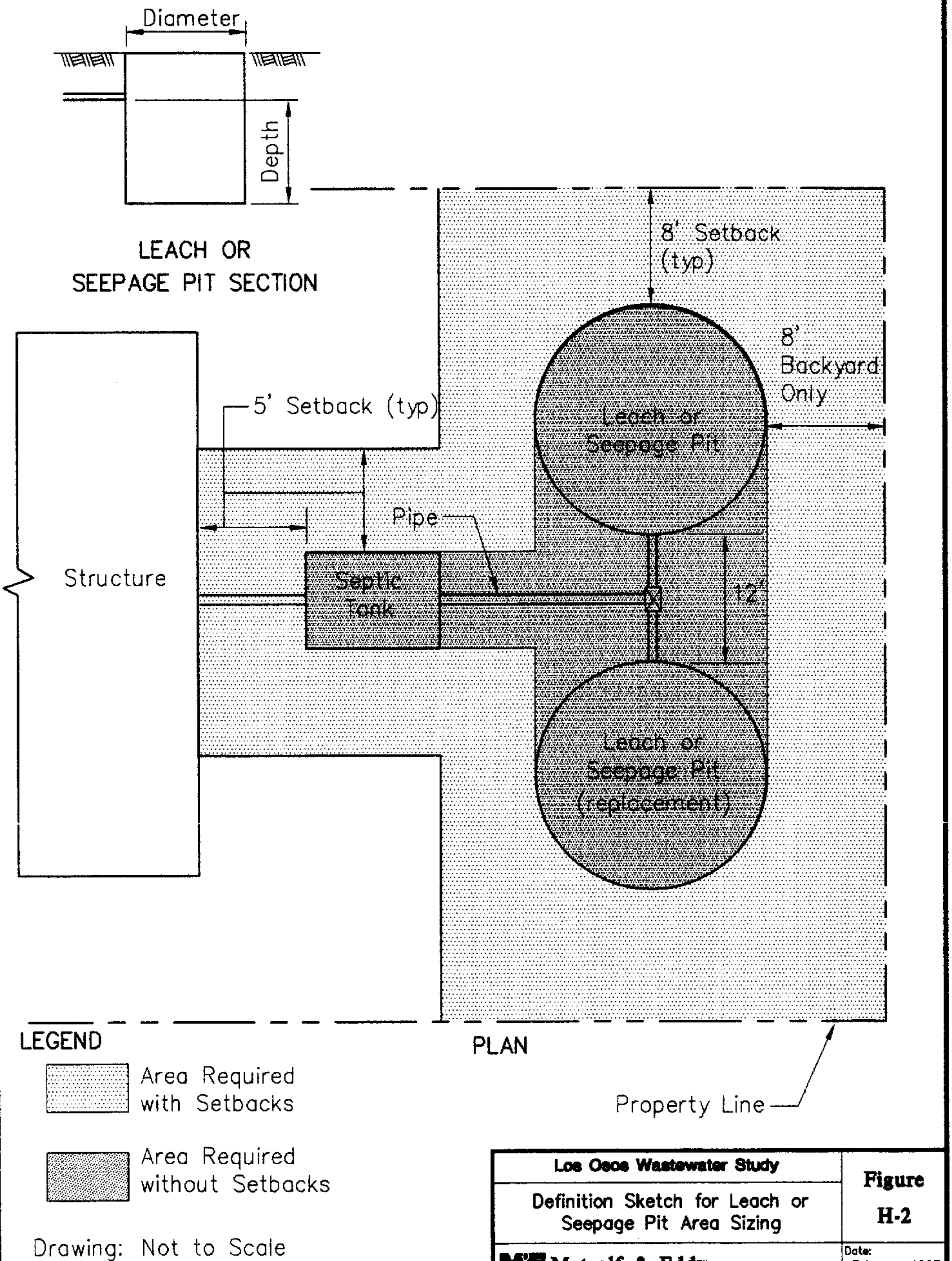
Los Osos Wastewater Study

Definition Sketch for Minimum Leachfield Area Sizing

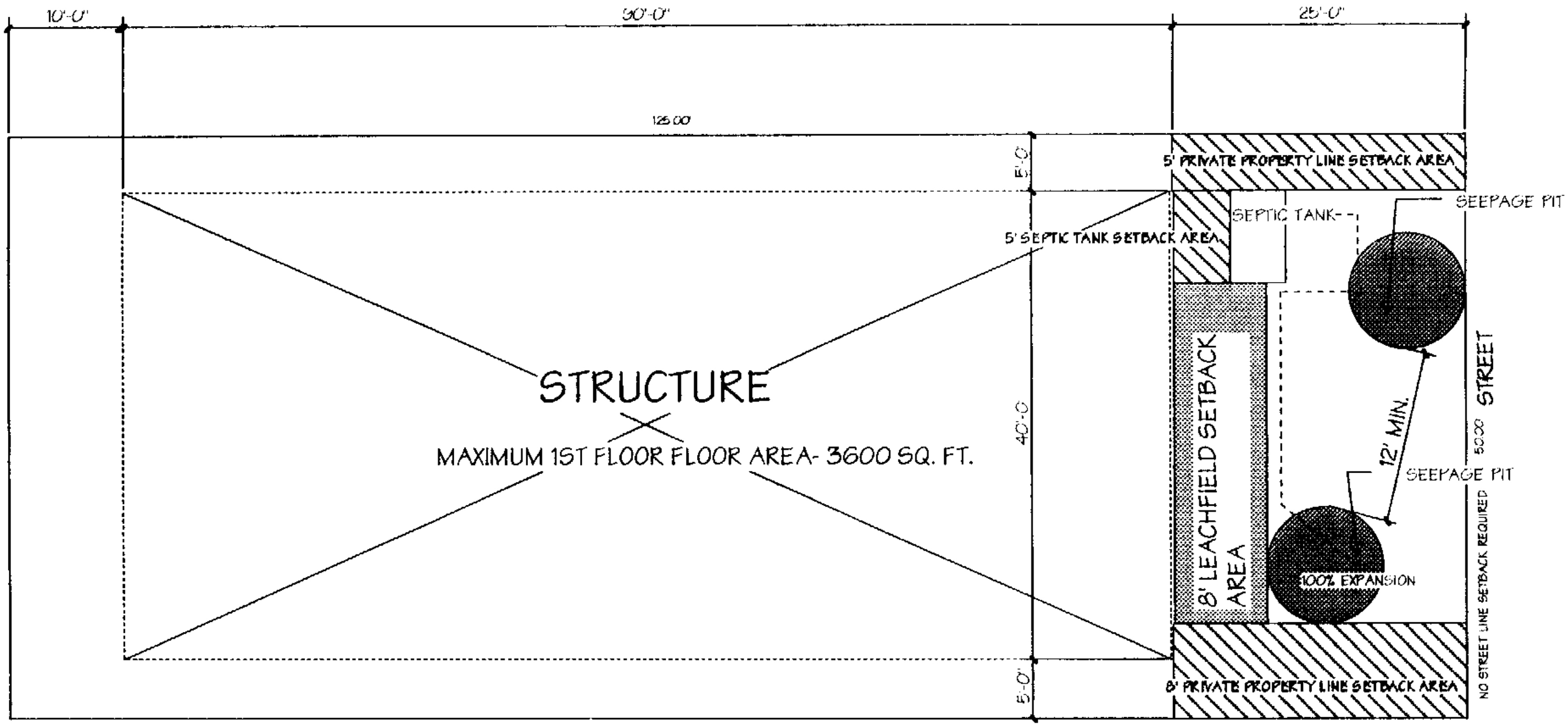
Figure H-1

Metcalf & Eddy

Date: October 1994

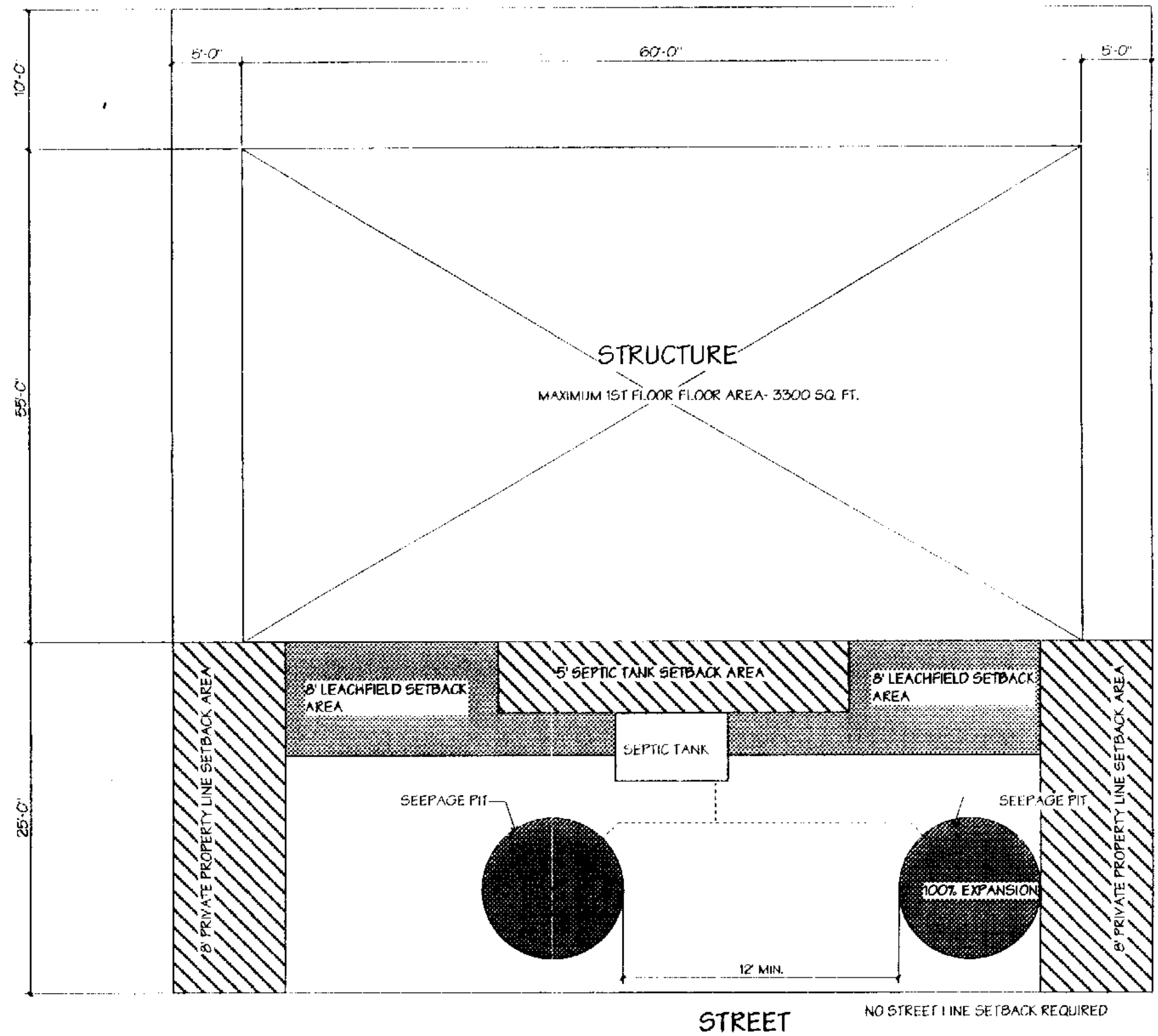


Los Osos Wastewater Study	Figure H-2
Definition Sketch for Leach or Seepage Pit Area Sizing	
M&E Metcalf & Eddy	Date: February 1995



TOWN OF EL MORO AREA (LOT SIZE 50'X125')

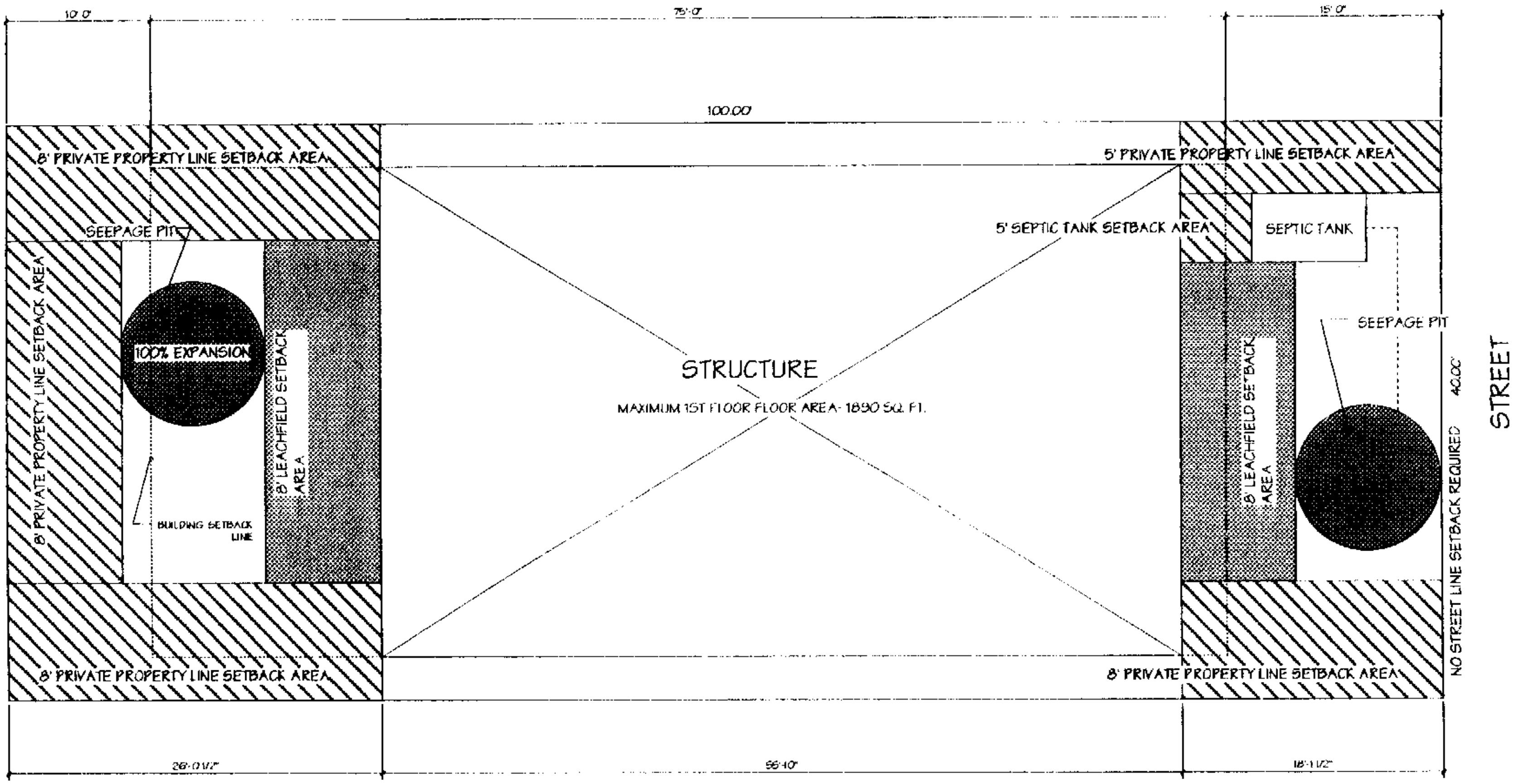
DEFINITION SKETCH FOR SEPTIC SYSTEM- SEEPAGE PIT SIZING



LOS OSOS-SUNSET TERRACE/MORRO PALISADES

(LOT SIZE 70'X90') SYSTEM SIZED FOR 3 BEDROOM RESIDENCE

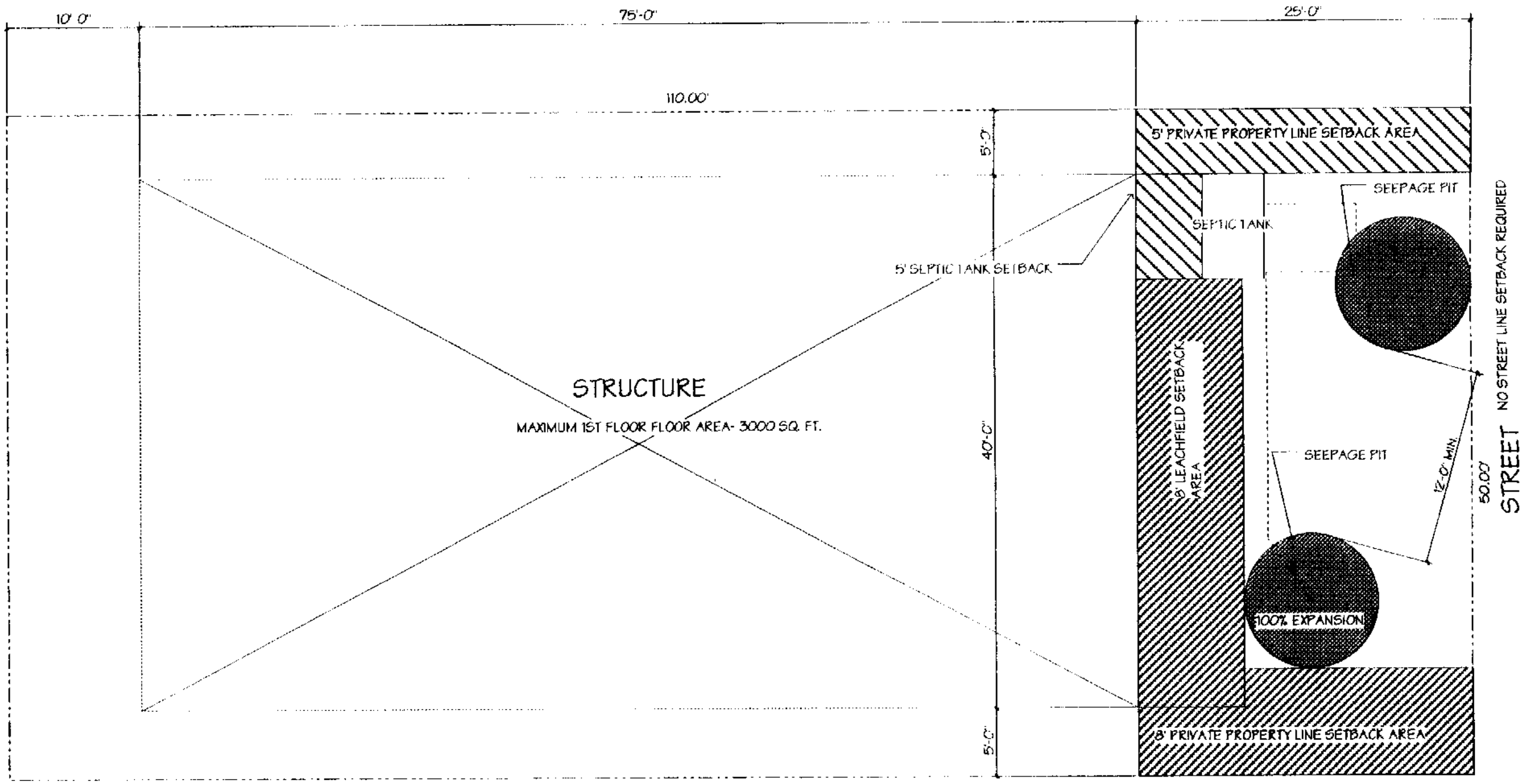
DEFINITION SKETCH FOR SEPTIC SYSTEM-SEEPAGE PIT SIZING



LOS OSOS- CUESTA BY THE SEA (LOT SIZE 40'X100')

SYSTEM SIZED FOR 3 BEDROOM RESIDENCE

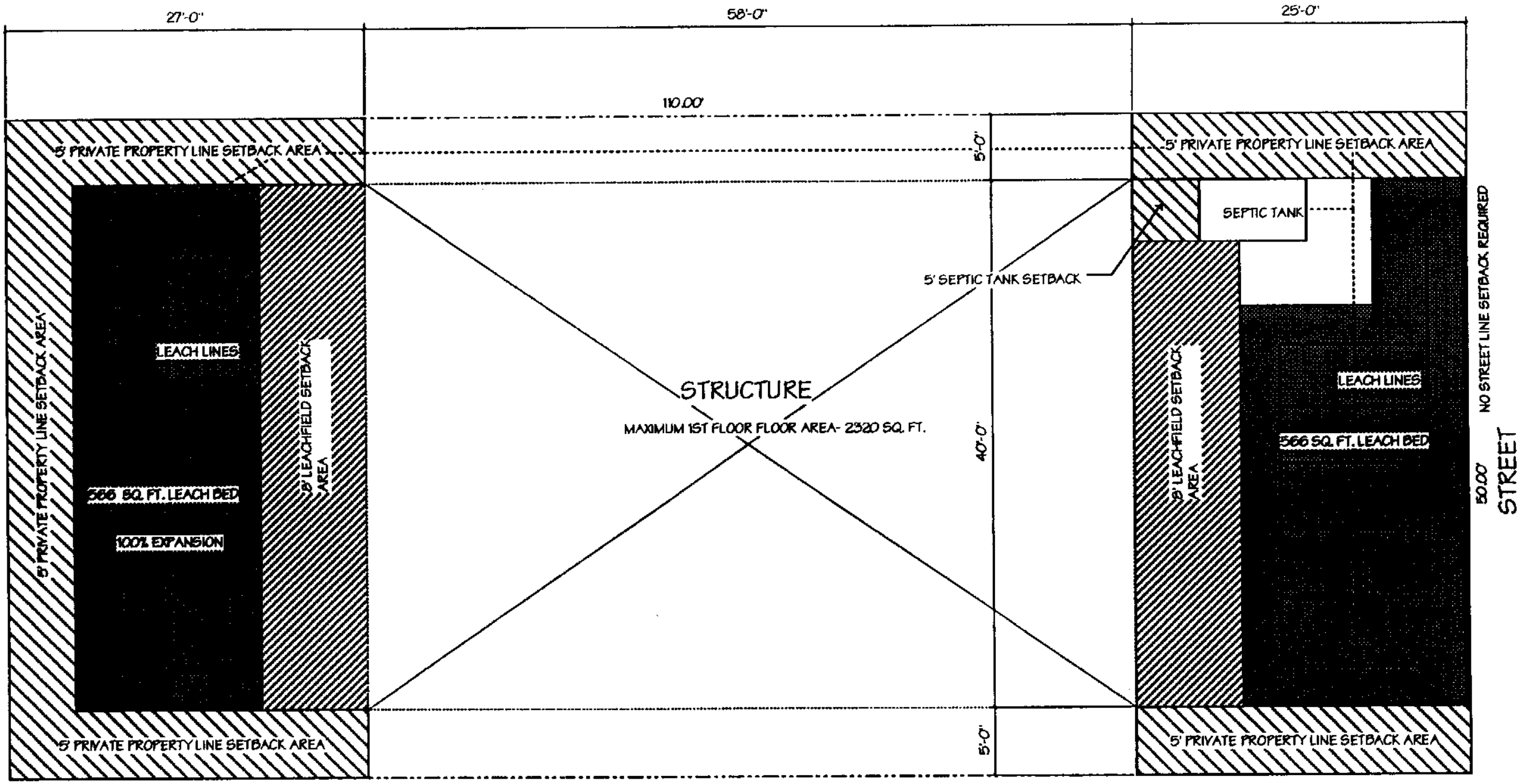
DEFINITION SKETCH FOR SEPTIC SYSTEM- SEEPAGE PIT SIZING



LOS OSOS-REDFIELD WOODS AREA (LOT SIZE 50'X110')

SYSTEM SIZED FOR 3 BEDROOM RESIDENCE

DEFINITION SKETCH FOR SEPTIC SYSTEM- SEEPAGE PIT SIZING



LOS OSOS-REDFIELD WOODS AREA (LOT SIZE 50'X110')

System Sized for 2 or 3 Bedroom Residence

DEFINITION SKETCH FOR SEPTIC SYSTEM- LEACH BED SIZING

APPENDIX I

REVIEW AND SUMMARY OF OTHER STUDIES

LOST OAKS VILLAGE WASTEWATER TREATMENT FACILITY [1,2]

This was a field test of percolation of wastewater through soil columns. The soil was taken from property at Pecho and Los Osos Valley Roads and packed into two 8-in. pipes to a depth of 7 ft. After rinsing the soil columns with a chlorine solution to destroy all native organisms, wastewater from the Los Oaks Condominium was applied to the columns over a 3-day period in April 1985. No rates of application for both the chlorine solution and wastewater are given. Both influent and percolated wastewater were tested for total coliform bacteria, nitrate, nitrite, ammonia, and total kjeldahl nitrogen twice each day. No samples within the soil column were analyzed.

The sampling and testing were requested by Fred H. Schott and Associates and done by Central Coast Analytical Services and the results given in a letter report. Applied effluent total nitrogen was 35-42 mg/L, mostly in the ammonia and organic forms. After the 3-day period, total nitrogen in the percolate was <1 mg/L. The report concludes that "the desired reduction in the total nitrogen content of the percolated effluent were achieved [in the short run]."

Since no intermediate samples were taken from the columns, the evidence of nitrification/denitrification is indirect and subject to speculation. There are other difficulties with the test procedures that make the results difficult to interpret or explain. No information is given on dosing rates of the soil columns. If the wastewater dosing rate were low, it is conceivable that the wastewater may be diluted with the chlorine solution. If the dosing rate is high, the nitrification or ammonium removal is reduced as the system treatment capacity begins to reach its limit. Furthermore, no soil or water/wastewater samples were taken before and after the testing to determine effects on soil modification and saturation in the columns. Since the tests were run for only 3 days, no long-term data are available. Three days may not be enough time to establish a resident microorganism population in the soil columns. The report authors concede that long term effects could not be measured for the study.

Schott and Associates did further work at the Lost Oaks Village leachfield. A 10-day composite sample of percolate 6 feet beneath the leachfield was collected and analyzed during September 1985 after the leachfield had been in operation for six months. Nitrate content of these samples was 0.4 mg/L and total kjeldahl nitrogen was 3.0 mg/L. Schott concludes that nitrogen in the effluent is being nitrified and denitrified by the bacteria in the soil beneath the leachfield. As with the soil columns, there is no intermediate sampling, so the data are indirect evidence of nitrification/denitrification. However, the results are more realistic than for the soil columns.

NITROGEN ISOTOPE TESTS [3]

This was a series of 17 samples from shallow wells and one effluent sample each from Vista de Oro and Bayridge Estates analyzed for percent of the nitrogen-15 isotope. The tests were conducted by HTI, Inc. and completed in February and June 1987. The results were reported in three letters which constitute this report.

In general, percentages less than 5% reflect nitrate from agricultural sources and percentages greater than 10% indicate the nitrate source is primarily human or animal waste. The percentages for the well samples ranged 3.1% to 12.7% and most values were between 6 and 9%. By the above criteria, the results are ambiguous and no conclusions can be drawn.

However, the report states that the contribution of nitrate from onsite wastewater systems "is probably small in relation to the total nitrate." This statement seems to be based on the homogeneous nitrate levels in the 17 well samples, i.e., the expectation is to have extremes in nitrate levels because of differences in design, age, and distance to the wells. The preliminary assessment was that much of the nitrate is from nonpoint source such as fertilizer or the soil.

There are problems with this conclusion. First, since Los Osos has undergone steady growth since the early 1970s, these extremes probably have been moderated over time. Furthermore, more recent data since these tests were conducted have much more extreme values (Appendix B). Second, the reference has no study of nonpoint sources or even a discussion of land uses or economic activity to support the contention of nitrate from nonpoint sources. The above preliminary assessment is not justified by the data and analyses in this reference.

REFERENCES

1. Havlicek, Stephen C. Central Coast Analytical Service, Inc. Letter to Fred H. Schott and Associates. June 28, 1985.

2. Schott, Fred H. Letter to John Goni, California Regional Water Quality Control Board, Central Coast Region. September 27, 1985.

3. Spalding, Roy F. Letters to Percy Garcia, San Luis Obispo County Engineering Department. March 13, 1987; August 10, 1987; and August 31, 1987.

APPENDIX J

LOS OSOS WASTEWATER STUDY
Summary of Sanitary Survey Results
and Permit and Complaint Data

Page, block		Sanitary Survey: Problems (Table 4-1): Wet spots	After rain	After visitors	Odors, back-ups	Total	Lots surveyed	Total problems/ lots surveyed	Non-vacant lots	Lots surveyed/ nonvacant lots	Sufficient data?*	Other Indicators: Permits	Complaints	Total	Total / nonvacant lots
4	15	0	0	0	4	4	12	0.33	9	133%	Yes	1	0	1	0.11
4	16	0	1	0	5	6	15	0.40	22	68%	Yes	4	0	4	0.18
4	17	0	0	0	1	1	7	0.14	22	32%	Yes	4	0	4	0.18
4	18	0	0	0	0	0	15	0.00	24	63%	Yes	4	0	4	0.17
4	19	1	0	0	0	1	23	0.04	23	100%	Yes	8	0	8	0.35
4	44	1	0	0	0	1	22	0.05	25	88%	Yes	6	0	6	0.24
4	45	0	0	0	0	0	16	0.00	24	67%	Yes	7	0	7	0.29
4	46	0	0	0	1	1	2	0.50	23	9%	No	3	0	3	0.13
4	47	1	0	0	0	1	4	0.25	24	17%	No	2	0	2	0.08
4	48	0	0	0	0	0	2	0.00	18	11%	No	1	0	1	0.06
5	20	0	0	0	0	0	12	0.00	24	50%	Yes	5	0	5	0.21
5	21	0	0	0	0	0	13	0.00	21	62%	Yes	3	0	3	0.14
5	22	0	0	0	0	0	9	0.00	19	47%	Yes	3	0	3	0.16
5	23	0	0	0	1	1	4	0.25	12	33%	Yes	0	0	0	0.00
5	24	0	0	0	0	0	3	0.00	8	38%	Yes	2	0	2	0.25
5	39	0	0	0	0	0	8	0.00	23	35%	Yes	6	0	6	0.26
5	40	0	0	0	1	1	11	0.09	20	55%	Yes	5	0	5	0.25
5	41	0	1	2	1	4	15	0.27	22	68%	Yes	4	0	4	0.18
5	42	0	1	0	0	1	10	0.10	21	48%	Yes	7	0	7	0.33
5	43	0	1	1	3	5	17	0.29	23	74%	Yes	6	0	6	0.26
6	25	0	0	0	0	0	4	0.00	7	57%	Yes	1	0	1	0.14
6	26	0	0	0	0	0	5	0.00	7	71%	Yes	1	0	1	0.14
6	27	1	0	0	0	1	7	0.14	11	64%	Yes	1	0	1	0.09
6	28	0	0	0	2	2	12	0.17	17	71%	Yes	0	0	0	0.00
6	29	0	0	0	0	0	16	0.00	18	89%	Yes	3	0	3	0.17
6	34	0	0	0	1	1	8	0.13	22	36%	Yes	4	0	4	0.18
6	35	1	0	0	0	1	7	0.14	20	35%	Yes	3	0	3	0.15
6	36	2	0	0	0	2	18	0.11	20	90%	Yes	5	0	5	0.25
6	37	1	0	0	0	1	9	0.11	16	56%	Yes	7	0	7	0.44
6	38	0	0	1	1	2	9	0.22	20	45%	Yes	8	0	8	0.40
7	2	0	0	0	0	0	6	0.00	7	86%	Yes	1	0	1	0.14
7	3	0	0	0	0	0	3	0.00	3	100%	Yes	1	0	1	0.33
7	5	0	0	0	0	0	6	0.00	10	60%	Yes	0	0	0	0.00
7	6	0	0	0	0	0	8	0.00	13	62%	Yes	0	0	0	0.00
7	7	0	0	0	0	0	10	0.00	16	63%	Yes	0	0	0	0.00
7	30	1	0	0	3	4	11	0.36	19	58%	Yes	4	0	4	0.21
7	31	2	0	0	4	6	10	0.60	16	63%	Yes	2	0	2	0.13
7	32	0	0	0	0	0	2	0.00	16	13%	No	5	0	5	0.31
7	33	0	0	1	1	2	10	0.20	21	48%	Yes	3	0	3	0.14
8	1	0	0	1	1	2	14	0.14	14	100%	Yes	3	0	3	0.21
8	4	0	0	0	0	0	2	0.00	3	67%	Yes	0	0	0	0.00
8	64	0	0	0	0	0	2	0.00	9	22%	Yes	0	0	0	0.00
8	65	0	0	0	1	1	2	0.50	10	20%	Yes	3	1	4	0.40
8	67	0	0	0	0	0	1	0.00	0	--	No	0	0	0	--
9	59	0	0	0	0	0	5	0.00	27	19%	No	8	1	9	0.33
9	60	0	0	0	0	0	12	0.00	19	63%	Yes	1	0	1	0.05

APPENDIX J

LOS OSOS WASTEWATER STUDY
Summary of Sanitary Survey Results
and Permit and Complaint Data

	Sanitary Survey										Other Indicators			
	Problems (Table 4–1)													
Page, block	Wet spots	After rain	After visitors	Odors, back–ups	Total	Lots sur–veyed	Total problems/ lots sur–veyed	Non–vacant lots	Lots surveyed/ nonva–cant lots	Suf–ficient data?*	Per–mits	Com–plaints	Total	Total / nonva–cant lots
9 61	0	0	0	1	1	7	0.14	22	32%	Yes	7	0	7	0.32
9 62	0	0	0	0	0	13	0.00	24	54%	Yes	6	0	6	0.25
9 63	0	1	1	1	3	6	0.50	18	33%	Yes	5	0	5	0.28
9 68	0	0	1	0	1	11	0.09	22	50%	Yes	3	0	3	0.14
9 69	0	0	0	0	0	7	0.00	21	33%	Yes	6	0	6	0.29
9 70	0	0	0	0	0	8	0.00	16	50%	Yes	9	0	9	0.56
9 71	2	3	1	1	7	8	0.88	23	35%	Yes	5	0	5	0.22
9 72	1	5	2	3	11	15	0.73	23	65%	Yes	4	0	4	0.17
10 54	1	2	1	3	7	20	0.35	23	87%	Yes	5	0	5	0.22
10 55	0	0	2	2	4	19	0.21	27	70%	Yes	1	0	1	0.04
10 58	0	4	4	6	14	16	0.88	28	57%	Yes	3	0	3	0.11
10 73	1	3	4	3	11	10	1.10	22	45%	Yes	11	0	11	0.50
10 74	0	2	1	3	6	15	0.40	29	52%	Yes	8	0	8	0.28
10 75	0	3	1	2	6	13	0.46	23	57%	Yes	6	0	6	0.26
10 76	0	0	1	1	2	10	0.20	16	63%	Yes	4	0	4	0.25
10 77	0	1	0	4	5	15	0.33	21	71%	Yes	7	0	7	0.33
11 49	0	0	0	0	0	10	0.00	17	59%	Yes	8	0	8	0.47
11 50	0	0	0	3	3	9	0.33	21	43%	Yes	4	0	4	0.19
11 51	0	1	1	2	4	22	0.18	26	85%	Yes	7	0	7	0.27
11 52	0	0	1	1	2	13	0.15	21	62%	Yes	4	0	4	0.19
11 53	0	0	2	2	4	16	0.25	22	73%	Yes	4	0	4	0.18
11 78	0	0	0	0	0	6	0.00	14	43%	Yes	5	0	5	0.36
11 79	1	1	1	2	5	18	0.28	26	69%	Yes	3	0	3	0.12
11 80	0	4	3	4	11	14	0.79	26	54%	Yes	8	0	8	0.31
11 81	0	0	0	0	0	14	0.00	22	64%	Yes	3	0	3	0.14
11 82	1	0	0	2	3	17	0.18	25	68%	Yes	5	0	5	0.20
13 86	0	0	0	1	1	7	0.14	25	28%	Yes	7	0	7	0.28
13 83	2	3	3	4	12	14	0.86	23	61%	Yes	5	0	5	0.22
13 84	0	3	1	2	6	14	0.43	24	58%	Yes	3	0	3	0.13
13 85	0	2	1	0	3	19	0.16	23	83%	Yes	8	0	8	0.35
13 87	0	0	1	2	3	10	0.30	18	56%	Yes	6	0	6	0.33
13 108	0	0	0	0	0	3	0.00	25	12%	No	11	0	11	0.44
13 109	0	0	0	1	1	11	0.09	24	46%	Yes	7	0	7	0.29
13 110	0	0	0	0	0	11	0.00	26	42%	Yes	5	0	5	0.19
13 111	0	0	0	0	0	14	0.00	25	56%	Yes	7	0	7	0.28
13 112	0	0	0	0	0	15	0.00	26	58%	Yes	4	0	4	0.15
14 88	2	0	0	1	3	11	0.27	23	48%	Yes	5	0	5	0.22
14 89	0	0	0	0	0	10	0.00	22	45%	Yes	4	0	4	0.18
14 90	1	0	0	0	1	4	0.25	19	21%	Yes	5	0	5	0.26
14 91	0	0	0	0	0	5	0.00	27	19%	No	7	0	7	0.26
14 92	1	0	0	0	1	15	0.07	21	71%	Yes	4	0	4	0.19
14 103	1	1	1	1	4	32	0.13	46	70%	Yes	5	0	5	0.11
14 104	0	0	0	0	0	0	––	23	0%	No	9	0	9	0.39
14 105	0	0	0	0	0	6	0.00	22	27%	Yes	7	0	7	0.32
14 106	0	0	0	2	2	9	0.22	25	36%	Yes	4	0	4	0.16
14 107	0	2	2	2	6	13	0.46	24	54%	Yes	13	0	13	0.54

APPENDIX J

LOS OSOS WASTEWATER STUDY
Summary of Sanitary Survey Results
and Permit and Complaint Data

Page, block	Sanitary Survey: Problems (Table 4-1): Wet spots	After rain	After visitors	Odors, back-ups	Total	Lots surveyed	Total problems/lots surveyed	Non-vacant lots	Lots surveyed/nonvacant lots	Sufficient data?*	Other Indicators: Permits	Complaints	Total	Total/nonvacant lots
15 93	0	0	0	1	1	12	0.08	23	52%	Yes	6	0	6	0.26
15 94	0	0	2	1	3	15	0.20	22	68%	Yes	7	0	7	0.32
15 95	0	0	0	1	1	7	0.14	15	47%	Yes	2	0	2	0.13
15 96	0	0	0	1	1	2	0.50	20	10%	No	5	0	5	0.25
15 97	0	1	0	1	2	9	0.22	18	50%	Yes	3	0	3	0.17
15 98	0	1	0	0	1	1	1.00	1	100%	Yes	0	0	0	0.00
15 99	0	0	0	0	0	2	0.00	19	11%	No	1	0	1	0.05
15 100	1	0	0	0	1	16	0.06	25	64%	Yes	3	0	3	0.12
15 101	0	0	0	0	0	14	0.00	27	52%	Yes	5	0	5	0.19
15 102	0	1	0	1	2	14	0.14	27	52%	Yes	5	0	5	0.19
17 15	0	0	0	0	0	4	0.00	11	36%	Yes	1	0	1	0.09
17 21	0	0	0	0	0	2	0.00	14	14%	No	1	0	1	0.07
17 22	0	0	0	0	0	1	0.00	10	10%	No	1	1	2	0.20
17 26	0	1	0	0	1	1	1.00	1	100%	Yes	0	0	0	0.00
17 27	0	0	0	0	0	2	0.00	14	14%	No	0	0	0	0.00
17 28	0	0	0	0	0	5	0.00	17	29%	Yes	1	0	1	0.06
17 31														
17 32	0	0	1	0	1	9	0.11	60	15%	No	2	0	2	0.03
17 33														
17 34	0	0	0	0	0	3	0.00	10	30%	Yes	2	0	2	0.20
18 4	0	0	0	0	0	1	0.00	1	100%	Yes	1	0	1	1.00
18 5	0	1	0	1	2	4	0.50	12	33%	Yes	0	2	2	0.17
18 13	0	0	0	0	0	0	--	3	0%	No	0	0	0	0.00
18 14	0	0	0	1	1	1	1.00	11	9%	No	2	0	2	0.18
18 35	0	0	0	0	0	8	0.00	20	40%	Yes	1	0	1	0.05
19 1	0	0	0	0	0	14	0.00	17	82%	Yes	2	0	2	0.12
19 2	0	0	0	0	0	2	0.00	6	33%	Yes	0	0	0	0.00
20 1	0	0	0	1	1	9	0.11	14	64%	Yes	2	0	2	0.14
20 2	0	0	0	0	0	7	0.00	17	41%	Yes	3	0	3	0.18
20 3	0	0	1	1	2	8	0.25	21	38%	Yes	3	0	3	0.14
20 6	2	0	0	0	2	7	0.29	17	41%	Yes	1	0	1	0.06
20 7	0	0	2	2	4	6	0.67	11	55%	Yes	1	0	1	0.09
20 8	0	0	0	0	0	9	0.00	23	39%	Yes	2	0	2	0.09
20 9	0	0	0	0	0	3	0.00	16	19%	No	1	0	1	0.06
20 10	0	1	0	0	1	5	0.20	17	29%	Yes	1	3	4	0.24
20 11	0	0	0	0	0	4	0.00	13	31%	Yes	3	0	3	0.23
20 12	0	0	0	0	0	5	0.00	14	36%	Yes	0	1	1	0.07
21 17	0	0	0	0	0	0	--	17	0%	No	2	1	3	0.18
21 18	0	0	0	0	0	0	--	18	0%	No	1	0	1	0.06
21 19	0	0	0	0	0	1	0.00	17	6%	No	2	0	2	0.12
21 20	0	0	0	0	0	5	0.00	18	28%	Yes	2	0	2	0.11
21 23	0	2	1	0	3	4	0.75	20	20%	Yes	1	1	2	0.10
21 24	0	1	0	0	1	22	0.05	34	65%	Yes	4	0	4	0.12
21 25	0	0	0	0	0	5	0.00	22	23%	Yes	1	0	1	0.05
21 28	0	0	0	0	0	11	0.00	30	37%	Yes	4	0	4	0.13
21 29	0	0	0	0	0	4	0.00	17	24%	Yes	6	0	6	0.35
21 30	0	0	0	0	0	9	0.00	15	60%	Yes	1	0	1	0.07
23	0	0	0	0	0	7	0.00	20	35%	Yes	3	0	3	0.15
24 122	0	1	1	1	3	14	0.21	21	67%	Yes	4	0	4	0.19
24 123	0	0	0	0	0	2	0.00	24	8%	No	6	0	6	0.25
24 124	0	0	1	0	1	9	0.11	23	39%	Yes	4	0	4	0.17
24 125	0	0	0	0	0	0	--	1	0%	No	0	0	0	0.00
24 126	0	0	0	0	0	2	0.00	4	50%	Yes	2	0	2	0.50
24 127	0	0	0	0	0	13	0.00	23	57%	Yes	5	0	5	0.22
24 128	0	0	0	1	1	21	0.05	22	95%	Yes	6	0	6	0.27

APPENDIX J

LOS OSOS WASTEWATER STUDY
Summary of Sanitary Survey Results
and Permit and Complaint Data

	Sanitary Survey										Other Indicators			
	Problems (Table 4–1)													
Page, block	Wet spots	After rain	After visitors	Odors, back–ups	Total	Lots sur–veyed	Total problems/ lots sur–veyed	Non–vacant lots	Lots surveyed/ nonva–cant lots	Suf–ficient data?*	Per–mits	Com–plaints	Total	Total / nonva–cant lots
25 117	0	0	0	1	1	13	0.08	29	45%	Yes	4	0	4	0.14
25 118	0	0	0	0	0	18	0.00	25	72%	Yes	10	1	11	0.44
25 119	1	2	2	3	8	12	0.67	24	50%	Yes	8	0	8	0.33
25 120	0	0	0	1	1	14	0.07	23	61%	Yes	11	0	11	0.48
25 121	0	0	0	0	0	13	0.00	22	59%	Yes	3	0	3	0.14
25 129	0	0	2	3	5	10	0.50	21	48%	Yes	5	0	5	0.24
25 130	0	0	0	0	0	14	0.00	25	56%	Yes	4	0	4	0.16
25 131	0	0	0	0	0	3	0.00	18	17%	No	11	0	11	0.61
25 132	0	0	0	0	0	1	0.00	23	4%	No	4	0	4	0.17
25 133	0	0	0	1	1	4	0.25	22	18%	No	11	0	11	0.50
26 113	0	0	0	0	0	0	0.00	5	0%	No	0	0	0	0.00
26 114	3	0	0	2	5	5	1.00	5	100%	Yes		0	0	0.00
26 115	0	0	1	0	1	10	0.10	24	42%	Yes	7	0	7	0.29
26 116	2	0	0	0	2	12	0.17	26	46%	Yes	6	0	6	0.23
26 134	0	0	0	0	0	9	0.00	18	50%	Yes	5	0	5	0.28
26 135	0	0	0	0	0	1	0.00	6	17%	No	1	0	1	0.17
27	0	0	0	0	0	0	––	39	0%	No	7	2	9	0.23
27 137	0	0	0	0	0	0	––	10	0%	No	7	0	7	0.70
28 138	0	0	0	0	0	6	0.00	19	32%	Yes	8	0	8	0.42
28 139	0	0	1	2	3	10	0.30	19	53%	Yes	1	0	1	0.05
28 140	0	1	2	1	4	14	0.29	21	67%	Yes	8	0	8	0.38
28 141	0	0	0	0	0	8	0.00	17	47%	Yes	4	0	4	0.24
28 142	0	0	1	1	2	14	0.14	22	64%	Yes	4	0	4	0.18
28 143	0	0	0	0	0	2	0.00	2	100%	Yes	0	0	0	0.00
28 145	0	0	0	0	0	5	0.00	15	33%	Yes	2	0	2	0.13
28 146	0	0	0	0	0	0	––	15	0%	No	2	0	2	0.13
28 147	0	0	0	0	0	1	0.00	15	7%	No	3	0	3	0.20
28 148	0	0	0	0	0	0	––	7	0%	No	0	0	0	0.00
29	0	0	0	0	0	1	0.00	33	3%	No	10	1	11	0.33
30	0	0	0	0	0	0	––	30	0%	No	6	0	6	0.20
31 a	0	0	0	0	0	4	0.00	21	19%	No	6	0	6	0.29
31 b	1	0	0	0	1	10	0.10	25	40%	Yes	6	0	6	0.24
31 c	0	1	2	2	5	10	0.50	27	37%	Yes	4	0	4	0.15
31 d	0	1	1	2	4	13	0.31	29	45%	Yes	5	0	5	0.17
31 151 31 152 31 153	0				0	0	––	16	0%	No	3	0	3	0.19
32	0	0	0	0	0	0	––	4	0%	No	0	0	0	0.00
33 b	1	0	0	1	2	11	0.18	28	39%	Yes	3	0	3	0.11
34 a	0	0	0	1	1	8	0.13	11	73%	Yes	1	0	1	0.09
35 a1	0	0	0	0	0	12	0.00	11	109%	Yes	1	0	1	0.09
35 a2	0	0	0	0	0	19	0.00	24	79%	Yes	4	0	4	0.17
35 a3	0	1	0	0	1	19	0.05	25	76%	Yes	7	0	7	0.28
35 a4	0	0	0	0	0	13	0.00	14	93%	Yes	4	0	4	0.29
35 b1,2	0	0	0	4	4	48	0.08	77	62%	Yes	10	0	10	0.13

APPENDIX J

LOS OSOS WASTEWATER STUDY
Summary of Sanitary Survey Results
and Permit and Complaint Data

Page, block		Sanitary Survey										Other Indicators			
		Problems (Table 4-1)													
Page	block	Wet spots	After rain	After visitors	Odors, back-ups	Total	Lots surveyed	Total problems/lots surveyed	Non-vacant lots	Lots surveyed/nonvacant lots	Sufficient data?*	Permits	Complaints	Total	Total / nonvacant lots
38	c	0	0	0	0	0	2	0.00	7	29%	Yes		0	0	0.00
38	3	1	0	0	0	1	19	0.05	24	79%	Yes	2	0	2	0.08
38	6	1	0	0	2	3	10	0.30	25	40%	Yes	1	0	1	0.04
38	9	0	0	1	1	2	11	0.18	25	44%	Yes	5	1	6	0.24
38	12	1	0	1	1	3	11	0.27	28	39%	Yes	5	0	5	0.18
38	15	0	0	0	0	0	11	0.00	23	48%	Yes	5	0	5	0.22
38	18	0	0	0	0	0	5	0.00	13	38%	Yes	0	0	0	0.00
39	1	1	0	1	2	4	12	0.33	24	50%	Yes	6	0	6	0.25
39	2	0	0	0	0	0	9	0.00	26	35%	Yes	4	0	4	0.15
39	4	0	0	0	1	1	9	0.11	25	36%	Yes	5	0	5	0.20
39	5	0	0	0	0	0	10	0.00	24	42%	Yes	2	0	2	0.08
39	7	0	0	0	0	0	16	0.00	24	67%	Yes	2	0	2	0.08
39	8	0	1	0	1	2	10	0.20	25	40%	Yes	6	0	6	0.24
39	10	1	0	0	1	2	6	0.33	24	25%	Yes	5	0	5	0.21
39	11	0	0	0	2	2	11	0.18	26	42%	Yes	7	0	7	0.27
39	13	0	0	0	0	0	1	0.00	25	4%	No	2	0	2	0.08
39	14	0	0	0	0	0	9	0.00	20	45%	Yes	6	0	6	0.30
39	16	0	0	0	0	0	1	0.00	11	9%	No	1	0	1	0.09
39	17	1	0	0	1	2	5	0.40	14	36%	Yes	2	0	2	0.14
40	a	0	0	1	1	2	8	0.25	20	40%	Yes	4	0	4	0.20
40	b	0	0	0	0	0	2	0.00	19	11%	No	1	0	1	0.05
40	C	0	0	0	0	0	0	--	20	0%	No	1	0	1	0.05
40	D	0	0	0	0	0	12	0.00	20	60%	Yes	3	0	3	0.15
40	E	0	0	0	0	0	8	0.00	19	42%	Yes	2	0	2	0.11
40	F	0	0	0	0	0	5	0.00	10	50%	Yes	1	0	1	0.10
40	1	0	0	0	0	0	3	0.00	8	38%	Yes	1	0	1	0.13
40	2	0	0	0	0	0	3	0.00	8	38%	Yes	2	0	2	0.25
40	3	0	0	0	0	0	3	0.00	7	43%	Yes	2	0	2	0.29
40	4	0	0	0	0	0	5	0.00	8	63%	Yes	1	0	1	0.13
40	5	0	0	0	0	0	3	0.00	7	43%	Yes	2	0	2	0.29
40	6	0	0	0	0	0	1	0.00	4	25%	Yes	0	0	0	0.00
41	b	0	0	0	0	0	5	0.00	6	83%	Yes	1	0	1	0.17
41	1	0	0	0	0	0	0	--	13	0%	No	2	0	2	0.15
41	2	0	0	0	0	0	3	0.00	14	21%	Yes	4	0	4	0.29
41	3	0	0	0	0	0	2	0.00	14	14%	No	1	0	1	0.07
41	4	1	0	0	1	2	9	0.22	13	69%	Yes	4	0	4	0.31
41	5	0	0	0	0	0	1	0.00	14	7%	No	3	0	3	0.21
41	6	0	0	0	0	0	0	--	8	0%	No	1	0	1	0.13
41	7	0	0	0	0	0	11	0.00	10	110%	Yes	2	0	2	0.20
41	8	0	0	0	0	0	2	0.00	17	12%	No	3	0	3	0.18
41	9	0	0	0	0	0	0	--	6	0%	No	1	0	1	0.17
42	1	0	0	0	1	1	13	0.08	15	87%	Yes	2	0	2	0.13
42	2	0	0	0	0	0	4	0.00	8	50%	Yes	1	0	1	0.13
42	3	0	0	0	0	0	6	0.00	6	100%	Yes	1	0	1	0.17
42	4	0	0	1	1	2	7	0.29	8	88%	Yes	2	0	2	0.25
42	5	0	0	1	0	1	7	0.14	10	70%	Yes	2	0	2	0.20
42	6	1	0	0	1	2	9	0.22	14	64%	Yes	1	0	1	0.07
42	7	0	2	1	1	4	12	0.33	54	22%	Yes	0	0	0	0.00
44		0	0	0	3	3	17	0.18	25	68%	Yes	4	0	4	0.16
45		0	0	0	0	0	2	0.00	50	4%	No	13	0	13	0.26
46		0	1	1	1	3	14	0.21	41	34%	Yes	5	0	5	0.12
48		0	0	0	0	0	0	--	12	0%	No	1	1	2	0.17
Totals		44	65	71	154	334	2,027	0.16	4,563	44%	--	880	17	897	0.20

NOTES:

* If number of lots surveyed / number of nonvacant lots is greater than or equal to 20%.

1. Page 14 block 103 also includes page 14 block 104.
2. Page 26 block 114 also includes page 26 block 113.