Questa Engineering Corporation
CIVIL, ENVIRONMENTAL, AND WATER RESOURCE ENGINEERS

February 17, 1995

Mr. Roger Briggs, Executive Officer
California Regional Water Quality Control Board
Central Coast Region
81 Higuera Street, Suite 200
San Luis Obispo, CA 93401-5414

Subject: Los Osos/Baywood Park Nitrogen Study

Dear Mr. Briggs:

At the request of the staff of the Central Coastal Regional Water Quality Control Board I have completed an independent review of the Los Osos/Baywood Park Nitrogen Study, dated July 1994. I have also toured the study area and viewed the individual monitoring sites. I have worked in the field of on-site sewage disposal for the past 20 years, including considerable study of nitrate and other cumulative impact issues. A copy of my curriculum vitae is attached summarizing my educational background and experience. This letter summarizes my review comments.

GENERAL COMMENTS

The study provides considerable useful monitoring data and clearly represents a significant effort on the part of the Technical Advisory Committee (TAC) and their consultants to help document and understand the septic system effects in the Los Osos/Baywood area. However, I have sharp disagreement with the overall conclusions and many of the interpretations presented in the report.

Contrary to the conclusion of the TAC, the monitoring results provide overwhelming evidence that the nitrate-nitrogen from septic systems in Los Osos/Baywood Park is contaminating the groundwater in the area. The TAC concluded that virtually all of the nitrogen in septic system effluent is removed in the soil, and attributed the documented groundwater nitrate contamination immediately beneath the leachfield test sites to "unknown off-site sources". In reading the report it appears to me that this conclusion was reached due, at least in part, to a lack of technical understanding of certain groundwater/contaminant flow principles and a failure to critically examine all aspects of the data and the sampling methodology. Examples of some of the key flaws in the TAC's study are as follows.

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ATTACHMENT ONE

1. **Contaminant Flow in Groundwater.** The TAC study showed high nitrate levels in the upper groundwater zone (i.e., at the water table) immediately beneath each of the three leachfield sites monitored. The groundwater and associated contaminants at the water table are a direct reflection of the recharge in the immediate vicinity of the sampling point; this is fundamental to groundwater flow phenomena. In the case of a constant source of recharge, such as a leachfield system, the contaminant "plume" will follow a pattern similar to that shown in Attachment A, in which the contaminant migrates deeper with distance from the source. This is due to the hydraulic forces of other recharge waters downgradient of the contaminant source. Exceptions to this occur for liquids with a specific gravity less than that of water (e.g., petroleum products), which tend to float at the water surface. Because of its high solubility, nitrate follows the contaminant behavior shown in Attachment A; and this is well documented. Thus, for case of the Los Osos/Baywood Study, it is not possible for groundwater (and nitrate) from an off-site (upgradient) source to appear at the water table beneath the leachfield and displace the constantly percolating wastewater. The assertion in the TAC Study that this is the explanation for the high nitrate readings in the groundwater monitoring wells directly contradicts well established principles of groundwater and contaminant flow.

2. **Insufficient Groundwater Monitoring Points.** Each of the three monitoring sites in the study was instrumented with a single groundwater monitoring well, presumably for budgetary reasons. This is insufficient to draw any firm conclusions about groundwater flow direction or contaminant gradients; yet, the study concludes that the observed groundwater nitrate concentrations are from off-site sources. As discussed in the previous comment, a single shallow-zone monitoring well beneath a recharge source gives information on the recharge water; but it tells nothing about the horizontal distribution of contaminants. Normally, at least three or four "nested" monitoring wells are utilized to characterize and understand the "plume" in the vicinity of a suspected contaminant source. The lack of horizontal sampling data gives the TAC study no basis for drawing any conclusion about the influx of nitrate from off-site sources; thus, this conclusion in the report is little more than speculation which contradicts groundwater flow phenomena (as discussed in Comment 1).

3. **Dispersion/Dilution in the Unsaturated Zone.** The TAC study attempts to explain the nitrate-nitrogen concentration changes in the unsaturated zone (from lysimeter samples) as a function

of nitrification and denitrification processes only. The effects of contaminant dispersion and dilution by other recharge waters (i.e., rainfall percolation) is largely overlooked. The TAC's data interpretation appears to rest on the unrealistic assumption that the successively deeper lysimeters continue to collect only the water that is moving in an idealized vertical "tube", originating at the leachfield. Given the uniformity and high permeability of the sandy soils at these sites, a great deal of lateral dispersion and dilution in the unsaturated zone would generally not be expected. However, it can occur due to a variety of factors, including: (a) selective flow through "macropores" in the soil; (b) slight differences in particle size distribution in soil layers (e.g., finer sand particles or higher silt/clay content); (c) concentrated sources of rainfall recharge; and, (d) fully or partially perched groundwater zones.

The TAC report discusses the possible influence of perched groundwater in relation to some of the water quality readings at the 30 and 40-foot depths at the 13th Street and 14th Street study sites. However, the most obvious dilution effect is overlooked. This is at the 25-foot lysimeter at the 14th Street site, where nitrate, chloride, EC and pH readings all drop markedly from the readings at 20 feet. The TAC study improperly interpreted the lower nitrate readings as a function of dentrification when, in fact, the coincident drop in chloride concentration (from 80 mg/l to <30 mg/l) can only be explained by dilution. This clear oversight in the data analysis seriously undermines the overall conclusions of the study in regard to dentrification estimates.

4. **Soil Solution Nitrogen Data.** The method by which the TAC study converts soil solution measurements of nitrogen (in mg/kg) to projected groundwater concentrations (in mg/L) is highly irregular and technically unsupportable. This use of the data, as displayed in Table 9 of the study, is done to support the theory that the high groundwater-nitrate levels in the area are due to natural sources, such as vegetation and geology. In the study the TAC calculates the theoretical total nitrogen content of groundwater by assuming that all nitrogen measured in soil cores is associated with the liquid phase (i.e., the moisture) in the soil, which is clearly not the case. Nitrogen measurements from the soil solution is obtained by leaching all of the nitrogen from the sample, which includes nitrogen bound in the mineral matrix, as well as that associated with organic matter and within the liquid (moisture) phase. The study itself acknowledges that 98 percent of the nitrogen in the soils was found to be in immobile, organic-nitrogen forms. There is absolutely no basis for the study's conversion of these data to a projected groundwater

concentration computed according to the total mass of nitrogen and the moisture content of the soil. Moreover, this exercise serves to suggest that native soils in the area are unusually high in nitrogen when, in fact, the data reflect relatively low concentrations compared with most natural forest and grassland soils in California.

5. **Nitrification and Denitrification.** The TAC study concludes that complete nitrification followed by nearly complete dentrification occurs beneath septic systems at the study sites to prevent nitrate contamination of the groundwater by septic systems. With the exception of the Bayridge Estates site (discussed in a separate comment below) it is clear from the data that complete nitrification is achieved by passage of effluent through the deep sandy soils. This is entirely consistent with other research and experience with septic systems.

   With respect to dentrification, I agree that the study results indicate that some degree of dentrification is probably occurring in the unsaturated zone; and this is also consistent with the literature. The suggestion of the study that denitrification removes as much as 80 to 90 percent of the nitrogen is not supported by objective and critical review of the data. In reaching the conclusions about denitrification, the dilution effects are ignored as is the incontrovertible evidence of nitrate contamination at the water table immediately under the discharging leachfields.

<u>13th Street Site</u>

The monitoring data for the 13th Street site show a clear migration of nitrate-nitrogen from the leachpit to the groundwater. The nitrate concentrations decrease with depth, which is likely due to the combined effects of: (a) dispersion, dilution and mixing with other percolating recharge waters (i.e., rainfall) in the unsaturated zone; (b) dentrification in the unsaturated zone; and, (c) mixing and dilution with other groundwater at the water table. This reflects the classic understanding of nitrate behavior beneath septic systems in deep, sandy soils. I have personal experience with the installation and monitoring of leachfield system under similar conditions, with nearly identical observed effects on groundwater nitrate concentrations.

The TAC study appears to down-play the significance of the data from this sampling site, suggesting that possibly the newness of the system and/or the use of a pump system to deliver wastewater to the leachpit make the data less valid than the other sampling sites. There is also a suggestion of the influx of higher nitrate water from an adjacent unknown source (at the 40-foot lysimeter). I see no merit in these arguments. The data are very consistent over the 12-month monitoring period, indicating no noticeable effect of system age. The dosing of wastewater to the leachfield (via a pump system) may have some effect in a shallow water table situation - but not where there are 40-plus feet of unsaturated sands beneath the leachfield to even-out the small "pulses" of wastewater discharge. With respect to the influence of off-site sources, the only likely effects would be that from neighboring septic system discharges.

14th Street Site

As discussed in General Comment #3, the lysimeter sampling data at this site (specifically at the 25-foot depth) are clearly affected by dilution effects from other recharge waters; and this goes unnoticed in the TAC's analysis. The study site adjoins an unimproved street right-of-way (El Morro Street), which is a likely source of higher quality rainfall-recharge water. The TAC study does not give recognition to this factor, which, if considered, would aid in the understanding and interpretation of the monitoring results. The other recharge influences confound the attempts in the study to explain the nitrate changes in terms of denitrification alone. This is a clear case where additional groundwater monitoring wells and/or lysimeters distributed over the site would provide the needed information to fully understand the nitrate and other water quality changes that are occurring.

Bayridge Estates Site

Monitoring data for the Bayridge Estates site show a clear nitrate impact on groundwater nitrate quality from the leachfield system. The following two key issues are not adequately addressed in the TAC analysis and conclusions with respect to this site.

1. **Incomplete Nitrification.** The sampling data show significant levels of ammonia and TKN (five to ten mg/l, as N) in the 10-foot and 15-foot lysimeters, indicating incomplete nitrification of the percolating wastewater at these depths. Also, at seven of the 12 sampling times testing was not done for ammonia or TKN; this is potentially very significant information missing from the study. The TAC report includes a brief discussion of the incomplete nitrification (on page 76), but the data analysis fails to recognize that the ammonia and TKN make up part of the total nitrogen concentration that can be expected to be transformed ultimately to nitrate in the groundwater. The graphing and discussion of nitrate concentrations, as well as nitrate/chloride and nitrate/EC ratios as presented in the report are meaningless when significant nitrogen remains in the ammonia or organic forms. The conclusion of the TAC report that percolating wastewater meets the drinking water nitrate standard at the 15-foot lysimeter is seriously misleading and has no significance because of the high ammonia concentrations remaining.

2. **Nitrate Correspondence with Water Table Level.** The TAC study places strong emphasis on the apparent correspondence of the highest nitrate groundwater readings with the lowest water table conditions (i.e., when the leachfield is not in operation). This is cited as evidence that off-site sources, and not the leachfield system, are the cause of the high nitrate concentrations in groundwater.

   A careful review of the data, as presented in Figure 27 (attached) in the report, discounts this interpretation by the TAC. What Figure 27 shows is that the peak groundwater nitrate concentrations coincide with the start-up of leachfield operation after a period of resting. These peak groundwater concentrations also correspond with peak readings in the 10-foot and 15-foot lysimeters; inclusion of TKN values would make the lysimeter total nitrogen readings even more pronounced.

   The spike in the nitrate readings upon leachfield start-up is consistent with the seasonal flushing of pollutant build-up in the soil that is often seen in groundwater data. In this case, the resting period allows the residual nitrogen from the wastewater to be completely nitrified, and subsequently mobilized and carried into the groundwater with re-initiation of the leachfield discharge. The interpretation and conclusion of the TAC regarding influx

of nitrate from an off-site source is not supportable.

CONCLUSIONS

In formulating my comments on the study I have attempted to focus on the key technical issues which may influence future decisions and work effort on the Los Osos/Baywood nitrate problem. There is a considerable amount of useful information that has come from the monitoring efforts of the study; but, I strongly disagree with the conclusion that these data point to something other than septic systems as the primary source of groundwater-nitrate contamination. In terms of future efforts, I believe the strategic placement and sampling of several shallow zone monitoring wells at the previous study sites would be the most effective way to confirm the apparent septic system nitrate impacts. Diverting attention and study efforts to "natural" sources would, in my opinion, be seriously misguided.

I am available to answer questions about my review comments and participate in a meeting or workshop discussion if so desired.

Sincerely,

Norman N. Hantzsche

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Principal/Managing Engineer

NNH/amg

Ref.: 95005L1

ATTACHMENT A

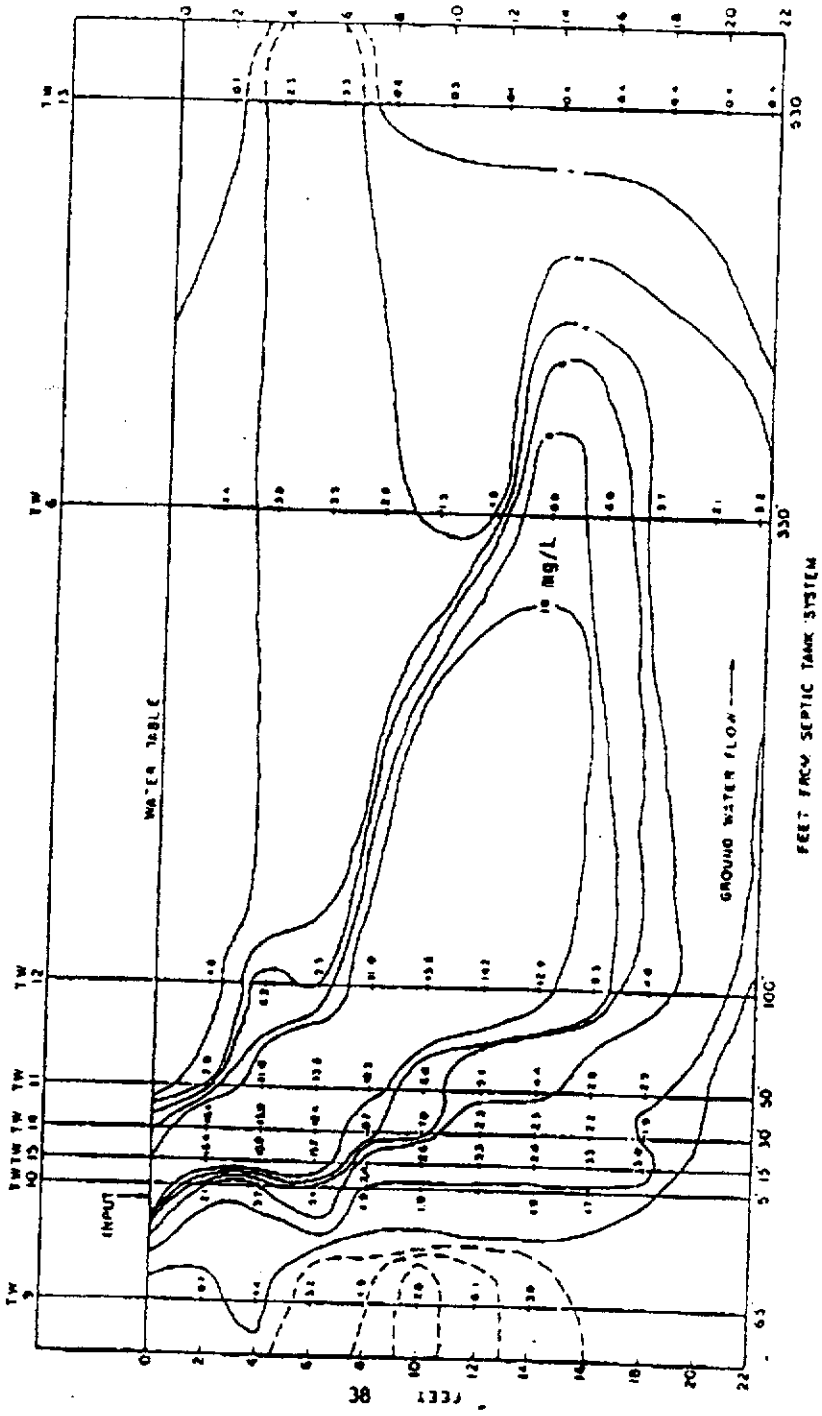
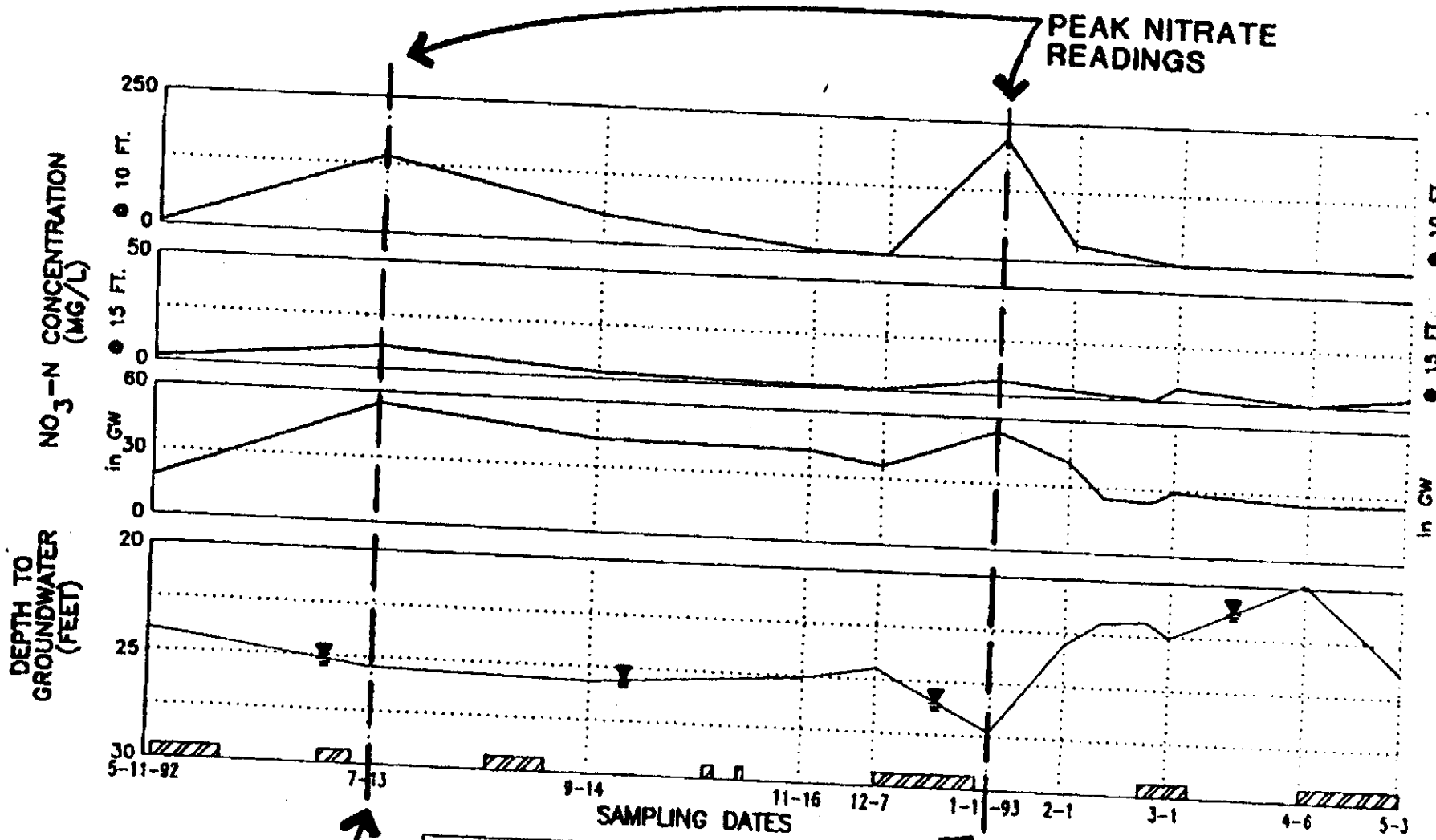


Diagram of Equal NO_3-N Concentration Lines (mg/L) in Groundwater Beneath Septic Tank Discharge

Source: "Assessment of Cumulative Impacts of Individual Sewage Treatment and Disposal Systems", RAMLIT Associates, 1982 Report for North Coast Regional Water Quality Control Board.



SYSTEM START-UP

LEGEND:

OFF — ON LEACHFIELD INFILTRATION

NO_3-N CONCENTRATION

GROUNDWATER LEVEL

FIGURE 27

NITRATE PROFILE AT BAYRIDGE SITE

BAYWOOD / LOS OSOS NITRATE STUDY

200-F012

NORMAN N. HANTZSCHE, P.E.
Principal/Managing Engineer

B.S., Civil Engineering, Stanford University, 1971
M.S., Civil Engineering, University of California, Davis, 1973
Engineer Degree Studies, Civil Engineering, Stanford University
Registered Civil Engineer in California

Mr. Hantzsche has a diverse background in hydrology, water resources and environmental engineering. Over the past nineteen years he has served as project manager and engineer on numerous wastewater, water quality, and hydrological investigations, as a consultant and on the staff of the California State and Regional Water Quality Control Boards. His principal areas of specialization are small-scale wastewater management, groundwater quality, water supply planning and watershed management. He is a noted authority on wetland hydrology and treatment processes and on-site sewage disposal practices and groundwater impacts, and has published a number of professional papers on these topics.

Representative Assignments

- Statewide assessment of groundwater contamination by pesticides, including case studies, pesticide transport and behavior, and mitigation practices.
- Field supervision and analysis of groundwater exploration and monitoring for underground chemical leakage at various industrial sites (San Jose, Sunnyvale, Mountain View, and Santa Rosa).
- Development of remedial action plan for extraction, treatment and disposal of contaminated groundwater at three major semiconductor facilities in Sunnyvale and Santa Clara, California, including design, installation, and testing of a groundwater extraction system.
- Planning and design of individual and small community wastewater treatment and disposal systems for over 500 individual residences, campgrounds, resorts, unsewered communities, and commercial establishments in northern California.
- Water supply investigations for various coastal communities and private developments in Marin, Mendocino, Humboldt, San Mateo and Sonoma counties.
- Planning and design of watershed improvements for correction of runoff and channel erosion problems in the Golden Gate National Recreation Area at Stinson Beach.
- Field investigations, mapping and planning of area-wide management programs for on-site wastewater disposal at The Sea Ranch (Sonoma County), Bolinas Mesa (Marin County), San Lorenzo Valley (Santa Cruz County) and Malibu (Los Angeles County).
- Analysis of storm drainage, wastewater and water supply impacts of urbanization in connection with specific development plans and environmental impact reports for various projects in northern California.

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- Design consultant for staff training, engineering review of sewage disposal plans, and development of County regulations for on-site sewage disposal, including alternative technologies.
- Assessment of cumulative surface and groundwater impacts from on-site waste disposal practices in the North Coast Region of California.
- Development and implementation of a soil erosion/siltation monitoring program for the Lake Tahoe Basin, including watershed mapping and hydrological studies.
- Research and evaluation of hydraulic/hydrologic processes and practices for managing wetland systems for wastewater and stormwater treatment.
- Field investigation and analysis of various non-point source runoff problems, including: (a) bacterial contributions to Humboldt Bay; (b) oil and grease contamination, City of Richmond; and, (c) erosion and agricultural runoff in the San Francisco Bay Area.
- Engineering assessment of levee conditions and rehabilitation needs in the Suisun Marsh, including photo interpretation, field survey and cost estimation.
- Consultation and expert witness testimony in litigation involving on-site wastewater disposal, groundwater supply and drainage (20+ cases).
- Principal Investigator for 3-year sediment and streamflow monitoring study and watershed erosion surveys for Olema Creek at Point Reyes National Seashore.
- Development of guidelines for pumping tests and hydrological studies required for evaluating the adequacy and impacts of new groundwater supplies in the coastal areas of Mendocino County.
- Feasibility study and engineering design for on-site wastewater disposal, cluster mounds and leachfields, intermittent and recirculating sand/gravel filters and STEP collection systems for 350-home community wastewater management project at Bolinas in Marin County.
- Engineering design and construction management for erosion control project at 300-acre quarry site near Foresthill in Placer County.
- Principal Investigator for eighteen wastewater pollution studies and sanitary surveys in unsewered rural communities in Lake, Marin, Mariposa, Placer, Santa Clara and Sonoma counties.
- Analysis of hydrologic conditions and development of engineering plans for wetland enhancement projects at various locations along the San Francisco Bay shoreline including Antioch, San Rafael, Burlingame and the Coyote Hills Regional Park at Fremont.

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Selected Publications

Hantzsche, N.N. and E.J. Finnemore, Predicting Ground-Water Nitrate-Nitrogen Impacts, Groundwater Jl., Vol. 30, No. 4, July-August 1992.

Hantzsche, N.N., J.E. Smiell, and R.A. Moore, Data Management System for On-Site Wastewater Inspection Program at the Sea Ranch, California, ASAE - Sixth National Symposium on Individual and Small Community Sewage Systems, Chicago, Illinois, December 1991.

Hantzsche, N.N., Y.J. Litwin and N.A. George. Groundwater Contamination by Pesticides: A California Assessment, Report to the California Water Resources Control Board. RAMLIT Associates, Inc., June, 1983.

Hantzsche, N.N. and E.J. Finnemore. Jl. of the Irrigation and Drainage Division, ASCE, Vol. 109, No. 2, June, 1983, Ground-Water Mounding Due to On-Site Sewage Disposal.

Hantzsche, N.N., Conference Paper - Ecological Considerations in Wetlands Treatment of Municipal Wastewaters, U.S. Fish and Wildlife Service and EPA, University of Massachusetts, Amherst, June 24-25, 1982, Wetland Systems for Wastewater Treatment: Engineering Applications.

Hantzsche, N.N., B.D. Kor and E.J. Finnemore. Assessment of Cumulative Impacts of On-Site Sewage Disposal Systems. Presented at the American Society of Civil Engineers 1982 National Spring Convention, Las Vegas, Nevada, April, 1982.

Hantzsche, N.N. and N.J. Fishman. Mound Systems for Cluster Development. ASAE - Third National Symposium on Individual and Small Community Sewage Treatment, Chicago, December 1981.

Hantzsche, N.N., W.T. Neikirk and T.J. Wistrom. Soil Textural Analysis for On-Site Sewage Disposal Evaluation. ASAE - Third National Symposium on Individual and Small Community Sewage Treatment, Chicago, December 1981.

Hantzsche, N.N., E. Chan, T.A. Bursztynsky and Y.J. Litwin. The Use of Wetlands for Water Pollution Control. U.S. EPA Municipal Environmental Research Laboratory, 1981.

Hantzsche, N.N. and J.B. Franzini. International Symposium on Urban Storm Runoff, University of Kentucky, Lexington, July 1980, Utilization of Infiltration Basins for Urban Stormwater Management.

NORMAN N. HANTZSCHE, P.E., Principal/Managing Engineer

Education

1980	Engineer Degree Studies, Environmental & Civil Engineering Stanford University
1973	Master of Engineering, Civil Engineering and Hydrology University of California, Davis
1971	Bachelor of Science, Civil Engineering Stanford University

Experience

1982 -	Principal and Managing Engineer. Questa Engineering Corporation, Point Richmond, California.
1979 - 1982	Senior Civil Engineer, Vice President, Project Manager. RAMLIT Associates, Inc., Berkeley, California.
1975 - 1979	Associate Water Resources Control Engineer. North Coast Regional Water Quality Control Board, Santa Rosa, California.
1973 - 1975	Assistant Engineering Specialist, Sanitary. State Water Resources Control Board, Sacramento, California.
1972 - 1973	Hydrologist. Burgy and Knight Associates, Davis, California.
1972	Teaching Assistant in Hydraulics and Surveying. University of California at Davis, Davis, California.
1970	Engineering Student Trainee - Surveying. State of California, Division of Highways, San Francisco, California.
1967 - 1968	Engineering Draftsman. Pacific Gas & Electric Co., Davis, California.

Professional Registration

- Registered Civil Engineer - California, License #24750

Professional Affiliations

- American Society of Civil Engineers
- Water Pollution Control Federation
- American Water Works Association