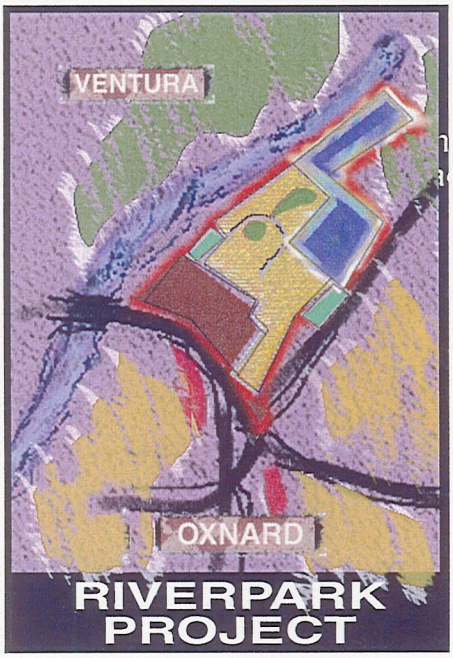
# CITY OF OXNARD
## Draft Environmental Impact Report

VOLUME II appendix

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IMPACT SCIENCES • DECEMBER 2001

# TABLE OF CONTENTS

**VOLUME I: ENVIRONMENTAL IMPACT REPORT**


| Section | | | Page |
|---|---|---|---|
| | SUMMARY | | S-1 |
| 1.0 | INTRODUCTION | | 1.0-1 |
| 2.0 | ENVIRONMENTAL SETTING | | 2.0-1 |
| 3.0 | PROJECT DESCRIPTION | | 3.0-1 |
| 4.0 | ENVIRONMENTAL IMPACT ANALYSIS | | 4.0-1 |
| | 4.1 | Land Use Planning, Programs & Policies | 4.1-1 |
| | 4.2 | Aesthetics | 4.2-1 |
| | 4.3 | Earth Resources | 4.3-1 |
| | 4.4 | Biological Resources | 4.4-1 |
| | 4.5 | Water Resources | 4.5-1 |
| | 4.6 | Agricultural Resources | 4.6-1 |
| | 4.7 | Transportation & Circulation | 4.7-1 |
| | 4.8 | Air Quality | 4.8-1 |
| | 4.9 | Noise | 4.9-1 |
| | 4.10 | Public Services | 4.10-1 |
| | | 4.10.1 Public Schools | 4.10.1-1 |
| | | 4.10.2 Fire Protection | 4.10.2-1 |
| | | 4.10.3 Police Protection | 4.10.3-1 |
| | | 4.10.4 Parks & Recreation | 4.10.4-1 |
| | | 4.10.5 Solid Waste Management | 4.10.5-1 |
| | | 4.10.6 Library Services | 4.10.6-1 |
| | 4.11 | Public Utilities | 4.11-1 |
| | | 4.11.1 Stormwater Drainage | 4.11.1-1 |
| | | 4.11.2 Water Supply and Distribution | 4.11.2-1 |
| | | 4.11.3 Wastewater Service | 4.11.3-1 |
| | | 4.11.4 Energy | 4.11.4-1 |
| | 4.12 | Cultural Resources | 4.12-1 |
| | 4.13 | Hazards | 4.13-1 |
| 5.0 | ALTERNATIVES | | 5.0-1 |
| 6.0 | GROWTH INDUCING IMPACT ANALYSIS | | 6.0-1 |
| 7.0 | SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES | | 7.0-1 |
| 8.0 | REFERENCES | | 8.0-1 |
| 9.0 | ORGANIZATIONS & PERSONS CONSULTED | | 9.0-1 |

# LIST OF APPENDICES

**VOLUME II**


Appendix 1.0 – Notice of Preparation and Responses
Appendix 4.0 – Related Projects List
Appendix 4.3 – Geology Reports
Appendix 4.4 – Biological Data
Appendix 4.5 – Water Quality Data


**VOLUME III**


Appendix 4.7 – Traffic Study
Appendix 4.8 – Air Quality Calculations
Appendix 4.9 – Noise Calculations
Appendix 4.12 – Cultural Resources Reports
Appendix 4.13 – Site Assessment Report
Appendix 5.0 – Alternatives Information

# LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 2.0-1 | Regional Location | 2.0-3 |
| 2.0-2 | Project Vicinity Map | 2.0-4 |
| 2.0-3 | Project Location | 2.0-5 |
| 2.0-4 | Onsite Land Uses | 2.0-6 |
| 2.0-5 | RiverPark Area 'A' Features | 2.0-7 |
| 2.0-6 | RiverPark Area 'B' Features | 2.0-10 |
| 2.0-7 | Surrounding Land Uses | 2.0-13 |
| 2.0-8 | Existing General Plan Land Use | 2.0-20 |
| 2.0-9 | HERO Area within Project Site | 2.0-21 |
| 3.0-1 | Conceptual Land Use Diagram | 3.0-5 |
| 3.0-2 | Illustrative Plan | 3.0-8 |
| 3.0-3 | Conceptual Oblique View Looking North | 3.0-9 |
| 3.0-4 | Conceptual Oblique View Looking South | 3.0-10 |
| 3.0-5 | Community Landscape Master Plan | 3.0-11 |
| 3.0-6 | Trail and Sidewalk System | 3.0-14 |
| 3.0-7 | Pedestrian Travel Distance | 3.0-15 |
| 3.0-8 | Conceptual Land Use Plan | 3.0-20 |
| 3.0-9 | Roadway Circulation | 3.0-25 |
| 3.0-10 | Bicycle Facilities Plan | 3.0-26 |
| 3.0-11 | Proposed Stormwater Quality Treatment System | 3.0-29 |
| 3.0-12 | Development Phasing Plan | 3.0-32 |
| 3.0-13 | General Plan Land Use Amendment | 3.0-35 |
| 4.1-1 | Existing General Plan Land Use | 4.1-3 |
| 4.2-1 | Existing View of Project Site from the South | 4.2-5 |
| 4.2-2 | Existing Northward View of Vineyard Avenue from Myrtle Street | 4.2-6 |
| 4.2-3 | Existing Southwesterly View of the Project Site from Vineyard Avenue | 4.2-7 |
| 4.2-4 | Existing View of the Project Site from El Rio West Neighborhood | 4.2-8 |
| 4.2-5 | Existing View of the Project Site from the North | 4.2-9 |
| 4.2-6 | Existing Westward View of the Project Site from Telephone Road | 4.2-10 |
| 4.2-7 | General Plan Community Design Structure Map | 4.2-13 |
| 4.2-8 | Streetscape Master Plan | 4.2-16 |
| 4.2-9 | Open Space Master Plan | 4.2-17 |
| 4.2-10 | View of Project from the South - Post-Development | 4.2-20 |
| 4.2-11 | Southwesterly View of the Project Site from Vineyard Avenue - Post Development | 4.2-21 |
| 4.2-12 | Cross Section of El Rio West Neighborhood Buffer - Northern Edge | 4.2-24 |
| 4.2-13 | View of the Project Site from El Rio West Neighborhood - Post-Development | 4.2-25 |
| 4.2-14 | Westward View of the Project Site from Telephone Road - Post-Development | 4.2-26 |
| 4.3-1 | Geologic Map | 4.3-3 |
| 4.3-2 | Site Reclamation Plan | 4.3-10 |
| 4.4-1 | Vegetation Communities | 4.4-5 |
| 4.5-1 | Montalvo Forebay Location | 4.5-3 |
| 4.5-2 | Key Well Locations | 4.5-6 |
| 4.5-3 | Hydrograph 2N/22W-22R1 | 4.5-9 |
| 4.5-4 | Annual Precipitation and Water Levels in Well 2N/22W-22H1 | 4.5-10 |
| 4.5-5 | Site Drainage Area Locations | 4.5-15 |
| 4.5-6 | Artificial Recharge Montalvo Forebay | 4.5-20 |
| 4.5-7 | Total Pumpage Montalvo Forebay | 4.5-21 |
| 4.5-8 | RiverPark Pre-Project Water Balances | 4.5-24 |
| 4.5-9 | Ambient Water Quality Well Locations | 4.5-41 |

# LIST OF FIGURES (continued)


| Figure | | Page |
|---|---|---|
| 4.5-10 | Surface Water Runoff and Pit Sampling Locations | 4.5-52 |
| 4.5-11 | Proposed Stormwater Treatment System Drainage Areas | 4.5-67 |
| 4.5-12 | RiverPark Post-Project Water Balances | 4.5-72 |
| 4.5-13 | Drainage Area 2B Hydrographs | 4.5-89 |
| 4.5-14 | Drainage Area 3A Hydrographs | 4.5-90 |
| 4.5-15 | Drainage Area 3B Hydrographs | 4.5-91 |
| 4.5-16 | Drainage Area 4 Hydrographs | 4.5-92 |
| 4.6-1 | Greenbelts and CURB and CBB Boundaries | 4.6-9 |
| 4.6-2 | State Important Farmland Map | 4.6-12 |
| 4.6-3 | Existing Agricultural Land in the Specific Plan Area | 4.6-13 |
| 4.7-1 | Existing Circulation System | 4.7-7 |
| 4.7-2 | Existing (2000) Traffic Volumes, AM Peak Hour | 4.7-12 |
| 4.7-3 | Existing (2000) Traffic Volumes, PM Peak Hour | 4.7-13 |
| 4.7-4 | Specific Plan Roadway Network | 4.7-22 |
| 4.7-5 | Future (2020) Traffic Volumes, without Project, AM Peak Hour | 4.7-25 |
| 4.7-6 | Future (2020) Traffic Volumes, without Project, PM Peak Hour | 4.7-26 |
| 4.7-7 | Future (2020) Traffic Volumes, with Project, AM Peak Hour | 4.7-27 |
| 4.7-8 | Future (2020) Traffic Volumes, with Project, PM Peak Hour | 4.7-28 |
| 4.9-1 | Noise Attenuation by Barriers | 4.9-3 |
| 4.9-2 | Land Use Compatibility Guidelines for Noise | 4.9-6 |
| 4.9-3 | Noise Levels of Typical Construction Equipment | 4.9-11 |
| 4.9-4 | Development Areas and Surrounding Uses | 4.9-12 |
| 4.10.1-1 | Rio School District School Attendance Boundary | 4.10.1-3 |
| 4.10.1-2 | Oxnard Union High School District School Attendance Boundary | 4.10.1-4 |
| 4.10.2-1 | Response Areas of Fire Stations | 4.10.2-3 |
| 4.10.3-1 | Locations of Police Stations | 4.10.3-3 |
| 4.10.3-2 | City of Oxnard Police Beats | 4.10.3-4 |
| 4.10.4-1 | Open Space Master Plan | 4.10.4-5 |
| 4.10.4-2 | Proposed Pedestrian Trails | 4.10.4-8 |
| 4.10.4-3 | Proposed Biking Trails | 4.10.4-9 |
| 4.11.1-1 | Site Drainage Area Locations | 4.11.1-3 |
| 4.11.1-2 | City of Oxnard Storm Drain Master Plan | 4.11.1-8 |
| 4.11.1-3 | RiverPark Storm Drain Master Plan | 4.11.1-11 |
| 4.11.2-1 | RiverPark Specific Plan Water Master Plan | 4.11.2-9 |
| 4.11.3-1 | Central Trunk System | 4.11.3-3 |
| 4.11.3-2 | RiverPark Specific Plan Sewer Master Plan | 4.11.3-6 |

# LIST OF TABLES


| Table | | Page |
|---|---|---|
| 3.0-1 | Riverpark Specific Plan Summary of Proposed Land Uses | 3.0-13 |
| 3.0-2 | RiverPark Draft Specific Plan Land Use Summary by Planning District | 3.0-19 |
| 4.1-1 | Adopted VCOG Population Projections | 4.1-5 |
| 4.1-2 | Adopted VCOG Housing Projections | 4.1-6 |
| 4.1-3 | Adopted 1998-2005 City of Oxnard Regional Housing Needs | 4.1-7 |
| 4.1-4 | SCAG Demographic Projections - VCOG Subregion | 4.1-32 |
| 4.1-5 | SCAG Demographic Projections - City of Oxnard | 4.1-33 |
| 4.3-1 | Summary of Nearby Faults | 4.3-9 |
| 4.4-1 | Special-Status Plant Species Potentially Occurring in the RiverPark Specific Plan Vicinity | 4.4-13 |
| 4.4-2 | Special-Status Wildlife Species Observed or Potentially Occurring on the Project Site | 4.4-14 |
| 4.4-3 | Projected Discharge of Selected Chemical Constituents and Toxicity Levels for Fish | 4.4-27 |
| 4.4-4 | Ornamentals to be Prohibited from the Project Site | 4.4-30 |
| 4.5-1 | Key Wells | 4.5-5 |
| 4.5-2 | Regional Water Balance – Montalvo Forebay | 4.5-17 |
| 4.5-3 | RiverPark Site Water Balances – Existing Conditions Analysis | 4.5-26 |
| 4.5-4 | Primary Drinking Water Standards | 4.5-32 |
| 4.5-5 | Secondary Drinking Water Standards | 4.5-33 |
| 4.5-6 | Basin Plan Surface Water Quality Objectives | 4.5-36 |
| 4.5-7 | Basin Plan Groundwater Quality Objectives | 4.5-36 |
| 4.5-8 | Ambient Groundwater Quality Range | 4.5-42 |
| 4.5-9 | Summary of Existing Total Dissolved Solids Conditions | 4.5-43 |
| 4.5-10 | Summary of Existing Chloride Conditions | 4.5-44 |
| 4.5-11 | Summary of Existing Sulfate Conditions | 4.5-45 |
| 4.5-12 | Summary of Existing Nitrate Conditions | 4.5-45 |
| 4.5-13 | Summary of Existing Boron Conditions | 4.5-46 |
| 4.5-14 | Summary of Existing Metal Concentrations at Freeman Diversion | 4.5-47 |
| 4.5-15 | Summary of Existing Metal Conditions for City of Oxnard Wells | 4.5-48 |
| 4.5-16 | Pit Water and Storm Water Runoff Quality | 4.5-53 |
| 4.5-17 | Anticipated Stormwater Constituent Concentrations vs. Land-Use for Storms Smaller than 10-Year Event | 4.5-55 |
| 4.5-18 | Anticipated Stormwater Constituent Concentrations vs. Land-Use for Storms Greater than 10-Year Event | 4.5-56 |
| 4.5-19 | Thresholds of Significance for Surface Water and Groundwater Quality | 4.5-61 |
| 4.5-20 | NPDES Dewatering Permit Effluent Limitations | 4.5-63 |
| 4.5-21 | RiverPark Site Water Balances - Project Analysis | 4.5-74 |
| 4.5-22 | Project Impacts on Water Quantity | 4.5-77 |
| 4.5-23 | Comparison of Dewatered Groundwater Quality with NPDES Standards | 4.5-79 |
| 4.5-24 | Anticipated BMP Removal Efficiencies | 4.5-81 |
| 4.5-25 | RiverPark Project Stormwater Discharges to Santa Clara River | 4.5-82 |
| 4.5-26 | RiverPark Project Stormwater Discharges to Water Storage/Infiltration Basins | 4.5-83 |
| 4.5-27 | Rainfall Depth-Duration-Frequency at El Rio Station 239 | 4.5-87 |
| 4.5-28 | Existing and Project Runoff Quantities Tributary to the Water Storage/Infiltration Basins | 4.5-88 |
| 4.5-29 | Projected Concentrations for Diverted Santa Clara River Water | 4.5-93 |
| 4.5-30 | UWCD Santa Clara River Diversion Water Quality Analysis | 4.5-95 |
| 4.5-31 | Project Stormwater Concentrations and Loads for TMDL-Related Constituents | 4.5-96 |
| 4.5-32 | Existing Conditions and Project Runoff Comparison | 4.5-96 |
| 4.5-33 | Existing Conditions and Project Percolation Comparison | 4.5-97 |

# LIST OF TABLES (continued)


| Table | | Page |
|---|---|---|
| 4.5-34 | Existing and Project Groundwater and Surface Water Net Contributions Comparison | 4.5-98 |
| 4.6-1 | Conversion of Farmlands within Ventura County 1988-1998 | 4.6-5 |
| 4.7-1 | Level of Service as a Function of V/C Values | 4.7-11 |
| 4.7-2(a) | Intersection Volume/Capacity Summary Existing (2000) Conditions, Project Area Intersections | 4.7-14 |
| 4.7-2(b) | Intersection Volume/Capacity Summary Existing (2000) Conditions, City of Ventura Intersections | 4.7-14 |
| 4.7-3 | Freeway Mainline Level of Service Definitions | 4.7-15 |
| 4.7-4 | Existing (2000) Freeway Volumes and Level of Service | 4.7-16 |
| 4.7-5 | City of Oxnard Vehicle Trip Generation Rates | 4.7-21 |
| 4.7-6 | RiverPark Project Trip Generation | 4.7-23 |
| 4.7-7 | Directional Distribution of Project Traffic, Average Daily Traffic, Study Year: 2020 | 4.7-24 |
| 4.7-8(a) | Intersection Volume/Capacity Summary - Future (2020) Peak Hour Traffic Conditions, Project Area Intersections | 4.7-29 |
| 4.7-8(b) | Intersection Volume/Capacity Summary - Future (2020) Peak Hour Traffic Conditions, City of Ventura Intersections | 4.7-30 |
| 4.7-9 | Future (2020) Freeway Volumes and Level of Service | 4.7-32 |
| 4.7-10(a) | Intersection Volume/Capacity Summary - Future (2020) Peak Hour Traffic Conditions with Project and Mitigation, Project Area Intersections | 4.7-34 |
| 4.7-10(b) | Intersection Volume/Capacity Summary - Future (2020) Peak Hour Traffic Conditions with Project and Mitigation, City of Ventura Intersections | 4.7-34 |
| 4.8-1 | Ambient Pollutant Concentrations | 4.8-7 |
| 4.8-2 | Existing Carbon Monoxide Concentrations | 4.8-8 |
| 4.8-3 | Estimated Operational Emissions - Proposed RiverPark Project, Year 2020 | 4.8-13 |
| 4.8-4 | With Project Carbon Monoxide Concentrations | 4.8-14 |
| 4.8-5 | Estimated Operational Emission Reductions – Proposed RiverPark Project, Year 2020 | 4.8-23 |
| 4.9-1 | Outside to Inside Noise Attenuation | 4.9-2 |
| 4.9-2 | Existing Roadway Noise Levels | 4.9-7 |
| 4.9-3 | Construction Equipment Noise Thresholds | 4.9-9 |
| 4.9-4 | Future On-site Noise Contours and Land Use Types | 4.9-16 |
| 4.9-5 | Existing Plus Project Roadway Noise Levels | 4.9-19 |
| 4.9-6 | Cumulative Roadway Noise Levels | 4.9-21 |
| 4.10.1-1 | Design Capacities and Current Enrollments of Local School Districts | 4.10.1-2 |
| 4.10.1-2 | Student Generation - Allowed Residential Units | 4.10.1-10 |
| 4.10.1-3 | Student Generation Impacts of Allowed Uses upon School Districts | 4.10.1-10 |
| 4.10.5-1 | Estimated Volume of Solid Waste Generated by Permitted Uses | 4.10.5-7 |
| 4.11.1-1 | Existing and Proposed Stormwater Flow Characteristics (10 year / 100 year) | 4.11.1-13 |
| 4.11.1-2 | Freeboard Analysis - RiverPark at Santa Clara River | 4.11.1-14 |
| 4.11.1-3 | 100-year Storm Runoff Discharges to Water Storage/Recharge Basins | 4.11.1-14 |
| 4.11.2-1 | Projected Water Demand | 4.11.2-10 |
| 4.11.3-1 | Estimated Wastewater Generation | 4.11.3-5 |
| 4.11.3-2 | Oxnard Wastewater Master Plan 2020 Build-out Flow Projections - Central Trunk System | 4.11.3-8 |
| 4.11.4-1 | California Electrical Energy Generation, 1983 to 1999; Total Production, by Resource Type (millions of kilowatt hours) | 4.11.4-2 |
| 4.11.4-2 | Electricity Consumption Year 1980 to 2010 (GWh) | 4.11.4-3 |
| 4.11.4-3 | Projected Electrical Consumption at Total Build-out of the Project | 4.11.4-6 |
| 4.11.4-4 | Approved Power Plants | 4.11.4-8 |
| 4.11.4-5 | Projected Natural Gas Consumption at Total Build-out of the Project | 4.11.4-9 |

# APPENDIX 1.0
## Notice of Preparation and Responses

## NOTICE OF PREPARATION

**To:** Responsible and Trustee Agencies (Distribution List is attached to this notice)

**Subject:** **Notice of Preparation of a Draft Environmental Impact Report**

| **Lead Agency:** | | **Consulting Firm:** | |
|---|---|---|---|
| Agency Name: | City of Oxnard | Firm Name: | Impact Sciences, Inc. |
| Street Address: | 305 West Third St. | Mailing Address: | 30343 Canwood St., #210 |
| City/State/Zip Code: | Oxnard, CA 93030 | City/State/Zip Code: | Agoura Hills, CA 91301 |
| Contact: | Gary Y. Sugano | Contact: | Tony Locacciato, AICP |

The City of Oxnard will be the Lead Agency for an environmental impact report to be prepared for the proposed project described in the attachments to this Notice of Preparation. The City needs to know the views of your agency regarding the scope and content of the environmental information that should be included in this EIR. The document to be prepared by the City should include any information necessary for your agency to meet any statutory responsibilities related to the proposed project. Your agency will need to use the EIR prepared by the City when considering any permit or other approvals necessary to implement the project. A preliminary list of the environmental topics the City has identified for study in this EIR is attached to this notice. If the topics of concern to your agency have already been identified for analysis, your agency need not provide a response to this notice.

The project description, location, and the environmental issues to be addressed in the EIR are contained in the attached materials. **Due to the time limits mandated by State law, your response must be sent to the City at the earliest possible date but not later than 30 days after receipt of this notice. Please send your response to Mr. Gary Sugano, Senior Associate Planner, Planning and Environmental Services Division, City of Oxnard, 305 West Third Street, Oxnard, California 93030.** Agency responses to this NOP should include the name of a contact person within the commenting agency.

**Project Title:** **RiverPark Specific Plan**

**Project Location:** **City of Oxnard, County of Ventura**

**Project Description (brief):**

The proposed project consists of a proposed Specific Plan to regulate the use of land within an approximate 700-acre area located immediately north of the Ventura Freeway (US 101) between Vineyard Avenue (SR 232) and the Santa Clara River. Various land uses are proposed within the Specific Plan Area including residential, commercial, public facilities and open space uses. A more detailed description of the site and proposed project are provided in the attachments to this notice.

Date: 5/9/00 Signature: _____

Marilyn Miller, AICP
Title: Planning & Environmental Services Manager
Telephone: (805) 385-7858

Reference: California Administrative Code, Title 14 (CEQA Guidelines), Sections 15082(a), 15103, 15375.

## PROJECT LOCATION

**Figure 1** illustrates the location of the City of Oxnard within Ventura County. As shown, the City of Oxnard is located in southern Ventura County near the coastline. The location of the 700-acre site for the proposed RiverPark Specific Plan ("Specific Plan") in relation to the City of Oxnard is illustrated in **Figure 2**. The Specific Plan site is generally located north of the Ventura Freeway (US 101), between Vineyard Avenue and the Santa Clara River.

## PROJECT BACKGROUND

As shown in **Figure 3**, the entire RiverPark site is located within the existing City of Oxnard City Urban Restriction Boundary (CURB) and the Sphere of Influence line for the City of Oxnard. An ordinance establishing the CURB was approved by the voters of Oxnard in November 1998. The CURB requires that the City restrict urban services and urbanized uses of lands to within the CURB line through the year 2020. The CURB line is conterminous with the Sphere of Influence line for the City in this area.

Currently, approximately 272 acres of the project site are located within the City of Oxnard. This portion of the project site is referred to as "RiverPark Area A." The remaining 428 acres of the site are currently located outside of the City of Oxnard. This portion of the site is referred to as "RiverPark Area B." The City of Oxnard adopted a specific plan for the majority of the RiverPark Area A in 1986 and annexed the area addressed by that specific plan (the small portion of RiverPark Area A not annexed by the City at that time was already within City limits). That existing specific plan is titled the "Oxnard Town Center Specific Plan." The adopted plan allows development of up to 4.4 million square feet of commercial and industrial space in the area addressed by that plan. RiverPark Area A includes the area addressed by the Oxnard Town Center Specific Plan and a small amount of additional land located directly north of US 101 and west of Vineyard Avenue. RiverPark Area A is also located within the Oxnard Community Development Commission's Historic Enhancement and Revitalization of Oxnard (HERO) Redevelopment Plan Area. RiverPark Area B includes an existing sand and gravel mine permitted by the County of Ventura in 1979 and detention basins operated by the Ventura County Flood Control District. All mining activities allowed by the current permit have been completed and the site is currently being reclaimed in accordance with the approved reclamation plan for this site.

The existing Oxnard 2020 General Plan land use map designations for the proposed project site are shown in **Figure 4**. RiverPark Area A is currently designated for development of Regional Commercial, Commercial Office, and Business and Research Park Uses consistent with the adopted Oxnard Town Center Specific Plan. RiverPark Area B is currently designated as Open Space-Mineral Resource and Open Space-Buffer on the Oxnard 2020 General Plan land use map, consistent with the existing mining use on this part of the site. RiverPark Area B is also designated as a Planning Reserve area as defined by the Oxnard 2020 General Plan. This Planning Reserve overlay was placed on certain open space areas contiguous to developed portions of the City to indicate that these areas may be considered for urbanization during the term of the 2020 General Plan.

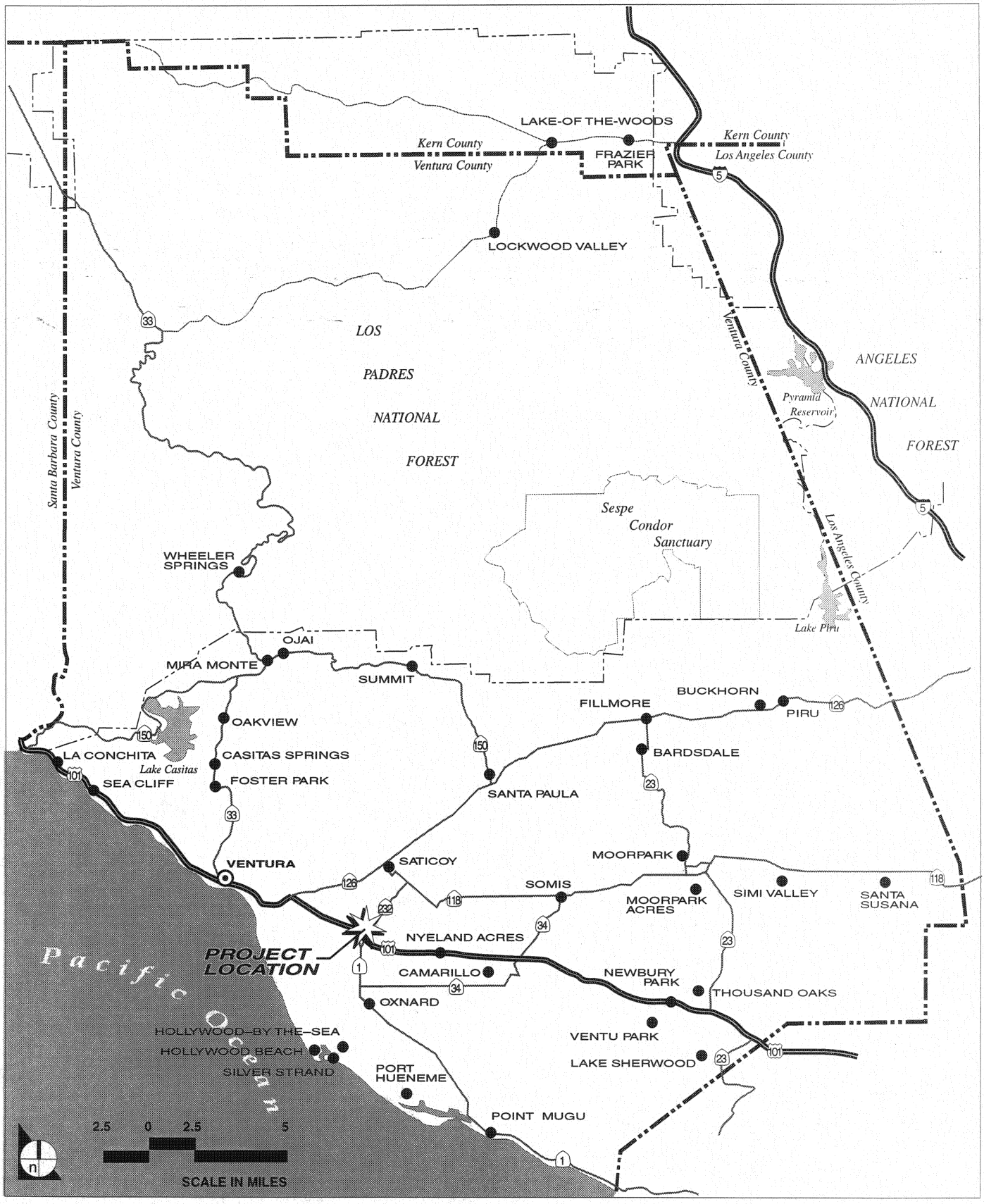


FIGURE 1

## Regional Location

City of Oxnard • Riverpark Specific Plan EIR • NOTICE OF PREPARATION

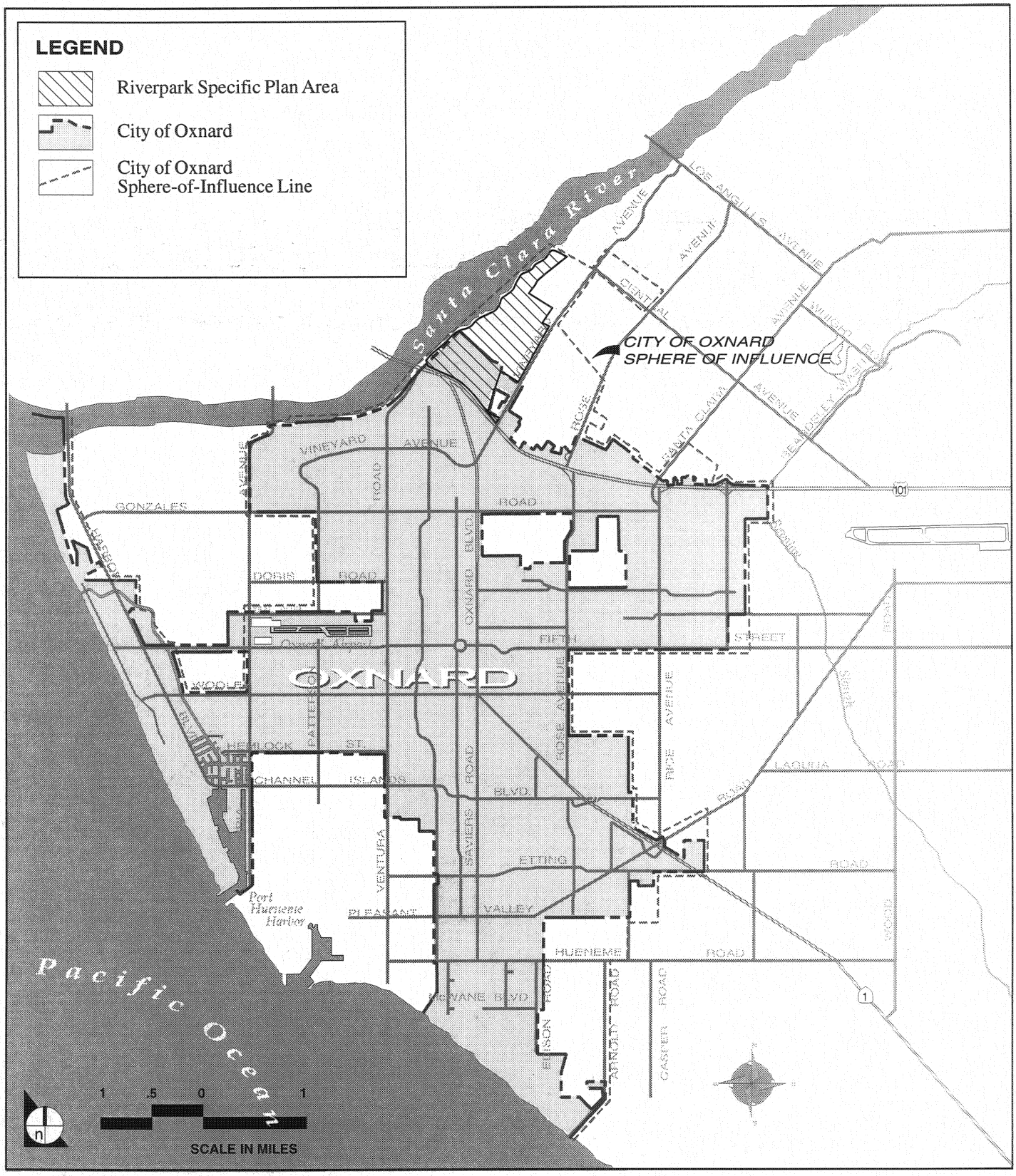


FIGURE 2

## Project Vicinity Map

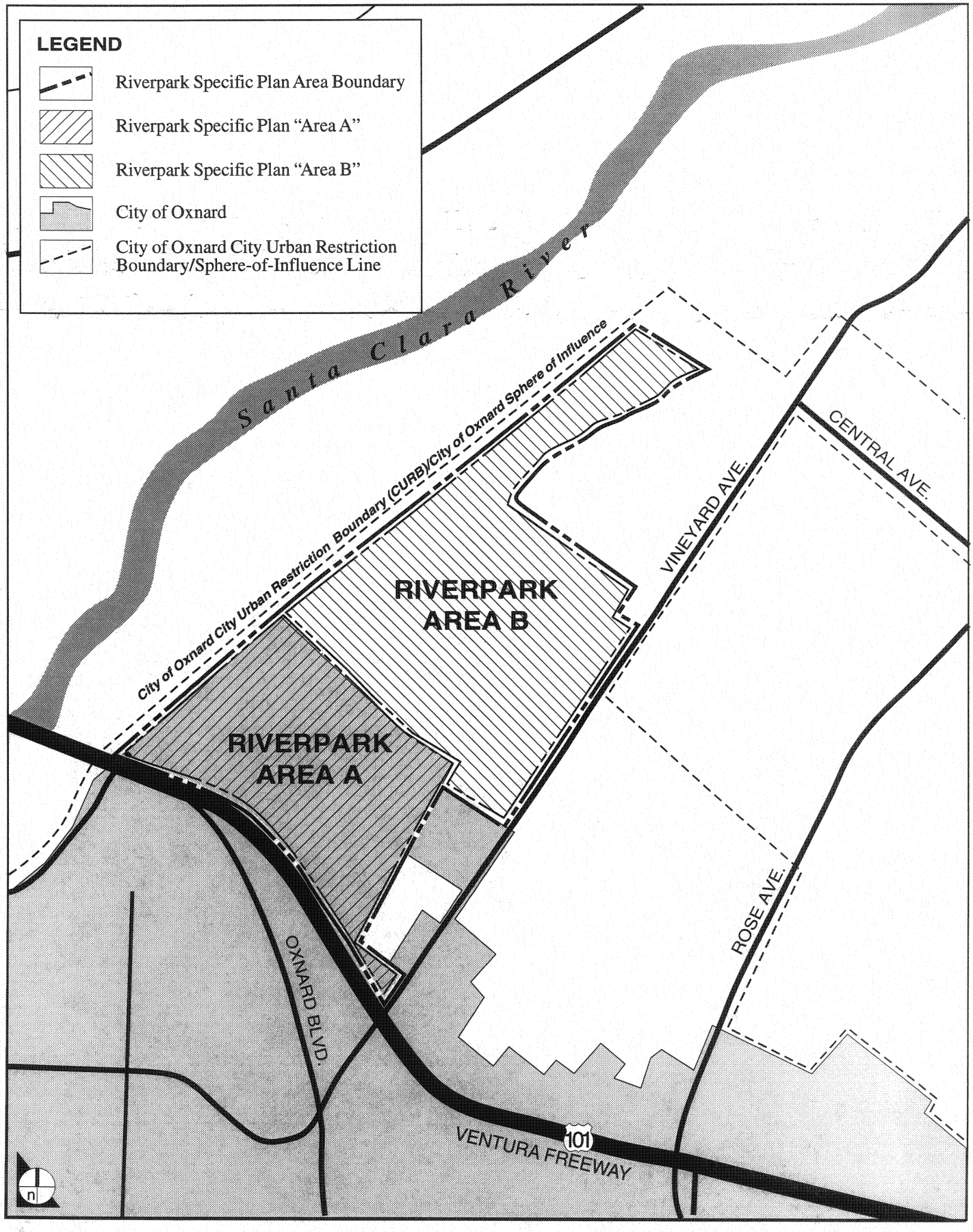


FIGURE 3

Project Location

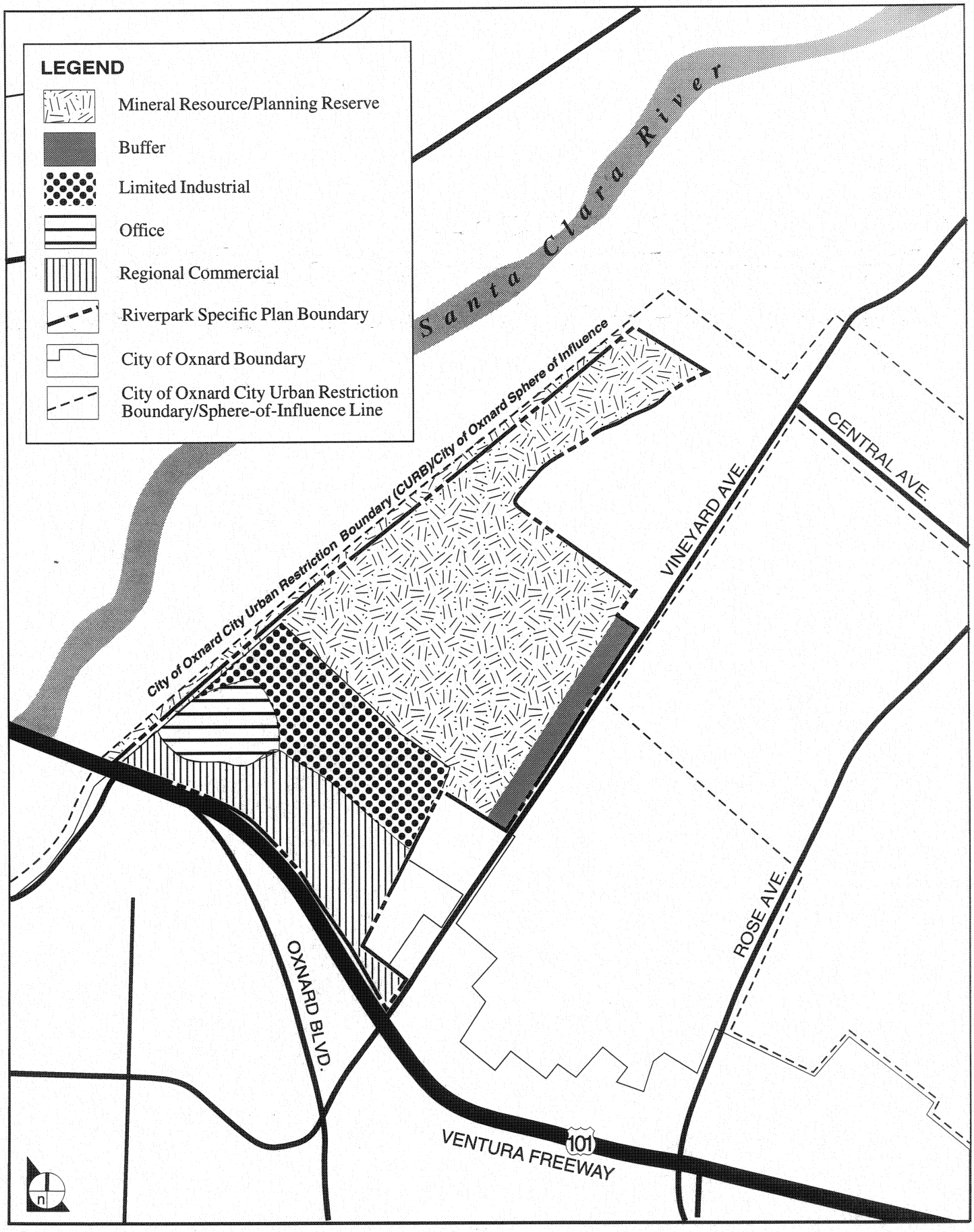


FIGURE 4

## Existing General Plan Land Use

An aerial photograph of the project site and surrounding areas is provided in **Figure 5**. RiverPark Areas A and B are also identified on this photograph. As shown in this photograph, the southwestern corner of RiverPark Area A has been previously developed. The existing streets, two office buildings and other infrastructure facilities built in the southwestern corner of RiverPark Area A were constructed in conformance with the adopted Oxnard Town Center Specific Plan. Immediately east of this developed area is a 14-acre area containing a complex of buildings housing various County of Ventura offices and facilities. The areas to the north and east of these developed portions of RiverPark Area A are currently in agricultural production. As discussed above, this part of the site was approved for urban use by the City of Oxnard in 1986.

Most of RiverPark Area B consists of the existing sand and gravel mine. As shown in the photograph, this part of the site contains three existing mine pits. These pits were originally mined to approximately 90 feet in depth. As a result of rising groundwater levels in this area, these pits now contain exposed groundwater. The mine site also includes equipment for processing sand and aggregate materials and associated administrative offices. RiverPark Area B also includes two existing detention basins, which were recently built by the Ventura County Flood Control District to accept runoff from areas to the east of Vineyard Avenue.

The Santa Clara River, located on the western edge of the project site, is separated from the site by a levee built by the U.S. Army Corps of Engineers (ACOE). The California Department of Transportation (Caltrans) and the City of Oxnard are also currently planning improvements to US 101 in the vicinity of the project site. These improvements consist of a new bridge across the Santa Clara River, widening of the freeway immediately east and west of the new bridge and the construction of a new interchange between the freeway and Oxnard Boulevard, which would serve existing uses to the south of the interchange as well as this project site. Caltrans is the Lead Agency, as defined by the California Environmental Quality Act, for the environmental review of this freeway improvement project. The Federal Highway Administration is the Lead Agency for the environmental review of this freeway improvement project under the National Environmental Policy Act (NEPA). A Draft Supplemental EIR/EIS for this freeway improvement project is currently being prepared by Caltrans. The proposed Specific Plan will address the phasing of the project in relation to the schedule for this freeway improvement project.

Existing and planned land uses located immediately east and north of the project site are also identified on **Figure 5**. As shown, there are existing residential uses in the El Rio West neighborhood, located between the project site and Vineyard Avenue. This neighborhood also contains commercial uses fronting Vineyard Avenue and some vacant parcels. Currently, portions of this neighborhood are within the City of Oxnard and portions are outside of the City limits. Existing industrial uses are located to the to the north of the project site. In addition, the site recently selected by the County of Ventura for development of a juvenile justice facility is located north of the project site.

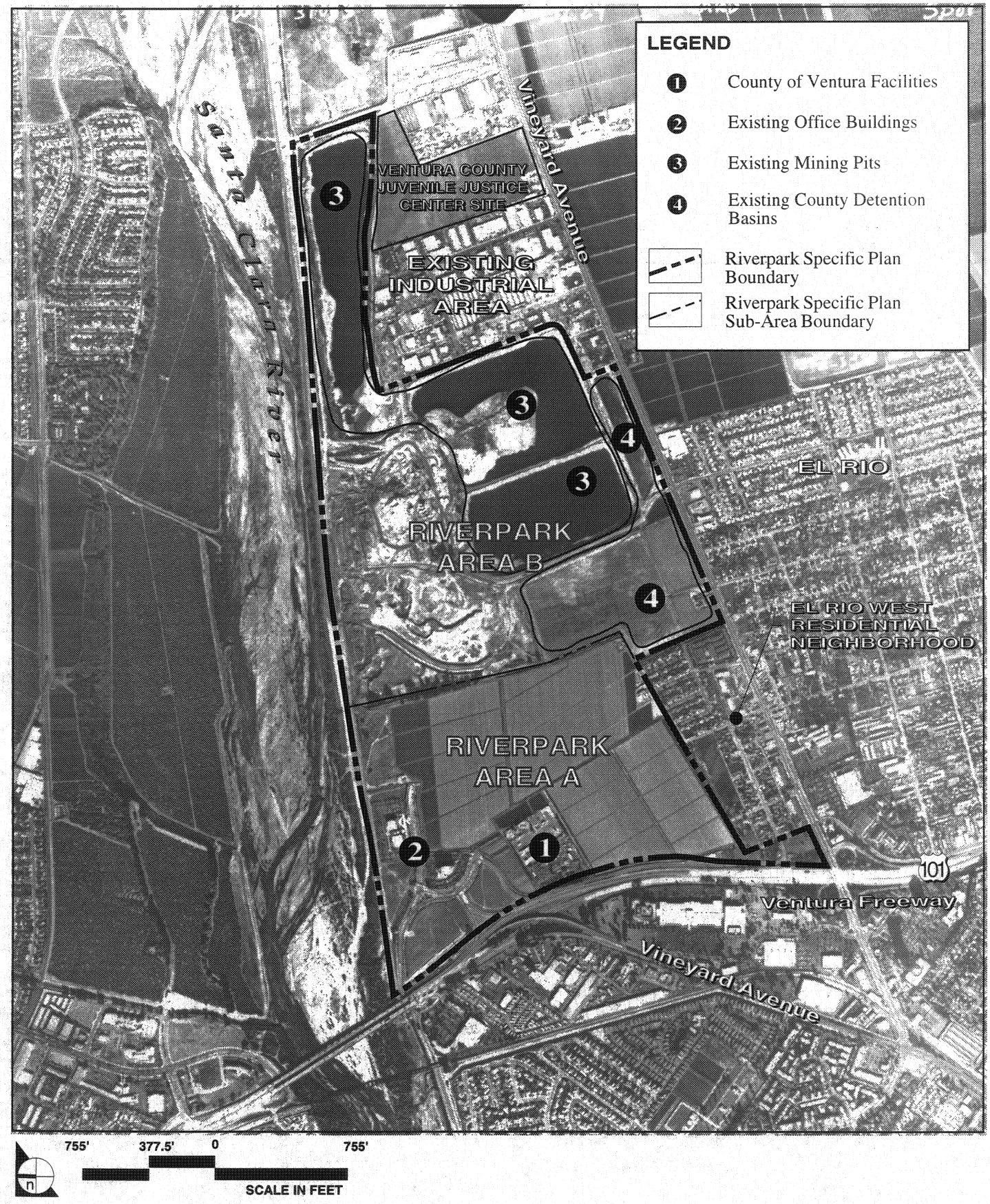


FIGURE 5

Aerial Photograph

## PROJECT CHARACTERISTICS

The Specific Plan is being prepared to guide the development of the project area as an integrated mixed-use community containing commercial, residential, open space and public facilities uses. A primary objective of the proposed Specific Plan is to plan for the reclamation of the existing sand and gravel mine pits to ensure the protection of surface and groundwater quality and compatibility with the existing and planned surrounding land uses. The Specific Plan will address all required items defined in Section 65451 of the Government Code including:

- Text and diagrams defining the distribution, location, and extent of the uses of land, including open space, within the area covered by the plan.
- Text and diagrams defining the proposed distribution, location, and extent of circulation, drainage, water and sewage facilities planned to support the land uses described in the plan.
- Standards and criteria by which development will proceed, including development standards, design guidelines and a phasing program.
- A program of implementation measures including regulations, programs and any necessary financing measures.

### Proposed Land Uses

The proposed Specific Plan would allow the development of a new integrated mixed-use community containing commercial, residential, open space and public facilities uses within the 700-acre Specific Plan Area. These uses would be linked by the proposed system of roadways and a network of open spaces. The conceptual land use plan for the project is presented in **Figure 6**.

As shown in the conceptual land use plan, a variety of commercial uses are proposed for the southern portion of the Specific Plan Area. Office, several types of retail commercial uses, a convention center, and hotel uses would be allowed in this portion of the Specific Plan Area along with a trade facility for food and wine products. Development of either commercial or residential uses would be allowed in three specific areas on the site. One of these areas, consisting of approximately 10 acres located in the southeastern corner of the site, could be developed with commercial uses or mixed-use commercial/residential uses. The second area, located on the western edge of the site, consists of approximately 20 acres which could be developed with office or multi-family residential uses. Mixed neighborhood oriented commercial uses and residential uses would also be allowed on a small site in the residential area. Development of some second-story residential units would also be allowed in the central retail commercial area.

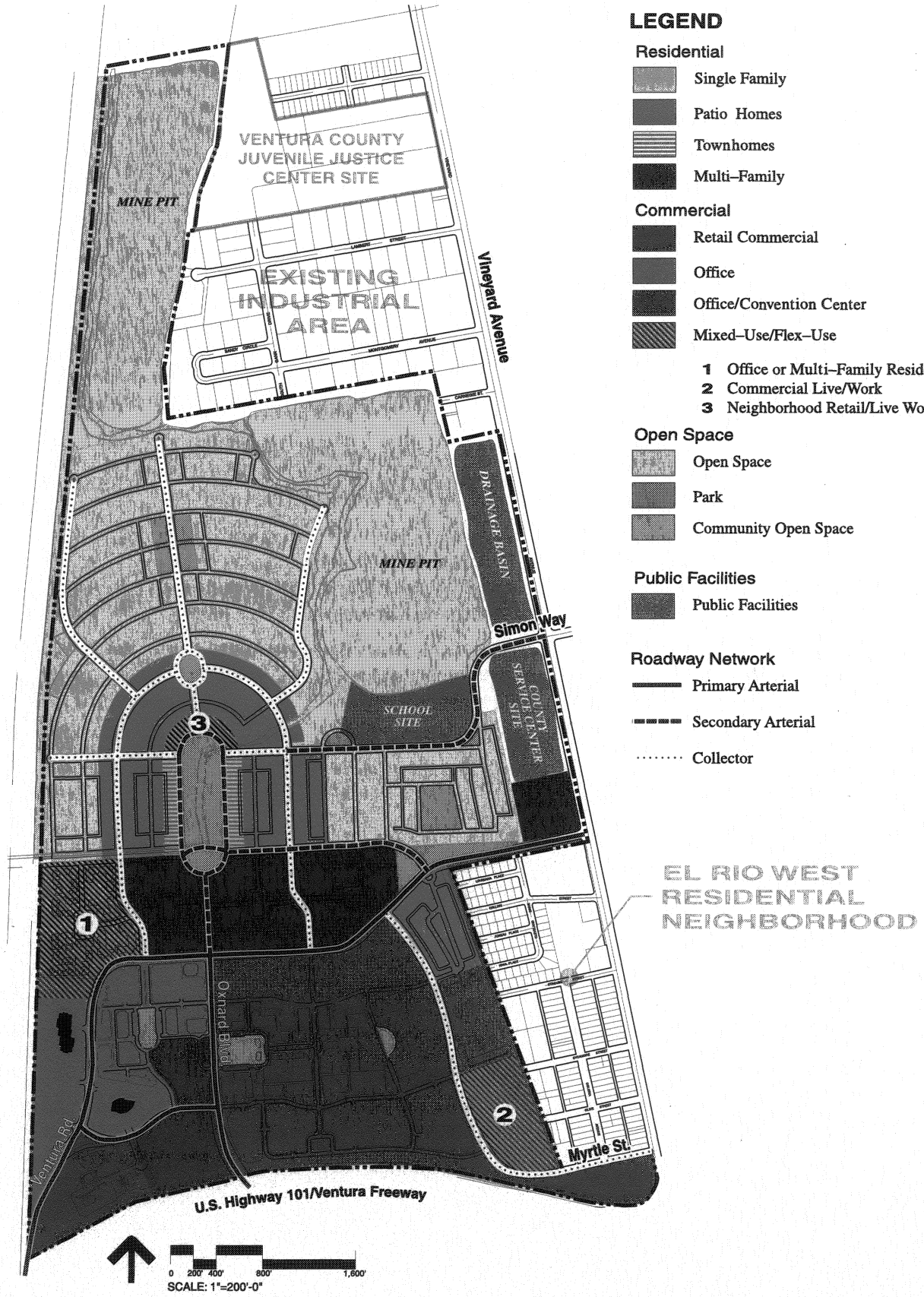


FIGURE 6

# Conceptual Land Use Plan

Proposed residential uses include single family homes, patio homes (attached single family homes), a small amount of townhomes and multi-family units (apartments). The single family neighborhoods would be located on the northern portion of the property. The proposed patio homes, townhomes and apartments would be located in the central portion of the site between the commercial and proposed single family residential areas and the proposed commercial areas and existing single family development to the east of the site. A park would also be provided on the eastern edge of the site along this existing residential neighborhood.

A variety of public open spaces, consisting of approximately 31 acres of small landscape greens and landscape buffers, would be located throughout the residential and commercial areas of the community. As previously mentioned, a 14-acre park site would also be provided. The existing mine pits would be reclaimed and remain as open space. The currently adopted reclamation plan for the existing sand and gravel mine calls for these pits to be partially filled. The proposed concept for reclamation of these pits would involve reconfiguring the edges of the pits, stabilizing the slopes on the sides of the pits and planting the pits with wetland vegetation

The City of Oxnard has formed a committee that includes representatives of the County of Ventura and the United Water Conservation District to address potential surface and groundwater quality issues associated with the existing exposed groundwater in the mining pits on the site, the proposed reclamation plans for these mine pits, and the potential effects of the proposed reclamation plans and urban development on surface and groundwater quality. This committee has retained a consultant to prepare a comprehensive water quality study addressing the issues identified above. This study will evaluate alternative scenarios for reclamation of the existing pits, including the proposed concept described above.

Proposed public facilities include a 12-acre site for an elementary school and approximately 13 acres site provided for the relocation of the County service center currently located along the southern edge of the site. The school site is proposed north and west of the residential areas. The site for the County service center would be located on Vineyard Avenue, immediately south of the existing drainage basin.

The proposed roadway network, consisting of primary arterial, secondary arterial, and collector streets, is shown in **Figure 6**. Ventura Road would be extended to the east through the community, connecting to Vineyard Avenue. Myrtle Street would be extended north to connect to Ventura Road, providing additional access from Vineyard Avenue. Oxnard Boulevard would also be extended north through the center of the community from the planned new interchange with US 101. Simon Way, which currently provides access to the sand and gravel mine site, would also provide access from Vineyard Avenue to the residential portion of the community. Other roadways proposed within the Specific Plan Area would provide access to the proposed commercial and residential uses.

A summary of the proposed land uses is presented in **Table 1**. As shown in the land use summary table, residential uses are proposed on approximately 34-39 percent of the site (241-271 acres), commercial uses are proposed for 25-30 percent of the site (180-210 acres), open space uses are proposed for 30 percent of the site (208 acres), and public facilities are proposed for the remaining 6 percent of the site (41 acres). Overall, the proposed Specific Plan would allow the development of between 2.4 to 2.6 million square feet of commercial uses and 2,175 to 2,900 residential units. As the plan includes several areas which could be developed with either commercial or residential uses, the total amount of allowed commercial and residential uses would be within the ranges defined above. Development of the maximum amount or commercial or residential uses would result in a reduction in the amount of potential development in the other category.

**Table 1**
**RiverPark Specific Plan**
**Summary of Proposed Land Uses**

| Uses | Acres | Sub-total | % | Amount | Sub-total |
|---|---|---|---|---|---|
| **Residential Uses** | | **265-271** | **34-39%** | | **2,175-2,900 Units** |
| Single Family Residential | 134 | | | 796 Units | |
| Patio Homes | 54 | | | 873 Units | |
| Townhouses | 3 | | | 50 Units | |
| Multi-Family | 50-80 | | | 900-1,625 Units | |
| **Commercial Uses** | | **180-210** | **25-30%** | | **2.4 – 2.6 million sq. ft.** |
| Office | 44-74 | | | 525-715,000 sq. ft. | |
| Hotel/Convention Center | 16 | | | 480,000 sq. ft. | |
| Regional Retail Commercial | 54 | | | 745,000 sq. ft. | |
| Food & Wine Venue | 35 | | | 360,000 sq. ft. | |
| Other Retail Commercial | 22 | | | 290,000 sq. ft. | |
| Neighborhood Mixed-Use | 1 | | | 15,000 sq. ft. | |
| **Open Space Uses** | | **208** | **30%** | | |
| Reclaimed Mine Pits | 163 | | | | |
| Park | 14 | | | | |
| Community Open Space | 31 | | | | |
| **Public Facilities Uses** | | **41** | **6%** | | |
| School | 12 | | | | |
| County Services Center | 13 | | | | |
| Existing Drainage Basin | 16 | | | | |
| **TOTAL** | **700** | | **100%** | | |

**Proposed Project Actions**

At this time, the City of Oxnard has identified the following actions that will need to be taken by the City of Oxnard, acting as lead agency for this project, and by Responsible Agencies. The list of Responsible Agencies and project actions is preliminary and the City anticipates that additional actions may be identified as a result of consultation facilitated by the environmental review process.

The ***City of Oxnard*** would be responsible for the following actions:

- Approve a General Plan Amendment consisting of changes to the 2020 General Plan Land Use Map designations for the project area.
- Adopt the proposed RiverPark Specific Plan.
- Initiate annexation of RiverPark Area B.
- Approve a Tentative Tract Map for the Specific Plan Area.
- Approve a Development Agreement with the Applicant.

The ***City of Oxnard Community Development Commission*** would be responsible for the following action related to the project:

- Approve an Owner Participation Agreement for RiverPark Area A.

The ***Ventura County Local Agency Formation Commission (LAFCO)*** would be responsible for the following action related to the project:

- Approve annexation of RiverPark Area B to the City of Oxnard.

The ***County of Ventura*** would be responsible for the following action:

- Approve any amendment to the currently approved reclamation plan for the sand and gravel mine in RiverPark Area B.

## TOPICS IDENTIFIED FOR STUDY IN THIS EIR

The City of Oxnard has completed a preliminary review of the applications for this project, as described in Section 15060 of the CEQA Guidelines, and has determined that an EIR should be prepared for the project. Based on the characteristics of the project, the City intends to prepare a Program EIR on the proposed Specific Plan project. The scope of work for this EIR will involve research, analysis, and study of the following issues and concerns. The City is planning to address the following environmental topics in the EIR for this project:

- Land Use and Planning
- Aesthetics
- Population and Housing
- Transportation & Traffic
- Air Quality
- Noise
- Geology and Soils
- Hydrology and Water Quality
- Biological Resources
- Public Services
- Utilities and Service Systems

A brief description of the scope of issues the City has identified for study related to each of these topics is provided as an attachment to this notice for your information.

The City of Oxnard will consider the comments received in response to this Notice of Preparation in determining the scope and content of the EIR for this project. Any comments provided should identify specific topics of environmental concern and your reason for suggesting the study of these topics in the EIR.

Please provide your comments in writing to:

Gary Y. Sugano, Senior Associate Planner
City of Oxnard
Planning and Environmental Services Division
305 West Third Street
Oxnard, CA 93030

Thank you for your participation in the environmental review of this project.

# PRELIMINARY SCOPE OF STUDY

## City of Oxnard
## RiverPark Specific Plan Draft EIR

Land Use and Planning - The EIR will evaluate the consistency of the proposed changes in the existing and planned land uses in the project area with applicable local and regional land use plans and policies. Consistency with the City's 2020 General Plan and the Oxnard Community Development Commission's Historic Enhancement and Revitalization of Oxnard (HERO) Redevelopment Plan will be analyzed, as will the consistency of the project with the Southern California Association of Government's (SCAG) *Regional Comprehensive Plan & Guide* (RCPG). The consistency of the proposed annexation with applicable State laws and Ventura County LAFCO policies will also be provided.

The compatibility of the proposed uses with existing and planned land uses on the project site and in surrounding areas will also be analyzed. Impact to the existing uses on the site, including agriculture, the existing detention basins and the County service facility will be assessed as part of this analysis.

Aesthetics - Analysis of this topic will address the change in the visual character of the project site as viewed from surrounding areas, streets and highways. Potential light & glare and shade & shadow impacts will be addressed, as will the consistency of the project with the policies in the Community Design Element of the City's General Plan.

Population and Housing - Analysis of the consistency of the project with adopted local and regional demographic projections will be provided.

Transportation & Traffic - A comprehensive traffic analysis will be prepared for the project in accordance with the City's *Traffic Impact Study Guidelines* based on information generated by the City of Oxnard Computer Transportation Model. Changes in roadway and intersection traffic volumes will be studied at all roadway facilities in the area that may be significantly impacted by traffic that would be generated by the project. Impacts on transit service in the area will also be addressed. The traffic study will evaluate the relationship of the proposed circulation plan for the Specific Plan Area with the improvements currently planned for US 101 in this area.

Air Quality - The impacts of the project on air quality will be evaluated in accordance with the *Guidelines for the Preparation of Air Quality Impact Analyses* prepared by the Ventura County Air Pollution Control District (VCAPCD). Specific items that will be addressed will include short-term construction related impacts, long-term operational impacts, any contribution to a carbon monoxide "hot-spot" along streets and highways, consistency with the Ventura County *Air Quality Management Plan*, and any potential impacts related to emissions from existing and planned surrounding uses.

Noise - Short-term construction noise impacts that may effect existing and planned surrounding land uses will be evaluated along with the change in roadway noise levels that will result from the additional traffic that would be generated by the project. Any potential impacts to the planned land uses from noise sources associated with surrounding land uses will also be addressed.

Geology and Soils - The EIR will address the existing geologic and soils conditions on the site, the proposed filling and reclamation of the existing mining pits and detention basins, and potential impacts that may result from these conditions.

Hydrology and Water Quality - The EIR will address the potential impacts of the project on existing drainage patterns and facilities and impacts on surface and groundwater quality. The City of Oxnard has formed a committee that includes representatives of the County of Ventura and the United Water Conservation District to address potential surface and groundwater quality issues associated with the existing exposed groundwater in the mining pits on site, the proposed reclamation plans for these mine pits, and the potential effects of the proposed reclamation plans and urban development on surface and groundwater quality. This committee has retained a consultant to prepare a comprehensive water quality study addressing the issues identified above. Information from this study will be incorporated into the EIR. The EIR will also evaluate the proposed drainage master plan included in the Specific Plan and effects on the existing drainage patterns in the area. Specific issues to be addressed include changes to off-site and on-site drainage patterns, impacts on existing drainage facilities, and options for treating runoff.

Biological Resources - The project site consists of areas disturbed for mining, agriculture, urban development and construction of the existing detention basins. As a result of these existing conditions, the project site will not directly impact native vegetation or habitat. The existing mining pits and agricultural drainage ditches do not qualify as jurisdictional wetland features. The EIR will address the potential indirect effects of the project on the biological resources in the adjacent Santa Clara River, including the potential beneficial effect of reclaiming the existing mining pits as wetland habitat.

Public Services - The EIR will address the needs of the project for police, fire, solid waste disposal, recreation and other public services from the City of Oxnard, and the ability of the City to meet this increased demand for services. The increased demand for school services provided by the Rio Elementary School and Oxnard Union High School Districts will also be analyzed.

Utilities and Service Systems - The impacts of the project on existing and planned sewer, water and storm drain facilities in the area will be evaluated along with potential impacts to electricity, natural gas and communications service systems in the area.

## Comment Letters on the May 9, 2000, Notice of Preparation

## Comment Letters Received on the June 12, 2001, Revised RiverPark NOP


State of California Governor's Office of Planning and Research ..... June 20, 2001
The Gas Company ..... June 20, 2001
Southern California Association of Governments ..... June 22, 2001
California Regional Water Quality Control Board, Los Angeles Region ..... June 25, 2001
County of Ventura Resource Management Agency, Planning Division ..... June 27, 2001
State of California Department of Transportation ..... June 28, 2001
Ventura County Office of Agricultural Commissioner ..... June 28, 2001
State of California Native American Heritage Commission ..... July 5, 2001
Ventura County Air Pollution Control District ..... July 9, 2001
County of Ventura Public Works Agency, Planning and Environmental Services Division ..... July 11, 2001
County of Ventura Resource Management Agency, Planning Division ..... July 12, 2001
Department of Toxic Substances Control ..... July 19, 2001
County of Ventura Public Works Agency, Transportation Department ..... July 20 and 24, 2001
United States Department of the Interior, Fish and Wildlife Service ..... August 29, 2001

STATE OF CALIFORNIA

# Governor's Office of Planning and Research

## State Clearinghouse

Gray Davis
GOVERNOR

Steve Nissen
DIRECTOR

RECEIVED
JUN 25 2001
PLANNING DIVISION
CITY OF OXNARD

**Notice of Preparation**

June 20, 2001

To: Reviewing Agencies

Re: RiverPark Specific Plan
SCH# 2000051046

Attached for your review and comment is the Notice of Preparation (NOP) for the RiverPark Specific Plan draft Environmental Impact Report (EIR).

Responsible agencies must transmit their comments on the scope and content of the NOP, focusing on specific information related to their own statutory responsibility, within 30 days of receipt of the NOP from the Lead Agency. This is a courtesy notice provided by the State Clearinghouse with a reminder for you to comment in a timely manner. We encourage other agencies to also respond to this notice and express their concerns early in the environmental review process.

Please direct your comments to:

**Gary Y. Sugano**
**City of Oxnard**
**305 West Third Street**
**Oxnard, CA 93030**

with a copy to the State Clearinghouse in the Office of Planning and Research. Please refer to the SCH number noted above in all correspondence concerning this project.

If you have any questions about the environmental document review process, please call the State Clearinghouse at (916) 445-0613.

Sincerely,

Scott Morgan
Project Analyst, State Clearinghouse

Attachments
cc: Lead Agency

# Document Details Report
# State Clearinghouse Data Base

**SCH#** 2000051046
**Project Title** RiverPark Specific Plan
**Lead Agency** Oxnard, City of

**Type** NOP Notice of Preparation

**Description** The proposed project consists of a proposed Specific Plan to regulate the use of land within an approximate 695-acre area located immediately north of the Ventura Freeway (US 101) between Vineyard Avenue (SR 232) and the Santa Clara River. Various land uses are proposed within the Specific Plan Area including residential, commercial, public facilities and open space uses.

## Lead Agency Contact

**Name** Gary Y. Sugano
**Agency** City of Oxnard
**Phone** 805-984-4658 **Fax**
**email**
**Address** 305 West Third Street
**City** Oxnard **State** CA **Zip** 93030

## Project Location

**County** Ventura
**City** Oxnard
**Region**
**Cross Streets** US 101/Vineyard Avenue/Santa Clara River/SR 232
**Parcel No.**
**Township** **Range** **Section** **Base**

## Proximity to:

**Highways** US 101/SR 232
**Airports**
**Railways**
**Waterways** Santa Clara River
**Schools**
**Land Use** Regional Commercial, Commercial Office, Business and Research Park Uses, Open Space-Mineral/Open Space-Buffer, Public Facilities

**Project Issues** Landuse; Aesthetic/Visual; Population/Housing Balance; Traffic/Circulation; Air Quality; Noise; Biological Resources; Agricultural Land; Water Quality; Water Supply; Wetland/Riparian; Wildlife; Archaeologic-Historic; Toxic/Hazardous; Other Issues

**Reviewing Agencies** Resources Agency; California Coastal Commission; Department of Conservation; Department of Parks and Recreation; Department of Water Resources; Department of Fish and Game, Region 5; Native American Heritage Commission; State Lands Commission; Caltrans, District 7; Department of Housing and Community Development; California Highway Patrol; Department of Toxic Substances Control; Regional Water Quality Control Board, Region 4

**Date Received** 06/20/2001 **Start of Review** 06/20/2001 **End of Review** 07/19/2001

Note: Blanks in data fields result from insufficient information provided by lead agency.

## NOP Distribution List

**County:** Ventura **SCH#** 2000051046

### Resources Agency

- [x] **Resources Agency**
  Nadell Gayou
- [ ] **Dept. of Boating & Waterways**
  Bill Curry
- [x] **California Coastal Commission**
  Elizabeth A. Fuchs
- [x] **Dept. of Conservation**
  Ken Trott
- [ ] **Dept. of Forestry & Fire Protection**
  Allen Robertson
- [ ] **Office of Historic Preservation**
  Hans Kreutzberg
- [x] **Dept of Parks & Recreation**
  Resource Mgmt. Division
- [ ] **Reclamation Board**
  Pam Bruner
- [ ] **S.F. Bay Conservation & Dev't. Comm.**
  Steve McAdam
- [x] **Resources Agency**
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  Dept. of Water Resources

### Health & Welfare

- [ ] **Health & Welfare**
  Wayne Hubbard
  Dept. of Health/Drinking Water

### Food & Agriculture

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  Tad Bell
  Dept. of Food and Agriculture

### Fish and Game

- [ ] **Dept. of Fish & Game**
  Scott Flint
  Environmental Services Division
- [ ] **Dept. of Fish & Game**
  Donald Koch
  Region 1
- [ ] **Dept. of Fish & Game**
  Banky Curtis
  Region 2
- [ ] **Dept. of Fish & Game**
  Robert Floerke
  Region 3
- [ ] **Dept. of Fish & Game**
  William Laudermilk
  Region 4
- [x] **Dept. of Fish & Game**
  Sandy Peterson
  Region 5, Habitat Conservation Program
- [ ] **Dept. of Fish & Game**
  Gabrina Gatchel
  Region 6, Habitat Conservation Program
- [ ] **Dept. of Fish & Game**
  Tammy Allen
  Region 6, Inyo/Mono, Habitat Conservation Program
- [ ] **Dept. of Fish & Game**
  Tom Napoli
  Marine Region

### Independent Commissions

- [ ] **California Energy Commission**
  Environmental Office
- [x] **Native American Heritage Comm.**
  Debbie Treadway
- [ ] **Public Utilities Commission**
  Andrew Barnsdale
- [x] **State Lands Commission**
  Betty Silva
- [ ] **Governor's Office of Planning & Research**
  State Clearinghouse Planner
- [ ] **Colorado River Board**
  Gerald R. Zimmerman
- [ ] **Tahoe Regional Planning Agency (TRPA)**
  Lyn Barnett
- [ ] **Office of Emergency Services**
  John Rowden, Manager
- [ ] **Delta Protection Commission**
  Debby Eddy
- [ ] **Santa Monica Mountains Conservancy**
  Paul Edelman

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- [ ] **Dept. of Transportation**
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  Local, Development Review,
  District 2
- [ ] **Dept. of Transportation**
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  Mike Sim
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  Caroline Yee for Kate Walton
  District 9
- [ ] **Dept. of Transportation**
  Chris Sayre
  District 10
- [ ] **Dept. of Transportation**
  Lou Salazar
  District 11
- [ ] **Dept. of Transportation**
  Aileen Kennedy
  District 12

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  Cathy Creswell
  Housing Policy Division
- [ ] **Caltrans - Division of Aeronautics**
  Sandy Hesnard
- [x] **California Highway Patrol**
  Lt. Dennis Brunette
  Office of Special Projects
- [ ] **Dept. of Transportation**
  Ron Helgeson
  Caltrans - Planning
- [ ] **Dept. of General Services**
  Robert Sleppy
  Environmental Services Section

**Air Resources Board**

- [ ] Airport Projects
  Jim Lerner
- [ ] Transportation Projects
  Ann Geraghty
- [ ] Industrial Projects
  Mike Tollstrup

- [ ] **California Integrated Waste Management Board**
  Sue O'Leary
- [ ] **State Water Resources Control Board**
  Diane Edwards
  Division of Clean Water Programs
- [ ] **State Water Resources Control Board**
  Greg Frantz
  Division of Water Quality
- [ ] **State Water Resouces Control Board**
  Mike Falkenstein
  Division of Water Rights
- [x] **Dept. of Toxic Substances Cont**
  CEQA Tracking Center

### Regional Water Quality Control Board (RWQCB)

- [ ] **RWQCB**
  Cathleen Hudson
  North Coast Region (1)
- [ ] **RWQCB**
  Environmental Document Coordinator
  San Francisco Bay Region (2)
- [ ] **RWQCB**
  Central Coast Region (3)
- [x] **RWQCB**
  Jonathan Bishop
  Los Angeles Region (4)
- [ ] **RWQCB**
  Central Valley Region (5)
  - [ ] **RWQCB**
    Central Valley Region (5)
    Fresno Branch Office
  - [ ] **RWQCB**
    Central Valley Region (5)
    Redding Branch Office
- [ ] **RWQCB**
  Lahontan Region (6)
  - [ ] **RWQCB**
    Lahontan Region (6)
    Victorville Branch Office
- [ ] **RWQCB**
  Colorado River Basin Region (7)
- [ ] **RWQCB**
  Santa Ana Region (8)
- [ ] **RWQCB**
  San Diego Region (9)

The Gas Company®

RECEIVED

JUN 25 2001

PLANNING DIVISION
CITY OF OXNARD

June 20, 2001

Gary Y. Sugano
CITY OF OXNARD
Planning/Environmental Services
305 West Third Street
Oxnard, CA 93030

**Southern California Gas Company**
*9400 Oakdale Avenue*
*Chatsworth, CA*
*91313-2300*

*Mailing Address:*
*Box 2300*
*Chatsworth, CA*
*91313-2300*

Subject: **Agency Comment for Revised NOP DEIR for RiverPark Specific Plan, City of Oxnard, County of Ventura, State of California. (Gas Co. Atlas # VCO 1495, 1496, 1624, 1625, 1626, 1627)**

***The S.C.Gas Company anticipates no environmental issues in serving this Project. The annexation portion will affect our franchise taxation and permits.***

This letter is not to be interpreted as a contractual commitment to serve this proposed project, but only as an information service. Its intent is to notify you that Southern California Gas Company has facilities in the area where this project is proposed. Gas service can be provided **without** significant impact on the environment from an existing **medium pressure mains in the vicinity of this Project.**

Service would be in accordance with our policies and extension rules on file with the California Public Utilities Commission at the time contractual arrangements are made. The availability of natural gas service, as set forth in this letter, is based on present conditions of gas supply and regulatory policies. As a public utility, Southern California Gas Company is under the jurisdiction of the California Public Utilities Commission. We can also be affected by actions of federal regulatory agencies. Should these agencies take any action which affects gas supply or the condition under which service is available, gas service will be provided in accordance with the revised conditions.

When your project has final approval by the city or county engineer, please contact Mr. Dave Conway, New Business Project Manager, at **(805) 385-4823**. It may require up to 90 days to process your application for the installation of gas lines in your project.

Sincerely,

Jim Hammel
Technical Services, Northern Region
818-701-3324
FAX: 818-701-3380

c: D. Conway, NBPM, Oxnard District
B. Huleis, Environmental Compliance
City Correspondence File

c:!Files\willserve\Oxnard.doc

SOUTHERN CALIFORNIA
ASSOCIATION of GOVERNMENTS

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**Ventura County:** Judy Mikels, Ventura County • Glen Becerra, Simi Valley • Donna De Paola, San Buenaventura • Toni Young, Port Hueneme

**Riverside County Transportation Commission:** Robin Lowe, Hemet

**Ventura County Transportation Commission:** Bill Davis, Simi Valley

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RECEIVED
JUN 27 2001
PLANNING DIVISION
CITY OF OXNARD

June 22, 2001

Mr. Gary Sugano
Senior Associate Planner
Planning and Environmental Services Division
City of Oxnard
305 West Third Street
Oxnard, CA 93030

RE: **Comments on the Revised Notice of Preparation for a Draft Environmental Impact Report for the RiverPark Specific Plan – SCAG No. I 20010324**

Dear Mr. Sugano:

Thank you for submitting the **Revised Notice of Preparation for a Draft Environmental Impact Report for the RiverPark Specific Plan** to SCAG for review and comment. As areawide clearinghouse for regionally significant projects, SCAG reviews the consistency of local plans, projects, and programs with regional plans. This activity is based on SCAG's responsibilities as a regional planning organization pursuant to state and federal laws and regulations. Guidance provided by these reviews is intended to assist local agencies and project sponsors to take actions that contribute to the attainment of regional goals and policies.

In addition, The California Environmental Quality Act requires that EIRs discuss any inconsistencies between the proposed project and the applicable general plans and **regional plans (Section 15125 [d])**. If there are inconsistencies, an explanation and rationalization for such inconsistencies should be provided.

Policies of SCAG's Regional Comprehensive Plan and Guide and Regional Transportation Plan, which may be applicable to your project, are outlined in the attachment. **We expect the Draft EIR to specifically cite the appropriate SCAG policies and address the manner in which the Project is consistent with applicable core policies or supportive of applicable ancillary policies. Please use our policy numbers to refer to them in your Draft EIR. Also, we would encourage you to use a side-by-side comparison of SCAG policies with a discussion of the consistency or support of the policy with the Proposed Project.**

Please provide a minimum of 45 days for SCAG to review the Draft EIR when this document is available. If you have any questions regarding the attached comments, please contact me at (213) 236-1867. Thank you.

Sincerely,

JEFFREY M. SMITH, AICP
Senior Planner
Intergovernmental Review

**COMMENTS
ON THE REVISED PROPOSAL TO DEVELOP A
DRAFT ENVIRONMENTAL IMPACT REPORT
FOR THE
RIVERPARK PLAN
SCAG NO. I 20010324**

## PROJECT DESCRIPTION

The purpose of the proposed Project is to facilitate the development of a complimentary and successful pattern of land uses that will occur over a period of time. The proposed Project would allow for a new integrated mixed-use community containing 2,440 residential units, three million square feet of commercial uses, 250-acres of open space and public facility uses. A system of roadways and a network of open spaces would link the proposed uses.

The Project area encompasses 695 acres. Approximately 265 acres of the Project area are located within the City of Oxnard. This portion of the project area is referred to as "RiverPark Area A." The remaining 430 acres of the site are currently located outside of the City of Oxnard, under the jurisdiction of the County of Ventura. This portion of the project area is referred to as "RiverPark Area B." The Project area is generally located north of the Ventura Freeway (US 101), between Vineyard Avenue and the Santa Clara River in the City of Oxnard.

## CONSISTENCY WITH REGIONAL COMPREHENSIVE PLAN AND GUIDE POLICIES

The **Growth Management Chapter (GMC)** of the Regional Comprehensive Plan and Guide (RCPG) contains the following policies that are particularly applicable and should be addressed in the Draft EIR for the RiverPark Specific Plan.

*3.01 The population, housing, and jobs forecasts, which are adopted by SCAG's Regional Council and that reflect local plans and policies, shall be used by SCAG in all phases of implementation and review.*

### Regional Growth Forecasts

The Draft EIR should reflect the most current SCAG forecasts which are the 2001 RTP (April 2001) Population, Household and Employment forecasts for the Ventura Council of Governments (VCOG) subregion and the City of Oxnard. These forecasts follow:

| VCOG Subregion Forecasts | 2000 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| Population | 739,780 | 765,358 | 836,185 | 874,881 | 915,004 |
| Households | 240,529 | 252,265 | 271,093 | 283,765 | 297,496 |
| Employment | 322.239 | 351,014 | 380,765 | 398,340 | 414,421 |

| City of Oxnard Forecasts | 2000 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| Population | 156,523 | 159,301 | 168,025 | 176,412 | 186,900 |
| Households | 42,714 | 44,640 | 47,606 | 50,925 | 55,163 |
| Employment | 46,442 | 52,492 | 58,747 | 62,438 | 65,819 |

*3.03 The timing, financing, and location of public facilities, utility systems, and transportation systems shall be used by SCAG to implement the region's growth policies.*

## REGIONAL TRANSPORTATION PLAN POLICIES

The **Regional Transportation Plan** (RTP) also has policies pertinent to this proposed project. This chapter links the goal of sustaining mobility with the goals of fostering economic development, enhancing the environment, reducing energy consumption, promoting transportation-friendly development patterns, and encouraging fair and equitable access to residents affected by socio-economic, geographic and commercial limitations. Among the relevant policies of this chapter are the following:

Core Regional Transportation Plan Policies

*4.01 Transportation investments shall be based on SCAG's adopted Regional Performance Indicators.*

*Mobility - Transportation Systems should meet the public need for improved access, and for safe, comfortable, convenient, faster and economical movements of people and goods.*

- *Average Work Trip Travel Time in Minutes – 25 minutes (Auto)*
- *PM Peak Freeway Travel Speed – 45 minutes (Transit)*
- *PM Peak Non-Freeway Travel Speed*
- *Percent of PM Peak Travel in Delay (Fwy)*
- *Percent of PM Peak Travel in Delay (Non-Fwy)*

*Accessibility - Transportation system should ensure the ease with which opportunities are reached. Transportation and land use measures should be employed to ensure minimal time and cost.*

- *Work Opportunities within 45 Minutes door to door travel time (Mode Neutral)*
- *Average transit access time*

*Environment - Transportation system should sustain development and preservation of the existing system and the environment. (All Trips)*

- *CO, ROG, NOx, PM10, PM2.5 – Meet the applicable SIP Emission Budget and the Transportation Conformity requirements*

*Reliability – Transportation system should have reasonable and dependable levels of service by mode. (All Trips)*

- *Transit – 63%*
- *Highway – 76%*

*Safety - Transportation systems should provide minimal accident, death and injury. (All Trips)*

- *Fatalities Per Million Passenger Miles – 0*
- *Injury Accidents – 0*

*Equity/Environmental Justice - The benefits of transportation investments should be equitably distributed among all ethnic, age and income groups. (All trips)*

- *By Income Groups Share of Net Benefits – Equitable Distribution of Benefits among all Income Quintiles*

*Cost-Effectiveness - Maximize return on transportation investment (All Trips). Air Quality, Mobility, Accessibility and Safety*

- *Return on Total Investment – Optimize return on Transportation Investments*

*4.02 Transportation investments shall mitigate environmental impacts to an acceptable level.*

*4.04 Transportation Control Measures shall be a priority.*

*4.16 Maintaining and operating the existing transportation system will be a priority over expanding capacity.*

## GMC POLICIES RELATED TO THE RCPG GOAL TO IMPROVE THE REGIONAL STANDARD OF LIVING

The Growth Management goals to develop urban forms that enable individuals to spend less income on housing cost, that minimize public and private development costs, and that enable firms to be more competitive, strengthen the regional strategic goal to stimulate the regional economy. The evaluation of the proposed project in relation to the following policies would be intended to guide efforts toward achievement of such goals and does not infer regional interference with local land use powers.

*3.05 Encourage patterns of urban development and land use, which reduce costs on infrastructure construction and make better use of existing facilities.*

*3.08 Encourage subregions to define an economic strategy to maintain the economic vitality of the subregion, including the development and use of marketing programs, and other economic incentives, which support attainment of subregional goals and policies.*

*3.09 Support local jurisdictions' efforts to minimize the cost of infrastructure and public service delivery, and efforts to seek new sources of funding for development and the provision of services.*

*3.10 Support local jurisdictions' actions to minimize red tape and expedite the permitting process to maintain economic vitality and competitiveness.*

## GMC POLICIES RELATED TO THE RCPG GOAL TO IMPROVE THE REGIONAL QUALITY OF LIFE

The Growth Management goals to attain mobility and clean air goals and to develop urban forms that enhance quality of life, that accommodate a diversity of life styles, that preserve open space and natural resources, and that are aesthetically pleasing and preserve the character of communities, enhance the regional strategic goal of maintaining the regional quality of life. The evaluation of the proposed project in relation to the following policies would be intended to provide direction for plan implementation, and does not allude to regional mandates.

*3.12 Encourage existing or proposed local jurisdictions' programs aimed at designing land uses which encourage the use of transit and thus reduce the need for roadway expansion, reduce the number of auto trips and vehicle miles traveled, and create opportunities for residents to walk and bike.*

*3.13 Encourage local jurisdictions' plans that maximize the use of existing urbanized areas accessible to transit through infill and redevelopment.*

*3.14 Support local plans to increase density of future development located at strategic points along the regional commuter rail, transit systems, and activity centers.*

*3.15 Support local jurisdictions strategies to establish mixed-use clusters and other transit-oriented developments around transit stations and along transit corridors.*

*3.16 Encourage developments in and around activity centers, transportation corridors, underutilized infrastructure systems, and areas needing recycling and redevelopment.*

*3.17 Support and encourage settlement patterns, which contain a range of urban densities.*

*3.18 Encourage planned development in locations least likely to cause environmental impact.*

*3.20 Support the protection of vital resources such as wetlands, groundwater recharge areas, woodlands, production lands, and land containing unique and endangered plants and animals.*

*3.21 Encourage the implementation of measures aimed at the preservation and protection of recorded and unrecorded cultural resources and archaeological sites.*

*3.22 Discourage development, or encourage the use of special design requirements, in areas with steep slopes, high fire, flood, and seismic hazards.*

*3.23 Encourage mitigation measures that reduce noise in certain locations, measures aimed at preservation of biological and ecological resources, measures that would reduce exposure to seismic hazards, minimize earthquake damage, and to develop emergency response and recovery plans.*

## GMC POLICIES RELATED TO THE RCPG GOAL TO PROVIDE SOCIAL, POLITICAL, AND CULTURAL EQUITY

The Growth Management Goal to develop urban forms that avoid economic and social polarization promotes the regional strategic goal of minimizing social and geographic disparities and of reaching equity among all segments of society. The evaluation of the

proposed project in relation to the policy stated below is intended guide direction for the accomplishment of this goal, and does not infer regional mandates and interference with local land use powers.

*3.24 Encourage efforts of local jurisdictions in the implementation of programs that increase the supply and quality of housing and provide affordable housing as evaluated in the Regional Housing Needs Assessment.*

*3.27 Support local jurisdictions and other service providers in their efforts to develop sustainable communities and provide, equally to all members of society, accessible and effective services such as: public education, housing, health care, social services, recreational facilities, law enforcement, and fire protection.*

## AIR QUALITY CHAPTER CORE ACTIONS

The **Air Quality Chapter** core actions related to the proposed project includes:

*5.07 Determine specific programs and associated actions needed (e.g., indirect source rules, enhanced use of telecommunications, provision of community based shuttle services, provision of demand management based programs, or vehicle-miles-traveled/emission fees) so that options to command and control regulations can be assessed.*

*5.11 Through the environmental document review process, ensure that plans at all levels of government (regional, air basin, county, subregional and local) consider air quality, land use, transportation and economic relationships to ensure consistency and minimize conflicts.*

## WATER QUALITY CHAPTER RECOMMENDATIONS AND POLICY OPTIONS

The **Water Quality Chapter** core recommendations and policy options relate to the two water quality goals: to restore and maintain the chemical, physical and biological integrity of the nation's water; and, to achieve and maintain water quality objectives that are necessary to protect all beneficial uses of all waters.

*11.02 Encourage "watershed management" programs and strategies, recognizing the primary role of local governments in such efforts.*

*11.06 Clean up the contamination in the region's major groundwater aquifers since its water supply is critical to the long-term economic and environmental health of the*

*region. The financing of such clean-ups should leverage state and federal resources and minimize significant impacts on the local economy.*

*11.07 Encourage water reclamation throughout the region where it is cost-effective, feasible, and appropriate to reduce reliance on imported water and wastewater discharges. Current administrative impediments to increased use of wastewater should be addressed.*

## OPEN SPACE CHAPTER ANCILLARY GOALS

Outdoor Recreation

*9.01 Provide adequate land resources to meet the outdoor recreation needs of the present and future residents in the region and to promote tourism in the region.*

*9.02 Increase the accessibility to open space lands for outdoor recreation.*

*9.03 Promote self-sustaining regional recreation resources and facilities.*

Public Health and Safety

*9.04 Maintain open space for adequate protection of lives and properties against natural and man-made hazards.*

*9.05 Minimize potentially hazardous developments in hillsides, canyons, areas susceptible to flooding, earthquakes, wildfire and other known hazards, and areas with limited access for emergency equipment.*

*9.06 Minimize public expenditure for infrastructure and facilities to support urban type uses in areas where public health and safety could not be guaranteed.*

Resource Production

*9.07 Maintain adequate viable resource production lands, particularly lands devoted to commercial agriculture and mining operations.*

Resource Protection

*9.08 Develop well-managed viable ecosystems or known habitats of rare, threatened and endangered species, including wetlands.*

## CONCLUSIONS

All feasible measures needed to mitigate any potentially negative regional impacts associated with the proposed project should be implemented and monitored, as required by CEQA.

**ENDNOTE**

## SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS

*Roles and Authorities*

SCAG is a ***Joint Powers Agency*** established under California Government Code Section 6502 et seq. Under federal and state law, SCAG is designated as a Council of Governments (COG), a Regional Transportation Planning Agency (RTPA), and a Metropolitan Planning Organization (MPO). SCAG's mandated roles and responsibilities include the following:

SCAG is designated by the federal government as the Region's ***Metropolitan Planning Organization*** and mandated to maintain a continuing, cooperative, and comprehensive transportation planning process resulting in a Regional Transportation Plan and a Regional Transportation Improvement Program pursuant to 23 U.S.C. □134(g)-(h), 49 U.S.C. □1607(f)-(g) et seq., 23 C.F.R. □450, and 49 C.F.R. □613. SCAG is also the designated ***Regional Transportation Planning Agency***, and as such is responsible for both preparation of the Regional Transportation Plan (RTP) and Regional Transportation Improvement Program (RTIP) under California Government Code Section 65080.

SCAG is responsible for developing the demographic projections and the integrated land use, housing, employment, and transportation programs, measures, and strategies portions of the ***South Coast Air Quality Management Plan***, pursuant to California Health and Safety Code Section 40460(b)-(c). SCAG is also designated under 42 U.S.C. □7504(a) as a ***Co-Lead Agency*** for air quality planning for the Central Coast and Southeast Desert Air Basin District.

SCAG is responsible under the Federal Clean Air Act for determining ***Conformity*** of Projects, Plans and Programs to the Air Plan, pursuant to 42 U.S.C. □7506.

Pursuant to California Government Code Section 65089.2, SCAG is responsible for ***reviewing all Congestion Management Plans (CMPs) for consistency with regional transportation plans*** required by Section 65080 of the Government Code. SCAG must also evaluate the consistency and compatibility of such programs within the region.

SCAG is the authorized regional agency for ***Inter-Governmental Review*** of Programs proposed for federal financial assistance and direct development activities, pursuant to Presidential Executive Order 12,372 (replacing A-95 Review).

SCAG reviews, pursuant to Public Resources Code Sections 21083 and 21087, ***Environmental Impact Reports*** of projects of regional significance for consistency with regional plans [California Environmental Quality Act Guidelines Sections 15206 and 15125(b)].

Pursuant to 33 U.S.C. □1288(a)(2) (Section 208 of the Federal Water Pollution Control Act), SCAG is the authorized ***Areawide Waste Treatment Management Planning Agency***.

SCAG is responsible for preparation of the ***Regional Housing Needs Assessment***, pursuant to California Government Code Section 65584(a).

SCAG is responsible (with the San Diego Association of Governments and the Santa Barbara County/Cities Area Planning Council) for preparing the ***Southern California Hazardous Waste Management Plan*** pursuant to California Health and Safety Code Section 25135.3.

# California Regional Water Quality Control Board
## Los Angeles Region

**Winston H. Hickox**
*Secretary for Environmental Protection*

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640
Internet Address: http://www.swrcb.ca.gov/~rwqcb4

**Gray Davis**
*Governor*


June 25, 2001


RECEIVED
JUN 26 2001
PLANNING DIVISION
CITY OF OXNARD


City of Oxnard
Attention: Gary Y. Sugano
305 West Third Street
Oxnard, CA 93030

Dear Sir or Madam,

Re: CEQA Documentation for Project in the Calleguas Watershed

RiverPark Specific Plan Project, SCH Number 2000051046

We appreciate the opportunity to comment on the CEQA documentation for the above mentioned project. For your information a list of permitting requirements and Regional Board Contacts is provided in Attachment A hereto.

The project site lies in the Calleguas watershed that was listed as being impaired pursuant to Section 303 (d) of the Clean Water Act. Constituents causing impairment in the Calleguas watershed include pesticides, metals, nitrogen, sedimentation, algae, salts, and coliform. The Los Angeles Regional Water Quality Control Board will be developing Total Maximum Daily Loads (TMDLs) for the watershed, but the proposed project is expected to proceed before applicable TMDLs are adopted. In the interim, the Regional Board must carefully evaluate the potential impacts of new projects that may discharge to impaired waterbodies.

Our review of your documentation shows that it does not include information on how this project will change the loading of these pollutants into the watershed. Please provide the following additional information for both the construction and operational phases of the project.

- For each constituent listed above, please provide an estimate of the concentration (ppb) and load (lbs/day) from non-point and point source discharges.

- Estimates of the amount of additional runoff generated by the project during wet and dry seasons.

- Estimate of the amount of increased or decreased percolation due to the project.

- Estimates of the net change in cubic feet per second of groundwater and surface water contributions under historic drought conditions (as compiled by local water purveyors, the Department of Water Resources, and others), and 10-year 50-year, and 100-year flood conditions.

If you have any questions please call me at (213) 576 6683.

Sincerely,

Elizabeth Erickson
Assoicate Geologist, TMDL Unit
Los Angeles Regional Water Quality Control Board

EE
Attachments (1)
cc:
State Clearinghouse
file

**ATTACHMENT A**

✓ If the proposed project is subject to a **federal license or permit**, and will result in a **discharge (dredge or fill) into a surface water**, including a dry streambed, the project may require a *Section 401 Water Quality Certification*, or waiver thereof. For further information, please contact:

Alex Fu at (213) 576-6692, or Anthony Klecha at (213) 576-6785, Nonpoint Source Unit

✓ If the project involves **inland disposal of nonhazardous contaminated soils and materials**, the proposed project may be subject to *Waste Discharge Requirements*. For further information, please contact:

Rodney Nelson, Landfills & Cleanup Unit, at (213) 576-6719

✓ If the overall project area is **larger than five acres**, the proposed project may be subject to the State *Board's General Construction Activity Storm Water Permit*. For further information, please contact:

Wayne Chiou, Los Angeles Inland Unit, at (213) 576-6664:
Los Angles County watersheds draining to Long Beach and San Pedro

Carlos Urrunaga, Los Angeles Coastal Unit, at (213) 576-6655:
Los Angeles County watersheds draining to Santa Monica Bay and Palos Verdes Peninsula
Ventura County watersheds draining to Malibu Creek watershed

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657:
Watersheds draining to Ventura County coastline

✓ If the project involves a facility that is proposing to discharge storm water associated with **industrial activity** (e.g., manufacturing, recycling and transportation facilities, etc.), the facility may be subject to the State Board's *General Industrial Activities Storm Water Permit*. For further information, please contact:

Robert Tom, Nonpoint Source Unit, at (213) 576-6789:
Watersheds draining to Los Angeles County coastline

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657:
Watersheds draining to Ventura County coastline

✓ If the proposed project involves any construction and/or groundwater **dewatering to be discharged to surface waters** or storm drains, including dry streambeds, the project may be subject to *NPDES/Waste Discharge Requirements*. For further information, please contact:

Wayne Chiou, Los Angeles Inland Unit, at (213) 576-6664:
Los Angles County watersheds draining to Long Beach and San Pedro

Mezhar Ali, Los Angeles Coastal Unit, at (213) 576-6652:
Los Angeles County watersheds draining to Santa Monica Bay and Palos Verdes Peninsula
Ventura County watersheds draining to Malibu Creek watershed

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657:
Watersheds draining to Ventura County coastline

✓ If the proposed project involves any construction and/or groundwater **dewatering to be discharged to land or groundwater**, the project may be subject to *Waste Discharge Requirements*. For further information, please contact:

Jau Ren Chen, Los Angeles Coastal Unit, at (213) 576-6656:
Watersheds draining to Los Angeles County coastline

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657:
Watersheds draining to Ventura County coastline

✓ The proposed project shall also comply with the local regulations associated with the applicable **Regional Board stormwater permit**:

Los Angeles County and co permittees:
NPDES No. CAS614001
Waste Discharge Requirements Order No. 96-054

Ventura County and co-permittees:
NPDES No. CAS063339
Waste Discharge Requirements Order No. 94-082

# COUNTY OF VENTURA
## RESOURCE MANAGEMENT AGENCY
### PLANNING DIVISION

## MEMORANDUM

**DATE, :** June 27 2001

**TO:** Joseph Eisenhut, Coordinator
Outside Environmental Documents

RE 01-052

**FROM:** Paul Merrett
SMARA staff

**SUBJECT:** NOTICE OF PREPARATION FOR THE RIVERPARK SPECIFIC PLAN EIR (YOUR REFERENCE NUMBER 00-056)

---

I would have nothing to add to Pat Richards' comments, other than to mention that, under state law, a jurisdiction must have an adopted mining ordinance in order to exercise any control over a mine reclamation plan: Since the Specific Plan area includes the Hanson Aggregates mine, the City must have their ordinance in place prior to transfer of jurisdiction.

# COUNTY OF VENTURA
## RESOURCE MANAGEMENT AGENCY
### PLANNING DIVISION

## MEMORANDUM

**DATE:** June 8, 2000

**TO:** Joseph Eisenhut, Coordinator
Outside Environmental Documents

**FROM :** Patrick Richards, Manager
Commerical & Industrial Permits Section

re 01-052

**SUBJECT: NOTICE OF PREPARATION FOR THE RIVERPARK SPECIFIC PLAN EIR (YOUR REFERENCE NUMBER 00-056)**

---

This memorandum is in response to the Notice of Preparation received May 9, 2000, for the RiverPark Specific Plan project proposed by the City of Oxnard. The collective comments of the Planning Division are as follows:

1. The proposed EIR should analyze the project against all Goals, Policies and Programs of the Ventura County General Plan and specifically the El Rio / Del Norte Area Plan so as to determine consistency between the County's General Plan and the proposed project.

2. The proposed EIR needs to analyze the effects upon the existing Kimball Road extension shown on the County's 2010 Regional Road Network.

3. Inasmuch as the project site includes "prime" agricultural land, there is a need to analyze the impacts cause by the reduction or elimination of this agricultural resource.

4. Although a requirement of CEQA, the NOP did not address how or under what condition(s) various alternatives were going to be considered. The selection of alternatives for the proposed project should consider the feasibility factors such as economic, social, environmental, technical and legal. Clearly writing the projects objectives will help to focus the range of reasonable alternatives.

5. The proposed project should consider the potential to size the sewer trunk line sufficiently to include the ability to serve the El Rio community in the future. In order that groundwater nitrate levels be reduced in compliance with recent RWQCB mandates; the use of septic systems in the El Rio area will sunset in the near future.

6. The "environmental setting" for the mine area (including the existing pits) should be analyzed in conjunction with the current County approved reclamation plan. Baseline information needs to

Plan.

7. The proposed EIR should address the slope stability issue surrounding the open mine pits. Also, a determination will need to be made as to the required setback needed from the edge of the open pit based upon the type of land use proposed.

8. At the present time, a Santa Clara River Plan is being created by a number of interested parties which is purported to include regional trails, habitat protection and the like. This proposed EIR should address its relationship to any such plan.

9. An increase to the local ambient noise level is possible due the planned project. The EIR should analyze the possible effects of such on existing land uses, especially the residential uses in the surrounding area.

10. The EIR should address when various infrastructure improvements are proposed to be accomplished. Specifically, the various local roadway and freeway improvements should be timed so they are in place prior to the demand need.

11. Inasmuch as the mine pits will remain within the proposed project and various land uses are proposed to be adjacent; the EIR should analyze the potential effects a seiche hazard to surrounding land uses.

12. The RiverPark proposal includes a future elementary school site located adjacent to one of the open water mine pits. Coordination should be accomplished with the State Department of Education as to the appropriateness of locating a school in proximity to an open water filled pit.

13. The EIR should analyze the impacts of the proposed project on the jobs/housing balance of the City of Oxnard. Analysis should include the kinds of jobs that will become available in the commercial and industrial areas and the City's ability to accommodate the residential needs of all income levels of the anticipated labor force, including low-income workers.

14. The EIR should address long term ownership responsibilities of the two open pits, various parks, future trails, town square, wetlands habitat, etc.

15. The EIR will need to identify the responsible party for the mine reclamation within Area "B" under the provisions of SMARA.

16. The Existing Community areas located in unincorporated areas of El Rio on the west side of Vineyard Avenue (zoned Urban Residential on the southeast and Industrial on the northeast) should be considered for annexation to the City of Oxnard. These areas are within the City's Sphere of Influence, and their identification with the unincorporated El Rio Community will be reduced by their proximity to the proposed project.

Thank you and the City of Oxnard for the additional efforts made towards collecting environmental comments in advance of preparation of the EIR. Should you or the City have any questions regarding the above, please call me at 805-654-5192 or Staff Planner, Kim Rodriguez at 805-662-6521.

*CC: Keith Turner, Bruce Smith, Todd Collart, Nancy Francis, Nancy Settle, Kim Rodriguez*

**DEPARTMENT OF TRANSPORTATION**
DISTRICT 7, ADVANCE PLANNING
IGR OFFICE 1-10C
120 SO. SPRING ST.
LOS ANGELES, CA 90012
TEL: (213) 897-6536 ATSS: 8- 647-6536
FAX: (213) 897-8906
E-mail: NYerjanian/D07/Caltrans/Cagov@DOT

RECEIVED
JUL 9 2001
PLANNING DIVISION
CITY OF OXNARD

Mr Gary Y. Sugano
Planning Department
City of Oxnard
305 West Third Street
Oxnard, CA. 93030

RE: IGR/CEQA # 010677NY
Notice of Preparation
River Park Specific Plan
Ven./101/21.01

June 28, 2001

Dear Mr. Sugano:

Thank you for including the California Department of Transportation (Caltrans) in the environmental review process for River Park Specific Plan.

Based on the information received, and to assist us in our efforts to completely evaluate and assess the impacts of this project on the State Transportation System, a traffic study in advance of the DEIR should be prepared to analyze the following information:

1. Assumptions and methods used to develop trip generation/distribution, percentages and assignments.

2. An analysis of ADT, AM, and PM peak-hour volumes for both the existing and future conditions. This should include US-101 crossroads, and controlling intersections.

3. This analysis should include project traffic, cumulative traffic generated for all approved developments in the area, Interchange Utilization (I.C.U.) and Level of Service (LOS) of affected freeway ramp intersections on the State Highway indicating existing + project(s) + other projects LOS (existing and future).

4. Discussion of mitigation measures appropriate to alleviate anticipated traffic impacts. These mitigation discussions should include, but not be limited to, the following:
    - o financing
    - o scheduling considerations
    - o implementation responsibilities
    - o monitoring plan

5. Developer's percent share of the cost, as well as a plan of realistic mitigation measures under the control of the developer should be addressed. Any assessment fees for mitigation should be of such proportion as to cover mainline highway deficiencies that occur as a result of the additional traffic generated by the project.

We look forward to reviewing the DEIR. We expect to receive a copy from the State Clearinghouse. However, to expedite the review process, you may send two copies in advance to the undersigned at the following address:

Stephen Buswell
IGR/CEQA Branch Chief
Caltrans District 07
Transportation Planning Office, 1-11B
120 S. Spring St., Los Angeles, CA 90012

If you have any questions, please call Mr. Yerjanian at (213) 897-6536 and refer to IGR/CEQA #010677NY.

Sincerely,

STEPHEN J. BUSWELL
IGR/CEQA Program Manager
Transportation Planning Office

JUN 2 9 2001

**Office Of**
**AGRICULTURAL COMMISSIONER**

P.O. Box 889, Santa Paula, CA 93061
815 East Santa Barbara Street
Telephone: (805) 933-3165
(805) 647-5931
FAX: (805) 525-8922

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**M E M O R A N D U M**

**TO:** **Joseph Eisenhut**
**Ventura County Planning Division**

**FROM:** Julie Bulla

**DATE:** June 28, 2001

**SUBJECT:** **Revised Notice of Preparation for the RiverPark Specific Plan EIR (RMA Reference No. 01-052)**

Thank you for the opportunity to review the revised Notice of Preparation for the RiverPark Specific Plan EIR. We have reviewed our previous response (dated June 1, 2000) to the original Notice of Preparation, and have the following corrections to the information provided.

- The crop yields and values for the 2000 Ventura County *Annual Crop Report* are enclosed, and should be used to determine the estimated yields and value of the agricultural acreage that will be converted to urban uses under the proposed Specific Plan.

- The significance thresholds from the most recent revision to the *Ventura County Initial Study Guidelines* (September 2000) should be used to assess project and cumulative impacts on onsite agricultural resources, as well as agricultural operations to the east of Vineyard Avenue. The EIR should address whether a minimum 300 foot buffer (recommended by the County Agricultural Policy Advisory Committee for various residential and school projects, and incorporated into the design of the Ventura County Juvenile Justice Center to the north of the project site) would be provided between the project's proposed school, park, and public facility uses (Planning Districts J, K and L) and the existing agricultural operations.

If the Oxnard Planning staff or the EIR consultant have any questions regarding our comments on the two NOPs, I can be reached at (805) 933-2095.

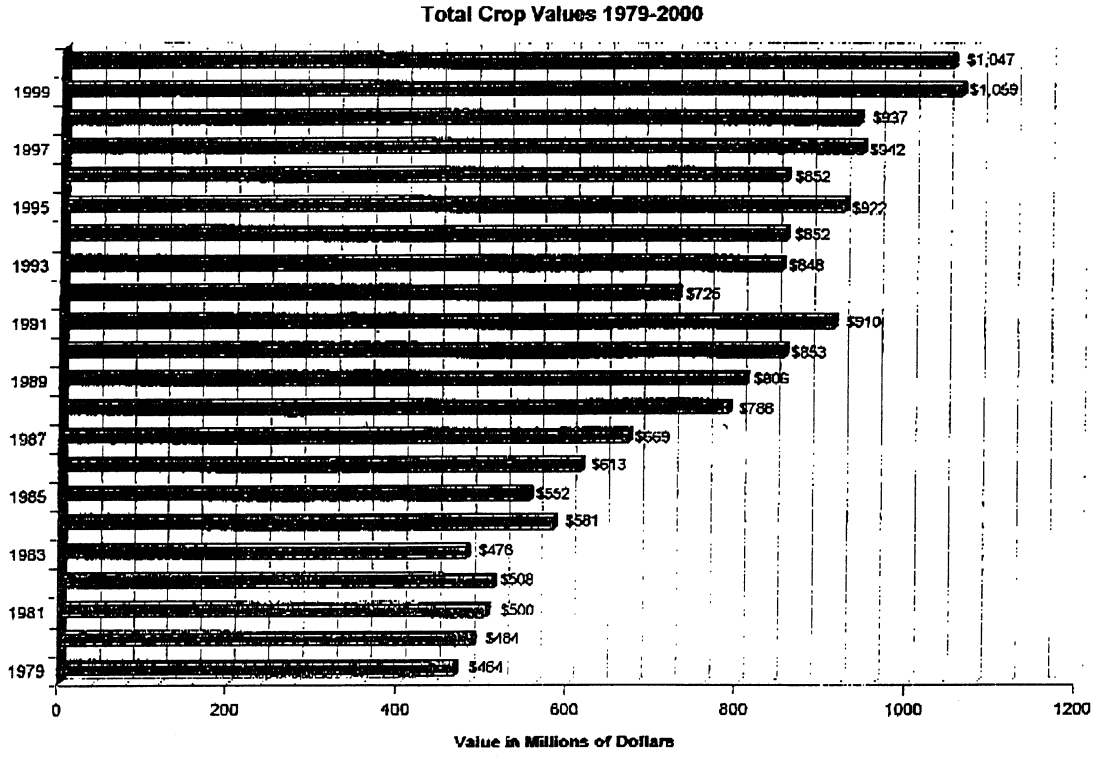
# AGRICULTURAL CROP REPORT
# RECAPITULATION AND INDEX
# 1999 - 2000

| CROP GROUPING | YEAR | $ VALUE* |
|---|---|---|
| 1. FRUIT AND NUT CROPS | 2000 | $473,683,000 |
| Page # 5 | 1999 | 571,080,000 |
| 2. VEGETABLE CROPS | 2000 | 357,929,000 |
| Page # 6-7 | 1999 | 296,839,000 |
| 3. NURSERY STOCK** | 2000 | 156,053,000 |
| Page # 8 | 1999 | 139,743,000 |
| 4. CUT FLOWERS | 2000 | 48,775,000 |
| Page # 9 | 1999 | 40,881,000 |
| 5. FIELD CROPS | 2000 | 3,808,000 |
| Page # 9 | 1999 | 4,240,000 |
| 6. LIVESTOCK AND POULTRY | 2000 | 2,709,000 |
| Page # 10 | 1999 | 2,437,000 |
| 7. APIARY PRODUCTS | 2000 | 845,000 |
| Page # 10 | 1999 | 350,000 |
| 8. TIMBER | 2000 | 74,000 |
| Page # 11 | 1999 | 66,000 |
| 9. SUSTAINABLE AGRICULTURE | 2000 | 3,252,000 |
| Page # 11 | 1999 | 3,487,000 |
| GRAND TOTAL | 2000 | $1,047,128,000 |
| | 1999 | $1,059,123,000 |

*Figures are rounded off to nearest $1000
**Includes Cut Christmas Trees

# Five Year Comparison of Ventura County Crop Values

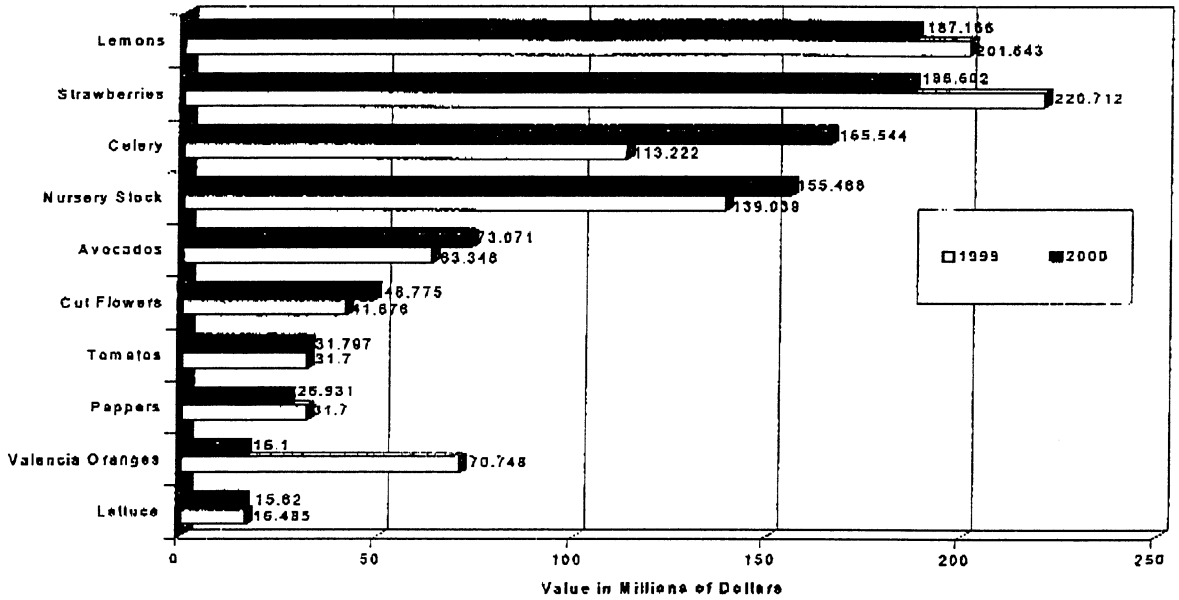
| | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|
| Fruit and Nut Crops | 452,064,000 | 510,712,000 | 470,472,000 | 571,080,000 | 473,683,000 |
| Vegetable Crops | 257,697,000 | 278,484,000 | 291,649,000 | 296,839,000 | 357,929,000 |
| Livestock and Poultry Products | 7,935,000 | 5,120,000 | 3,101,000 | 2,437,000 | 2,709,000 |
| Apiary Products | 595,000 | 242,000 | 380,000 | 350,000 | 845,000 |
| Nursery Stock | 89,468,000 | 95,281,000 | 125,246,000 | 139,743,000 | 156,053,000 |
| Cut Flowers | 34,655,000 | 43,527,000 | 36,817,000 | 40,881,000 | 48,775,000 |
| Field Crops | 5,929,000 | 5,780,000 | 5,791,000 | 4,240,000 | 3,808,000 |
| Timber | 84,000 | 59,000 | 75,000 | 66,000 | 74,000 |
| Biological Control | 3,504,000 | 3,121,000 | 3,608,000 | 3,487,000 | 3,252,000 |
| GRAND TOTAL | $851,931,000 | $942,326,000 | $937,139,000 | $1,059,123,000 | $1,047,128,000 |



# TEN LEADING CROPS FOR 2000

| RANK | CROP | VALUE |
|---|---|---|
| 1st | LEMONS | $187,166,000 |
| 2nd | STRAWBERRIES | 186,602,000 |
| 3rd | CELERY | 165,544,000 |
| 4th | NURSERY STOCK *** | 155,468,000 |
| 5th | AVOCADOS | 73,071,000 |
| 6th | CUT FLOWERS | 48,775,000 |
| 7th | TOMATOS | 31,797,000 |
| 8th | PEPPERS | 26,931,000 |
| 9th | VALENCIA ORANGES | 16,100,000 |
| 10th | LETTUCE | 15,620,000 |

*** Does not include Cut Christmas Trees



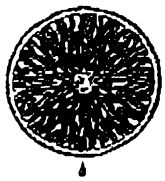

# OTHER MILLION DOLLAR CROPS

| | | | |
|---|---|---|---|
| *Veg. Transplants | 22,190,000 | Onions (all) | 4,109,000 |
| Broccoli | 15,407,000 | Orchids | 4,060,000 |
| Oriental Vegetables | 12,237,000 | **Chrysanthemums | 3,561,000 |
| Greens | 7,938,000 | Kale | 2,976,000 |
| Cilantro | 7,423,000 | Livestock | 2,708,000 |
| Spinach | 6,921,000 | Cauliflower | 2,192,000 |
| Cabbage | 6,818,000 | Radishes | 2,153,000 |
| Parsley | 5,830,000 | **Gypsophila | 1,799,000 |
| Carrots | 5,305,000 | Sweet Corn | 1,623,000 |
| *Poinsettia | 4,815,000 | Navel Oranges | 1,493,000 |
| Beans (all) | 4,631,000 | Cucumbers | 1,038,000 |

*included in Nursery Stock total above

**Included in Cut Flowers total above

# FRUIT AND NUT CROPS
# ACREAGE, PRODUCTION AND VALUES 1999-00



| CROP | YEAR | PRODUCTION HARVESTED ACREAGE | PRODUCTION PER ACRE | PRODUCTION TOTAL | UNIT | $ VALUE PER UNIT | $ VALUE TOTAL |
|---|---|---|---|---|---|---|---|
| AVOCADOS | 2000 | 15,760 | 2.06 | 32,396 | Tons | $2,255.56 | $73,071,000 |
| | 1999 | 15,394 | 1.62 | 24,871 | " | 2,547.06 | 63,348,000 |
| GRAPEFRUIT | | | | | | | |
| Total | 2000 | 186 | 12.38 | 2,301 | " | 181.23 | 417,000 |
| | 1999 | 194 | 16.71 | 3,241 | " | 237.58 | 770,000 |
| LEMONS | | | | | | | |
| Total | 2000 | 25,503 | 18.65 | 475,425 | " | 393.69 | 187,166,000 |
| | 1999 | 25,412 | 16.75 | 425,556 | " | 473.83 | 201,643,000 |
| ORANGES (NAVEL) | | | | | | | |
| Total | 2000 | 702 | 10.64 | 7,467 | " | 199.95 | 1,493,000 |
| | 1999 | 791 | 13.51 | 10,684 | " | 449.08 | 4,798,000 |
| ORANGES (VALENCIA) | | | | | | | |
| Total | 2000 | 9,360 | 12.00 | 112,244 | " | 143.44 | 16,100,000 |
| | 1999 | 10,361 | 17.61 | 182,481 | " | 387.70 | 70,748,000 |
| STRAWBERRIES | | | | | | | |
| Total | 2000 | 7,591 | 25.61 | 194,330 | " | 960.24 | 186,602,000 |
| | 1999 | 6,352 | 31.00 | 196,922 | " | 1,120.81 | 220,712,000 |
| Fresh | 2000 | | | 116,363 | " | 1,306.95 | 152,080,000 |
| | 1999 | | | 120,290 | " | 1,434.69 | 172,579,000 |
| Processed | 2000 | | | 77,967 | " | 442.78 | 34,522,000 |
| | 1999 | | | 76,632 | " | 628.11 | 48,133,000 |
| MISC. FRUITS AND NUTS* | 2000 | 660 | | | " | | 8,834,000 |
| | 1999 | 953 | | | " | | 9,061,000 |
| TOTAL | 2000 | 59,762 | | | | | $473,683,000 |
| | 1999 | 59,457 | | | | | $571,080,000 |

*MISC. FRUITS AND NUTS include Apples, Apricots, Asian Pears, Bushberries, Cherimoya, Grapes, Guavas, Kiwi, Limes, Persimmons, Macadamias, Tangelos, Tangerines, Walnuts; and miscellaneous citrus, deciduous, and subtropicals

# VEGETABLE CROPS
## ACREAGE, PRODUCTION AND VALUES 1999-00

| CROP | YEAR | PRODUCTION HARVESTED ACREAGE | PRODUCTION PER ACRE | PRODUCTION TOTAL | UNIT | $ VALUE PER UNIT | $ VALUE TOTAL |
|---|---|---|---|---|---|---|---|
| BEANS Green and Dry Limas, Green Snap | 2000 | 3,450 | 2.12 | 7,282 | Tons | $635.96 | $4,631,000 |
| | 1999 | 3,528 | 2.45 | 8,627 | " | 664.66 | 5,734,000 |
| BROCCOLI Fresh and Processed | 2000 | 3,801 | 7.31 | 27,752 | " | 555.17 | 15,407,000 |
| | 1999 | 4,956 | 6.99 | 33,134 | " | 556.23 | 18,430,000 |
| CABBAGE | 2000 | 1,759 | 20.90 | 36,749 | " | 185.53 | 6,818,000 |
| | 1999 | 1,125 | 17.64 | 19,840 | " | 209.68 | 4,160,000 |
| CARROTS | 2000 | 588 | 29.13 | 17,125 | " | 309.79 | 5,305,000 |
| | 1999 | 465 | 30.39 | 14,131 | " | 215.55 | 3,046,000 |
| CAULIFLOWER | 2000 | 335 | 10.03 | 3,358 | " | 652.77 | 2,192,000 |
| | 1999 | 614 | 9.19 | 5,644 | " | 601.70 | 3,396,000 |
| CELERY | 2000 | 11,024 | 40.26 | 443,825 | " | 373.00 | 165,544,000 |
| | 1999 | 11,300 | 37.40 | 422,603 | " | 267.92 | 113,222,000 |
| CILANTRO | 2000 | 1,474 | 9.85 | 14,507 | " | 511.69 | 7,423,000 |
| | 1999 | 1,520 | 9.58 | 14,555 | " | 467.54 | 6,805,000 |
| CUCUMBERS | 2000 | 181 | 9.97 | 1,804 | " | 575.39 | 1,038,000 |
| | 1999 | 279 | 10.42 | 2,906 | " | 535.44 | 1,556,000 |
| GREENS* | 2000 | 1,370 | - | 1,733,929 | Ctns | 4.58 | 7,938,000 |
| | 1999 | 1,747 | - | 1,947,493 | " | 4.84 | 9,420,000 |
| KALE | 2000 | 324 | 18.65 | 6,042 | Tons | 492.56 | 2,976,000 |
| | 1999 | 374 | 19.09 | 7,139 | " | 460.43 | 3,287,000 |
| LETTUCE Total | 2000 | 3,436 | 10.74 | 36,881 | " | 423.53 | 15,620,000 |
| | 1999 | 4,399 | 10.59 | 46,575 | " | 353.92 | 16,485,000 |
| Head | 2000 | 550 | 14.64 | 8,048 | " | 312.13 | 2,512,000 |
| | 1999 | 589 | 12.90 | 7,601 | " | 301.67 | 2,293,000 |
| Romaine | 2000 | 1,150 | 12.01 | 13,801 | " | 384.32 | 5,304,000 |
| | 1999 | 1,347 | 10.70 | 14,048 | " | 343.61 | 4,827,000 |
| Leaf | 2000 | 1,736 | 8.66 | 15,032 | " | 519.16 | 7,804,000 |
| | 1999 | 2,463 | 10.12 | 24,926 | " | 375.71 | 9,365,000 |
| ORIENTAL VEG | 2000 | 2,242 | 6.59 | 14,756 | " | 829.29 | 12,237,000 |
| | 1999 | 2,914 | 8.55 | 24,904 | " | 514.70 | 12,818,000 |
| ONIONS Green & Dry | 2000 | 696 | 14.24 | 9,910 | " | 414.64 | 4,109,000 |
| | 1999 | 1,341 | 18.96 | 25,432 | " | 346.10 | 8,802,000 |

*Includes: chard, collard, mustard, turnip and watercress

# VEGETABLE CROPS
# ACREAGE, PRODUCTION AND VALUES 1999-00

| CROP | YEAR | PRODUCTION HARVESTED ACREAGE | PRODUCTION PER ACRE | PRODUCTION TOTAL | UNIT | $ VALUE PER UNIT | $ VALUE TOTAL |
|---|---|---|---|---|---|---|---|
| PARSLEY | 2000 | 393 | 24.15 | 9,488 | Tons | $614.47 | $5,830,000 |
| | 1999 | 462 | 22.89 | 10,576 | " | 513.43 | 5,430,000 |
| PEPPERS Fresh and Processed | 2000 | 2,448 | 21.29 | 52,115 | " | 516.77 | 26,931,000 |
| | 1999 | 2,119 | 13.25 | 28,073 | " | 365.19 | 10,252,000 |
| PUMPKIN | 2000 | 112 | 8.98 | 1,005 | " | 225.88 | 227,000 |
| | 1999 | 125 | 9.54 | 1,192 | " | 188.76 | 225,000 |
| RADISHES | 2000 | 469 | 12.52 | 5,870 | " | 366.72 | 2,153,000 |
| | 1999 | 964 | 12.56 | 12,104 | " | 383.01 | 4,636,000 |
| SPINACH | 2000 | 1,303 | 7.44 | 9,693 | " | 714.03 | 6,921,000 |
| | 1999 | 1,807 | 6.40 | 11,569 | " | 639.90 | 7,403,000 |
| SWEET CORN | 2000 | 806 | 6.69 | 5,386 | " | 301.34 | 1,623,000 |
| | 1999 | 1,090 | 6.79 | 7,406 | " | 252.77 | 1,872,000 |
| TOMATOES* Fresh and Processed | 2000 | 366 | 76.30 | 27,930 | " | 1,138.46 | 31,797,000 |
| | 1999 | 502 | 56.88 | 28,556 | " | 1,110.10 | 31,700,000 |
| VEGETABLES, MISC.** Field, Indoor, & Processed | 2000 | 1,512 | | | " | | 31,209,000 |
| | 1999 | 1,332 | | | " | | 28,160,000 |
| TOTAL | 2000 | 38,089 | | | | | $357,929,000 |
| | 1999 | 42,963 | | | | | $296,839,000 |

* Includes hydroponics

** Includes artichokes, arugula, asparagus, baby vegetables, beets, eggplant, endive, garlic, gourds, herbs, kohlrabi, leeks, melons, mushrooms, peas, radicchio, sprouts, squash, tomatillos, and turnips.

# NURSERY STOCK
# PRODUCTION AND VALUES 1999-00

| ITEM | YEAR | PRODUCTION | | PRODUCTION AREA Greenhouse Square Feet. | Field Acres | Per Unit | TOTAL |
|---|---|---|---|---|---|---|---|
| NURSERY STOCK | | | | | | | |
| Total | 2000 | ——— | ——— | 5,106,256 | 2,984 | | $155,468,000 |
| | 1999 | ——— | ——— | 5,249,104 | 2,684 | | 139,039,000 |
| Fruit and Nut | 2000 | 345,830 | Trees | | 72 | 13.93 | 4,816,000 |
| Trees | 1999 | 231,898 | Trees | | 24 | 12.63 | 2,928,000 |
| Potted Plants | 2000 | 3,042,281 | Pots | 1,372,070 | 100 | 3.76 | 11,428,000 |
| | 1999 | 2,382,167 | Pots | 1,116,250 | 16 | 3.98 | 9,480,000 |
| Propagative Mat* | 2000 | 88,774,979 | Cuttings | 745,680 | 16 | .10 | 8,682,000 |
| | 1999 | 89,713,866 | Cuttings | 457,240 | 9 | .11 | 9,482,000 |
| Herb. Perennials | 2000 | 3,274,725 | Containers | 943,232 | 32 | 2.27 | 7,422,000 |
| | 1999 | 6,981,315 | Containers | 1,083,000 | 27 | 1.27 | 8,843,000 |
| Woody Orn. | 2000 | 4,407,125 | Tree/Shrubs | 637,820 | 663 | 8.10 | 35,689,000 |
| | 1999 | 3,692,205 | Tree/Shrubs | 546,670 | 538 | 8.33 | 30,767,000 |
| Bed. Plants | 2000 | 61,302,717 | Flats | 495,754 | 2,065 | 1.07 | 65,241,000 |
| and Turf | 1999 | 59,534,302 | Flats | 494,865 | 2,037 | .91 | 54,389,000 |
| Veg. Transplants | 2000 | 9,907,982 | Flats | 911,700 | 36 | 2.24 | 22,190,000 |
| | 1999 | 10,194,472 | Flats | 1,551,079 | 33 | 2.27 | 23,150,000 |
| CHRISTMAS | 2000 | 25,419 | Trees | | 61 | 23.02 | 585,000 |
| TREES (CUT) | 1999 | 30,487 | Trees | | 82 | 23.11 | 704,000 |
| TOTAL | 2000 | | | | | | $156,053,000 |
| | 1999 | | | | | | $139,743,000 |

*Includes Chrysanthemum and Gypsophila cuttings; and ornamental plantlets.

## CUT FLOWERS
## PRODUCTION AND VALUES 1999-00

| ITEM | YEAR | ACRES | PRODUCTION | UNIT | TOTAL $ VALUE |
|---|---|---|---|---|---|
| FLOWER BLOOMS & STEMS | 2000 | 46 | 7,636,945 | Blooms | $2,143,000 |
| | 1999 | 44 | 8,380,990 | " | 3,733,000 |
| CUT GREENS & DRIED FLOWERS | 2000 | 182 | 1,436,594 | Bunches | 1,063,000 |
| | 1999 | 245 | 1,074,154 | " | 2,207,000 |
| FLOWER BUNCHES | 2000 | 991 | 17,953,529 | Bunches | 45,569,000 |
| | 1999 | 1,125 | 14,177,216 | " | 34,941,000 |
| Gypsophila | 2000 | 157 | 1,047,487 | " | 1,799,000 |
| | 1999 | 225 | 1,816,959 | " | 2,491,000 |
| Chrysanthemums | 2000 | 87 | 3,348,036 | " | 5,716,000 |
| Sunflowers & Stock | 1999 | 66 | 1,966,500 | " | 2,741,000 |
| Lilies & Irises | 2000 | 66 | 2,248,879 | " | 8,574,000 |
| | 1999 | 41 | 1,437,124 | " | 5,710,000 |
| Statice, Larkspur & | 2000 | 228 | 3,351,082 | " | 8,159,000 |
| Snapdragons, Delphinium | 1999 | 324 | 2,853,552 | | 5,919,000 |
| Miscellaneous | 2000 | 453 | 7,958,045 | " | 21,321,000 |
| | 1999 | 469 | 6,103,081 | | 18,080,000 |
| TOTAL | 2000 | 1,219 | | | $48,775,000 |
| | 1999 | 1,414 | | | $40,881,000 |

## FIELD CROPS
## ACREAGE, PRODUCTION AND VALUES 1999-00

| CROP | YEAR | HARVESTED ACREAGE | TOTAL $ VALUE |
|---|---|---|---|
| ALFALFA AND PASTURE Irrigated & Non-Irrigated | 2000 | 148,335 | $1,740,000 |
| | 1999 | 148,537 | 1,379,000 |
| GRAIN*, HAY, FLOWER & VEGETABLE SEED | 2000 | 1,306 | 2,068,000 |
| | 1999 | 2,161 | 2,861,000 |
| TOTAL | 2000 | | $3,808,000 |
| | 1999 | | $4,240,000 |

*includes green barley

# LIVESTOCK AND POULTRY PRODUCTION AND VALUES 1999-00

| ITEM | YEAR | PRODUCTION | UNIT | $ VALUE PER UNIT | TOTAL |
|---|---|---|---|---|---|
| LIVESTOCK | | | | | |
| Cattle, Hogs | 2000 | 26,165 | cwt. | $76.94 | $2,013,000 |
| Sheep | 1999 | 29,801 | cwt. | 69.17 | 2,061,000 |
| POULTRY | | | | | |
| Eggs, Ducks and Squab | 2000 | | | | 696,000 |
| | 1999 | | | | 291,000 |
| TOTAL | 2000 | | | | $2,709,000 |
| | 1999 | | | | $2,437,000 |

# APIARY PRODUCTS PRODUCTION AND VALUES 1999-00

| CROP | YEAR | PRODUCTION | UNIT | $ VALUE PER UNIT | TOTAL |
|---|---|---|---|---|---|
| HONEY | 2000 | 929,728 | lbs. | $.54 | $500,000 |
| | 1999 | 270,850 | lbs. | .53 | 143,000 |
| BEESWAX | 2000 | 6,981 | | 1.44 | 10,000 |
| | 1999 | 4,529 | | 1.99 | 9,000 |
| POLLINATION USE | | | | | |
| | 2000 | | | | 335,000 |
| | 1999 | | | | 198,000 |
| TOTAL | 2000 | | | | $845,000 |
| | 1999 | | | | $350,000 |

# TIMBER
# PRODUCTION AND VALUES 1999-00

| CROP | YEAR | $ VALUE |
|---|---|---|
| TIMBER* | 2000 | $74,000 |
| | 1999 | $66,000 |

* Timber harvested for lumber.

# SUSTAINABLE AGRICULTURE

| ITEM | PEST | AGENT | SCOPE OF PROGRAM |
|---|---|---|---|
| BIOLOGICAL CONTROL | | | |
| Commercial Insectaries | Red and black scale, mealybug, snails, various aphids mites and flies | Aphytus melinus, Cryptolemus, Decollate snails, various predators, parasitic wasps and nematodes | Estimate 3,792,000,000 beneficials, released on 700 ranches. Valued at $ 3,252,000 |
| COLONIZATION OF BENEFICIAL ORGANISMS* | Giant Whitefly | Encarsiella noysi | 16 releases/total 6960 |
| | | Idioporus affinisi | 15 releases/total 7360 |
| PEST ERADICATION | Puna Grass | Mechanical/Pulling | 1 Site |
| PEST EXCLUSION | | Incoming Shipments | |
| | Various | Postal/UPS/Fed Express (Parcels) | 16,553 |
| | | Truck/Air Freight | 6,270 |
| | | Ship (Inspections) | 34 |
| | Gypsy Moth | Household Goods (Inspections) | 187 |
| | | | Total 23,044 |

| | | | | | |
|---|---|---|---|---|---|
| ORGANIC FARMING | Number of registered growers | 41 | Vegetables | Acreage | 2,708 |
| | | | Fruits and Nuts | Acreage | 1,375 |
| | | | Flowers | Acreage | 1 |

*released cooperative effort: U.C. Cooperative Extension and Univ. of Ca. Riverside

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-4082
(916) 657-5390 - Fax

RECEIVED
JUL 9 2001
PLANNING DIVISION
CITY OF OXNARD

July 5, 2001

Gary Y. Sugano
City of Oxnard
305 West Third Street
Oxnard, CA 93030

RE: SCH# 2000051046 – River Park Specific Plan

Dear Mr. Sugano:

The Native American Heritage Commission has reviewed the above mentioned NOP. To adequately assess the project-related impact on archaeological resources, the Commission recommends the following action be required:

- ✓ Contact the Native American Heritage Commission for:
  - A Sacred Lands File Check.
  - A list of appropriate Native American Contacts for consultation concerning the project site and assist in the mitigation measures.
- ✓ Provisions for accidental discovery of archeological resources:
  - Lack of surface evidence of archeological resources does not preclude the existence of archeological resources. Lead agencies should include provisions for accidentally discovered archeological resources during construction per California Environmental Quality Act (CEQA) §15064.5 (f).
- ✓ Provisions for discovery of Native American human remains
  - Health and Safety Code §7050.5, CEQA §15064.5 (e), and Public Resources Code §5097.98 mandates the process to be followed in the event of an accidental discovery of any human remains in a location other than a dedicated cemetery and should be included in all environmental documents.

If you have any questions, please contact me at (916) 653-4040.

Sincerely,

Rob Wood
Associate Governmental Program Analyst

CC: State Clearinghouse

JUL 10 2001

# VENTURA COUNTY
# AIR POLLUTION CONTROL DISTRICT
Memorandum

TO: Joseph Eisenhut, Planning DATE: July 9, 2001

FROM: Alicia Stratton AS

SUBJECT: Request for Review of Revised Notice of Preparation for Draft Environmental Impact Report, RiverPark Specific Plan, City of Oxnard (Reference No. 01-052)

Air Pollution Control District staff has reviewed the subject project revised notice of preparation for the draft environmental impact report. The project consists of a proposed Specific Plan to regulate the use of land within an approximate 695-acre area, which would include areas presently within the City of Oxnard and adjacent unincorporated area presently under the jurisdiction of the County of Ventura. The proposed Specific Plan would allow the development of a new mixed-use community containing commercial, residential, recreation, education and open space uses within the proposed Specific Plan Area. The project is located within the existing City of Oxnard City Urban Restriction Boundary and the Sphere of Influence Line for the City of Oxnard. Its eastern boundary is the Ventura Freeway and its southern boundary is Vineyard Avenue.

Page 17 of the notice of preparation for the draft environmental impact reports addresses probable environmental effects for study in the environmental impact report. The section on air quality impacts refers to the Ventura County *Guidelines for the Preparation of Air Quality Impact Analysis*. Please note that these Guidelines were updated and adopted by the Air Pollution Control Board in 2000, and is now the advisory document for lead agencies, consultants, and project applicants for preparing air quality evaluations for environmental documents. The comprehensive update is titled the *Ventura County Air Quality Assessment Guidelines*, and is available through our office.

In addition to those items listed on page 17 that will be addressed in the environmental impact report, the District recommends that a toxic air pollution evaluation be conducted due to adjacent industrial uses. This evaluation should consider the subject project in relation to existing and planned development, local wind patterns, and the types and amounts of toxic and hazardous materials that are stored, handled or used on adjacent properties. The potential for any toxic or hazardous materials to become airborne should also be addressed, and whether or not the threat from any airborne toxic substance is acute or chronic. Routes of exposure or pathways by which an affected population can be exposed to the toxic or hazardous substances should be identified.

A comprehensive air quality impact mitigation program should be prepared for inclusion in the Specific Plan. This Program should include a full range of operational and area air quality impact mitigation measures and programs.

If you have any questions, please call me at 645-1426.

# county of ventura

PUBLIC WORKS AGENCY
RONALD C. COONS
Director

Deputy Directors of Public Works
**Wm. Butch Britt**
Transportation
**John C. Crowley**
Water Resources & Engineering
**Lane B. Holt**
Central Services
**Kay Martin**
Solid Waste Management
**Jeff Pratt**
Flood Control

July 11, 2001

RECEIVED
JUL 13 2001
PLANNING DIVISION
CITY OF OXNARD

City of Oxnard
Gary Y Sugano, Senior Associate Planner
Planning and Environmental Services Division
305 West Third Street, 2nd Floor
Oxnard, CA 93030

SUBJECT: RMA 01-052, Revised Notice of Preparation of Draft Environmental Report River Park Specific Plan

Dear Mr. Sugano:

Thank you for providing the Ventura County Flood Control District (District) with the opportunity to comment on the Notice of Preparation (NOP) of Draft Environmental Report, for the subject project. We recommend the following information be included in the DEIR:

1. The project site contains several District jurisdictional channels and easements as well as some parcels to which the District is the fee titleholder. Comprehensive studies of potential impact to the District jurisdictional facilities shall be prepared and a range of alternatives, which avoid or otherwise minimize impacts to existing facilities, should be included. Project impacts should also be analyzed relative to their effect on off-site flooding and erosion.

2. There is a significant difference in the flow rates used to establish the FIRM flood zones for Santa Clara River and the design flow rates currently expected in a 100-year storm. The Draft EIR needs to evaluate the levee along the Santa Clara River as related to new water surface elevation and the adequacy of freeboard.

3. The project should be undertaken in accordance with conditions and requirements of the Ventura Countywide Stormwater Quality Management Program, National Pollutant Discharge Elimination System (NPDES) Permit No. CAS004002, which includes the requirement for a Stormwater Pollution Control Plan (SWPCP) or equivalent document, covering water quality protection during the construction phase of the project and the Stormwater Quality Urban Impact Mitigation Plan (SQUIMP) requirements.

If you have questions regarding this subject, please call the undersigned at 654-2906.

Very truly yours,

Kevin Keivanfar, P.E.
Manager, Permit Section
Planning and Regulatory Division
Flood Control Department

KK/aac

C: Sally Coleman, City of Oxnard
Joseph Eisenhut, RMA Planning, County of Ventura

RESOURCE MANAGEMENT AGENCY

county of ventura

Planning Division

Keith A. Turner
Director

July 12, 2001

G. Sugano
Oxnard, CA

FAX #: 385-7417

Subject: River Park Specific Plan/NOP

Thank you for the opportunity to review and comment on the subject document. Attached are the comments that we have received resulting from intra-county review of the subject document.

Your proposed responses to these comments should be sent directly to the commentator, with a copy to Joseph Eisenhut, Ventura County Planning Division, L#1740, 800 S. Victoria Avenue, Ventura, CA 93009.

If you have any questions regarding any of the comments, please contact the appropriate respondent. Overall questions may be directed to Joseph Eisenhut at (805) 654-2464.

Sincerely,

Keith Turner
County Planning Director

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Attachment

County RMA Reference Number 01-052

# Department of Toxic Substances Control

Edwin F. Lowry, Director
1011 N. Grandview Avenue
Glendale, California 91201

RECEIVED
JUL 26 2001
PLANNING DIVISION
CITY OF OXNARD

Winston H. Hickox
Agency Secretary
California Environmental
Protection Agency

Gray Davis
Governor

July 19, 2001

Mr. Gary Y. Sugano, Senior Associate Planner
City of Oxnard
Planning and Environmental Services Division
305 West Third Street
Oxnard, CA 93030

RE: NOTICE OF PREPARATION OF AN ENVIRONMENTAL IMPACT REPORT FOR THE RIVER PARK SPECIFIC PLAN, SCH No. 2000051046

Dear Mr. Sugano:

The Department of Toxic Substances Control (DTSC) has received the Notice of Preparation (NOP) for a draft Environmental Impact Report (EIR) for the above mentioned Project.

Based on the review of the document, the DTSC comments are as follows:

1) The draft EIR needs to identify and determine whether current or historic uses at the Project site have resulted in any release of hazardous wastes/substances at the Project area.

2) The draft EIR needs to identify any known or potentially contaminated site within the proposed Project area. For all identified sites, the draft EIR needs to evaluate whether conditions at the site pose a threat to human health or the environment.

3) The draft EIR should identify the mechanism to initiate any required investigation and/or remediation for any site that may require remediation, and which government agency will provide appropriate regulatory oversight.

DTSC provides guidance for Preliminary Endangerment Assessment (PEA) preparation and cleanup oversight through the Voluntary Cleanup Program (VCP). Also, in the near future, DTSC will be administering the $85 million Urban Cleanup Loan Program (UCLP), which will provide low-interest loans to investigate and cleanup hazardous materials at properties where redevelopment is likely to have a beneficial impact to a community. The program is composed of two main components: low interest loans of up to $100,000 to conduct preliminary endangerment assessments of underutilized properties; and loans of up to $2.5 million for the cleanup or removal of

hazardous materials also at underutilized urban properties. These loans are available to developers, businesses, schools, and local governments.

For additional information on the VCP or UCLP please visit DTSC's web site at www.dtsc.ca.gov. If you would like to meet and discuss this matter further please contact Arman Moheban, Project Manager, at (818) 551-2834 or me at (818) 551-2877.

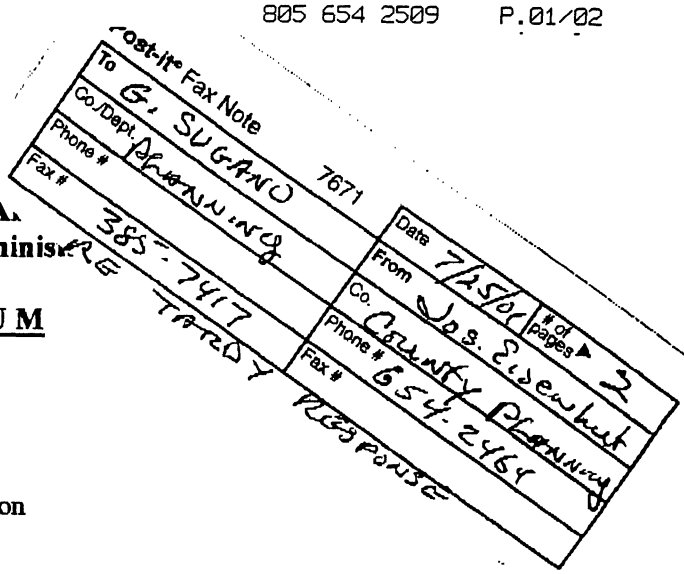
Sincerely,

Harlan R. Jeche

Harlan R. Jeche
Unit Chief
Southern California Cleanup Operations - Glendale Office

cc: Governor's Office of Planning and Research
State Clearinghouse
P.O. Box 3044
Sacramento, California 95812-3044

Mr. Guenther W. Moskat, Chief
Planning and Environmental Analysis Section
CEQA Tracking Center
Department of Toxic Substances Control
P.O. Box 806
Sacramento, California 95812-0806




**PUBLIC WORKS A**
**TRANSPORTATION DEPA.**
**Traffic and Planning & Administ**

**MEMORANDUM**
July 20, 2001

**TO:** Resource Management Agency, Planning Division
Attention: Joseph Eisenhut

**FROM:** Nazir Lalani, Principal Engineer NL

**SUBJECT:** Review of Document 01-052
Revised Notice of Preparation of a Draft Environmental Impact Report
River Park Specific Plan Located within the City of Oxnard and the adjacent unincorporated area presently under the jurisdiction of the County of Ventura
Lead Agency: The **City of Oxnard**

The Transportation Department has reviewed the subject Revised Notice of Preparation of a Draft Environmental Impact Report for the River Park Specific Plan as proposed by the City of Oxnard. The proposed Plan allows for the development of a new mixed-use community containing 250 acres of open space, 2,761 residential units and 3.0 million SF for commercial use. The project is located north of Ventura Freeway, between Vineyard Avenue and the Santa Clara River within the City of Oxnard and the adjacent unincorporated area presently under the jurisdiction of the County of Ventura. We offer the following comments:

1. We generally concur with the comments in the Notice of Preparation (NOP) for the Draft Environmental Impact Report (DEIR) for those areas under the purview of the Transportation Department.

2. This project will have site-specific impacts on the County's Regional Road Network. The Environmental Impact Report should show if traffic generated by this development will have a significant impact on the County's transportation system and roadway network in the unincorporated area. If this project will have a significant impact on the County's Regional Road Network, the Transportation Department will require the applicant to mitigate the impacts to less than significant levels.

3. To address the cumulative impacts of this project on the Regional Road Network, the project proponent must submit a traffic analysis in sufficient detail that shows the increases in average daily traffic (ADT) on the County's Regional Road Network attributable to this project. The Transportation Department can then calculate the traffic impact mitigation fee amount due the County.

4. A preliminary traffic analysis was provided by the City of Oxnard to the County. Based upon a review of this study, the following comments were communicated to the City on June 18, 2001:

   a. Mitigation of impacts to neighborhood streets in the El Rio area needs to be addressed.

   b. Impacts to the intersection of Victoria/ Olivas Park Drive and Victoria/ Gonzales Road need to be identified and mitigated, if necessary.

RECD JUL 25 2001

c. Impacts to the US 101 freeway east of Vineyard Avenue need to be identified and mitigated.

d. Project specific and cumulative impacts to segments of the Regional Road Network, including Hwy 118, need to be addressed where more than 20 peak hour trips are to be added to existing traffic.

e. Mitigation measures for the Central Avenue/ Vineyard Avenue intersection need to be identified. There is currently a County project under design to add additional left and right turn lanes on the Central Avenue approach.

f. The phasing of the project must be coordinated with the completion of the widening and other improvements planned for the US 101 freeway bridge across the Santa Clara River.

g. The project proposed to incorporate the existing County maintenance facilities located on El Rio Drive. The County will require that the project provide new maintenance facilities that meet the existing and future needs of the County maintenance operation currently housed at the El Rio facility to a location that is acceptable to the County.

5. Our review of this Notice of Preparation of the DEIR is limited to the impacts this project may have on the County's Regional Road Network.

Please call me at 654-2080 if you have any questions.

c: Jim Myers

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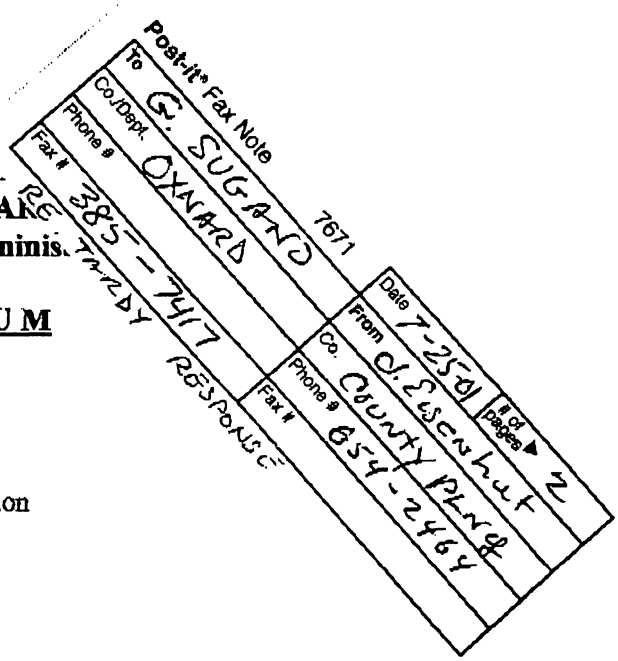


**PUBLIC WORKS AG.**
**TRANSPORTATION DEPAR**
**Traffic and Planning & Adminis.**

**MEMORANDUM**
July 24, 2001

**TO:** Resource Management Agency, Planning Division
Attention: Joseph Eisenhut

**FROM:** Nazir Lalani, Principal Engineer NL

**SUBJECT:** Review of Document 01-052
Revised Notice of Preparation of a Draft Environmental Impact Report
River Park Specific Plan Located within the City of Oxnard and the adjacent unincorporated area presently under the jurisdiction of the County of Ventura
Lead Agency: The **City of Oxnard**

The Transportation Department has reviewed the subject Revised Notice of Preparation of a Draft Environmental Impact Report for the River Park Specific Plan as proposed by the City of Oxnard. The proposed Plan allows for the development of a new mixed-use community containing 250 acres of open space, 2,761 residential units and 3.0 million SF for commercial use. The project is located north of Ventura Freeway, between Vineyard Avenue and the Santa Clara River within the City of Oxnard and the adjacent unincorporated area presently under the jurisdiction of the County of Ventura. We offer the following comments:

1. We generally concur with the comments in the Notice of Preparation (NOP) for the Draft Environmental Impact Report (DEIR) for those areas under the purview of the Transportation Department.

2. This project will have site-specific impacts on the County's Regional Road Network. The Environmental Impact Report should show if traffic generated by this development will have a significant impact on the County's transportation system and roadway network in the unincorporated area. If this project will have a significant impact on the County's Regional Road Network, the Transportation Department will require the applicant to mitigate the impacts to less than significant levels.

3. To address the cumulative impacts of this project on the Regional Road Network, the project proponent must submit a traffic analysis in sufficient detail that shows the increases in average daily traffic (ADT) on the County's Regional Road Network attributable to this project. The Transportation Department can then calculate the traffic impact mitigation fee amount due the County.

4. A preliminary traffic analysis was provided by the City of Oxnard to the County. Based upon a review of this study, the following comments were communicated to the City on June 18, 2001:

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   b. Impacts to the intersection of Victoria/ Olivas Park Drive and Victoria/ Gonzales Road need to be identified and mitigated, if necessary.

RECD JUL 25 2001

c. Impacts to the US 101 freeway east of Vineyard Avenue need to be identified and mitigated.

d. Project specific and cumulative impacts to segments of the Regional Road Network, including Hwy 118, need to be addressed where more than 20 peak hour trips are to be added to existing traffic.

e. Mitigation measures for the Central Avenue/ Vineyard Avenue intersection need to be identified. There is currently a County project under design to add additional left and right turn lanes on the Central Avenue approach.

f. The phasing of the project must be coordinated with the completion of the widening and other improvements planned for the US 101 freeway bridge across the Santa Clara River.

g. The project proposed to incorporate the existing County maintenance facilities located on El Rio Drive. The County will require that the project provide new maintenance facilities that meet the existing and future needs of the County maintenance operation currently housed at the El Rio facility to a location that is acceptable to the County.

5. Our review of this Notice of Preparation of the DEIR is limited to the impacts this project may have on the County's Regional Road Network.

Please call me at 654-2080 if you have any questions.

c: Jim Myers

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# United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, California 93003



RECEIVED

SEP 4 2001

PLANNING DIVISION
CITY OF OXNARD


August 29, 2001

Gary Y. Sugano
City of Oxnard
305 West Third Street
Oxnard, California 93030

Subject: Revised Notice of Preparation of a Draft Environmental Impact Report for the RiverPark Specific Plan Project, Oxnard, Ventura County, California

Dear Mr. Sugano:

The U.S. Fish and Wildlife Service (Service) has reviewed the notice of preparation (NOP) of a draft environmental impact report (EIR) for the proposed RiverPark Specific Plan project, located north of Highway 101 between Vineyard Avenue and the Santa Clara River in Oxnard. The proposed Specific Plan would allow for the development of a 694-acre commercial, residential, recreation, education and open space community within the proposed area. The original NOP was issued in May 2000, but changes to the project design and comments from interested public agencies and the public have led to the refinement of the Specific Plan.

We offer the following information and recommendations to aid you in planning for the conservation of sensitive wildlife habitats and federally listed species that could occur on the preferred or alternative sites and as a means to assist you in complying with pertinent federal statutes. The following comments are prepared in accordance with the Endangered Species Act of 1973, as amended (Act), and other authorities mandating Department of the Interior concern for environmental values.

The Service's responsibilities include administering the Act, including sections 7, 9, and 10. Section 9 of the Act prohibits the taking of any federally listed endangered or threatened species. Section 3(18) of the Act defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Service regulations (50 CFR 17.3) define "harm" to include significant habitat modification or degradation which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Harassment is defined by the Service as an intentional or negligent action that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species. Exemptions to the prohibitions against take may be obtained

through coordination with the Service in two ways: through interagency consultation for projects with Federal involvement pursuant to section 7 or through the issuance of an incidental take permit under section 10(a)(1)(B) of the Act.

We recommend that the draft EIR contain specific information to assist us in adequately evaluating the proposed project from the standpoint of fish and wildlife protection. This information should include the following:

1. A complete discussion of the purpose and need for the project should be provided.

2. The draft EIR should include all practicable, environmentally superior alternatives that have been considered to reduce impacts to listed and candidate species, wetland areas, other sensitive habitats, and fish and wildlife resources. In particular, the draft EIR should contain alternatives that explore a reduced project footprint, clustering of structures into less sensitive areas, or the selection of a site with the least impact to biological resources, if any are available.

3. Specific acreages of the amount and types of habitat that may be affected by the proposed project or project alternatives should be provided in the draft EIR. The draft EIR should also include detailed habitat descriptions and mapping of the extent and distribution of native vegetation. Of particular concern to the Service are the acreages of coastal sage scrub, wetland, and riparian habitats to be affected.

4. The draft EIR should supply descriptions of each habitat type on the site. These descriptions should include relative quantitative and qualitative information regarding wildlife and plant resources on the proposed and alternative project sites.

5. The draft EIR should assess the direct effects (habitat loss, degradation, or modification, animal mortality, habitat fragmentation, and others), and indirect effects (brush clearance, noise, human intrusions into adjacent habitats, the introduction of invasive, nonnative plants and animals, and others). The draft EIR should also analyze how this project contributes to the cumulative effects of the incremental loss of regional plant and wildlife habitat within the Santa Clara River.

6. The draft EIR should include a list of federally listed threatened or endangered species, state-listed species, and locally sensitive species that may be found at or near the project site. Discussion of these species should focus upon their distribution and abundance on the site and in the surrounding area, and the anticipated impacts of the project on these species.

   The Service is particularly interested in any and all pertinent information pertaining to potential or known impacts to populations of the federally endangered least Bell's vireo (*Vireo belli pusillus*) and the southwestern willow flycatcher (*Empidonax traillii*

*extimus*). Because portions of the proposed action area are adjacent to existing riparian vegetation and absent a compelling reason to do otherwise, we recommend that surveys for the least Bell's vireo and southwestern willow flycatchers be performed to determine if the species is nesting on or adjacent to the proposed action areas.

7. Specific mitigation measures should be provided to offset project-related impacts. Mitigation measures that require the development of revegetation or restoration plans should be prepared by persons or firms with specific expertise in southern California ecosystems and state-of-the-art native plant revegetation techniques. Such plans should include, at a minimum: a) methods to salvage on-site plant material, either through propagule collection or transplanting; b) the location of mitigation site(s); c) the species, actual number, and size of the plants to be used; d) a schematic layout depicting the arrangement of the plants within the compensation area; e) time of year that planting will occur; f) a description of the irrigation system to be employed and the duration of its use; g) measures to be taken to control exotic vegetation on site; h) a detailed monitoring program that includes provisions for replanting areas where planted materials have not survived; and i) identification of the agency that will guarantee the successful creation of the mitigation habitat and provide for the protection and perpetual conservation of the restoration site. In this regard, measures should be proposed (and subsequently implemented) to control access to the site, to curtail illegal dumping, to minimize lighting impacts to adjacent habitat, and to manage for sensitive species in any mitigation areas.

8. Identification of construction methods to be employed to prevent soil erosion, along with specific erosion and sedimentation control plans to be carried out throughout the life of the project and the development, should be discussed in the draft EIR.

9. The draft EIR should include an analysis of the effects of the project on the hydrology of the Santa Clara River and any other riparian or wetland communities within the sphere of influence of the project.

10. An analysis of any changes in groundwater depths and volumes resulting from groundwater pumpage that may be a part of the proposed development should be provided. The effects of any groundwater fluctuations should be related to the viability of potentially affected riparian and wetland habitats.

11. An analysis of the potential disturbance or migration of hazardous substances within the project area and the adjacent Santa Clara River should be provided. This analysis should include the potential for fish and wildlife resources to be exposed to hazardous substances.

12. The draft EIR should analyze the potential effects of increased adjacent urbanization on water quality. A discussion of the manner in which pollutants in storm water and "nuisance" runoff from the entire proposed development would be minimized should be provided.

We look forward to reviewing the draft environmental impact report when it becomes available. Should you have any questions regarding these comments, please contact Louise Lampara of my staff at (805) 644-1766.

Sincerely,

for Diane K. Noda
Field Supervisor

## REVISED NOTICE OF PREPARATION

**To:** Responsible and Trustee Agencies (Distribution List is attached to this notice)

**Subject:** **Revised Notice of Preparation of a Draft Environmental Impact Report**

| **Lead Agency:** | | **Consulting Firm:** | |
|---|---|---|---|
| Agency Name: | City of Oxnard | Firm Name: | Impact Sciences, Inc. |
| Street Address: | 305 West Third Street | Mailing Address: | 30343 Canwood St., #210 |
| City/State/Zip Code: | Oxnard, CA 93030 | City/State/Zip Code: | Agoura Hills, CA 91301 |
| Contact: | Gary Y. Sugano | Contact: | Tony Locacciato |

The City of Oxnard is serving as the Lead Agency for the environmental review of the proposed RiverPark Specific Plan Project described in the attachments to this Notice of Preparation. The City is currently preparing an Environmental Impact Report (EIR) for this project. **A Notice of Preparation for this EIR was distributed by the City for comment and review in May 2000.** The proposed Specific Plan has been revised and refined to reflect environmental information collected and analysis conducted over the past year and as a result of consultation by the City and the applicant with interested public agencies. In order to ensure that all interested public agencies and other parties have an opportunity to comment on the project as currently proposed, the City is circulating this Revised Notice of Preparation to provide an opportunity for additional comment. Please note that the City will be addressing all comments submitted in response to the May 2000 Notice of Preparation in determining the scope of topics to be addressed in this EIR. For this reason, no response is necessary unless your agency has additional comments on the revisions to the proposed project.

The City needs to know the views of your agency regarding the scope and content of the environmental information that should be included in this EIR. The document to be prepared by the City should include any information necessary for your agency to meet any statutory responsibilities related to the proposed project. Your agency will need to use the EIR prepared by the City when considering any permit or other approvals necessary to implement the project. A preliminary list of the environmental topics the City has identified for study in this EIR is attached to this notice. If the topics of concern to your agency have already been identified for analysis, your agency need not provide a response to this notice.

The project description, location, and the environmental issues to be addressed in the EIR are contained in the attached materials. **Due to the time limits mandated by State law, your response must be sent to the City at the earliest possible date but not later than July 12, 2001. Please send your response to Mr. Gary Sugano, Senior Associate Planner, Planning and Environmental Services Division, City of Oxnard, 305 West Third Street, Oxnard, California 93030.** Agency responses to this NOP should include the name of a contact person within the commenting agency.

**Project Title:** **RiverPark Specific Plan**

**Project Location:** **City of Oxnard, County of Ventura**

**Project Description (brief):**
The proposed project consists of a proposed Specific Plan to regulate the use of land within an approximate 695-acre area, which would include areas presently within the City of Oxnard and adjacent unincorporated area presently under the jurisdiction of the County of Ventura. Various land uses are proposed within the Specific Plan Area including residential, commercial, public facilities and open space. A more detailed description of the site and proposed project are provided in the attachments to this

notice. A summary of the changes to this proposed project since the first NOP was issued for this project in May 2000 is also provided.

The City of Oxnard will consider approval of several related discretionary actions including an amendment to the Oxnard 2020 General Plan; Pre-zoning of the portion of the proposed Specific Plan Area not currently located within the City of Oxnard and a Zone Change for the portion currently within the City; approval of an amendment to the City's code relating to the allowed location for multiplex theater complexes; Adoption of the RiverPark Specific Plan; Approval of a new mine reclamation plan; initiation of annexation of the portion of the proposed Specific Plan Area not currently located within the City of Oxnard; approval of a Development Agreement with the project applicant; and approval of a Tentative Tract Map. The Oxnard Community Development Commission will consider approval of an Owner Participation Agreement for the portion of the proposed Specific Plan Area located within the City's HERO Redevelopment Area.

Date: 6/12/01

Signature: M Miller

Marilyn Miller
Title: Planning & Environmental Services Manager
Telephone: (805) 385-7858

Reference: California Administrative Code, Title 14 (CEQA Guidelines), Sections 15082(a), 15103, 15375.

## PROJECT LOCATION

**Figure 1** illustrates the location of Oxnard within Ventura County. As shown, the City of Oxnard is located in southern Ventura County near the coastline. The location of the approximate 695-acre site for the proposed RiverPark Specific Plan in relation to the City of Oxnard is illustrated in **Figure 2**. As shown, the Specific Plan site is generally located north of the Ventura Freeway (U.S. 101), between Vineyard Avenue and the Santa Clara River.

## PROJECT BACKGROUND

As shown in **Figure 3**, the entire RiverPark site is located within the existing City of Oxnard City Urban Restriction Boundary (CURB) and the Sphere of Influence Line for the City of Oxnard. An ordinance establishing the CURB was approved by the voters in Oxnard in November 1998. The CURB requires that the City restrict urban services and urbanized uses of lands to within the CURB Line through the year 2020. The CURB line matches the Sphere of Influence Line for the City in this area.

Currently, approximately 265 acres of the project site are located within the City of Oxnard. This portion of the project site is referred to as "RiverPark Area A." The remaining 430 acres of the site are currently located outside of the City of Oxnard and this unincorporated land is currently under the jurisdiction of the County of Ventura. This portion of the site is referred to as "RiverPark Area B." The City of Oxnard adopted a specific plan for the majority of the RiverPark Area A in 1986 and annexed the area addressed by this specific plan. This existing plan is titled the "Oxnard Town Center Specific Plan." This adopted plan allows development of up to 4.4 million square feet of commercial and industrial space in the area addressed by this specific plan. RiverPark Area A includes the area addressed by the Oxnard Town Center Specific Plan and a small amount of additional land located directly north of the Ventura Freeway and west of Vineyard Avenue. RiverPark Area A is also located within the Oxnard Community Development Commission's Historic Enhancement and Revitalization of Oxnard (HERO) Redevelopment Plan Area.

RiverPark Area B includes an existing sand and gravel mine permitted by the County of Ventura in 1979 and two retention basins owned and operated by the Ventura County Flood Control District. All mining activities allowed by the current permit have been completed and the site is currently being reclaimed in accordance with an existing approved reclamation plan for this site previously approved by the County of Ventura.

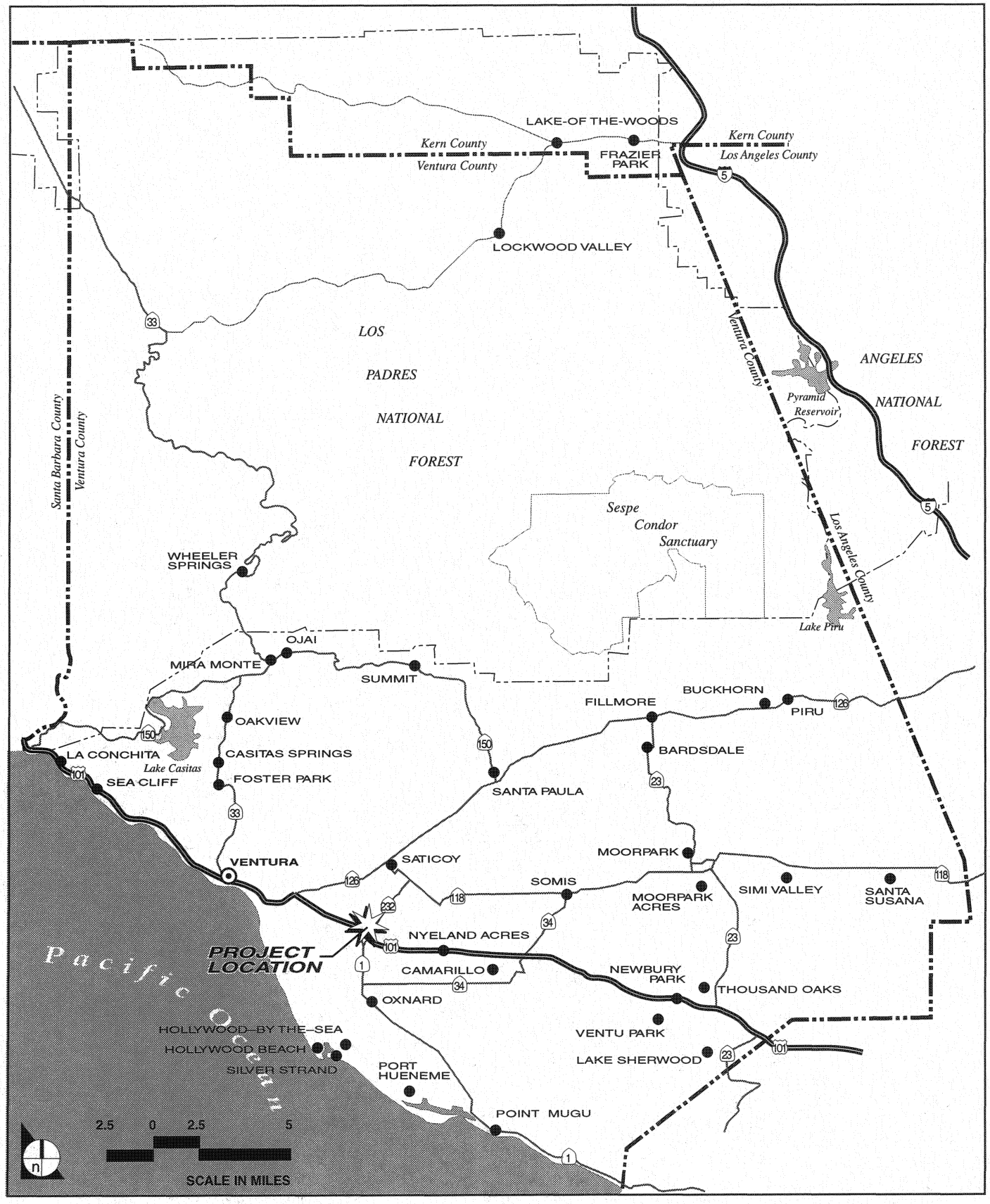


FIGURE 1

## Regional Location

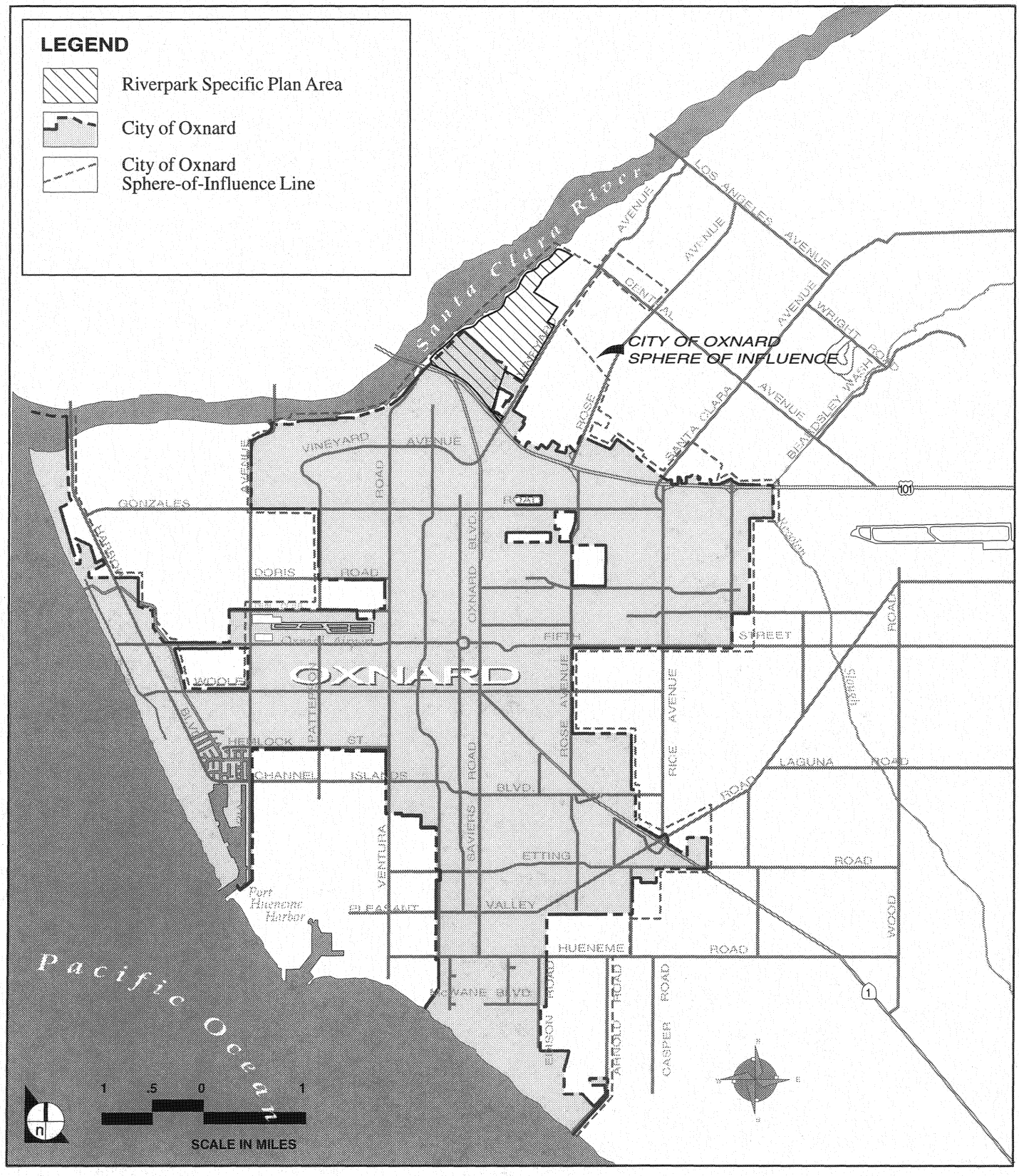


FIGURE 2

## Project Vicinity Map

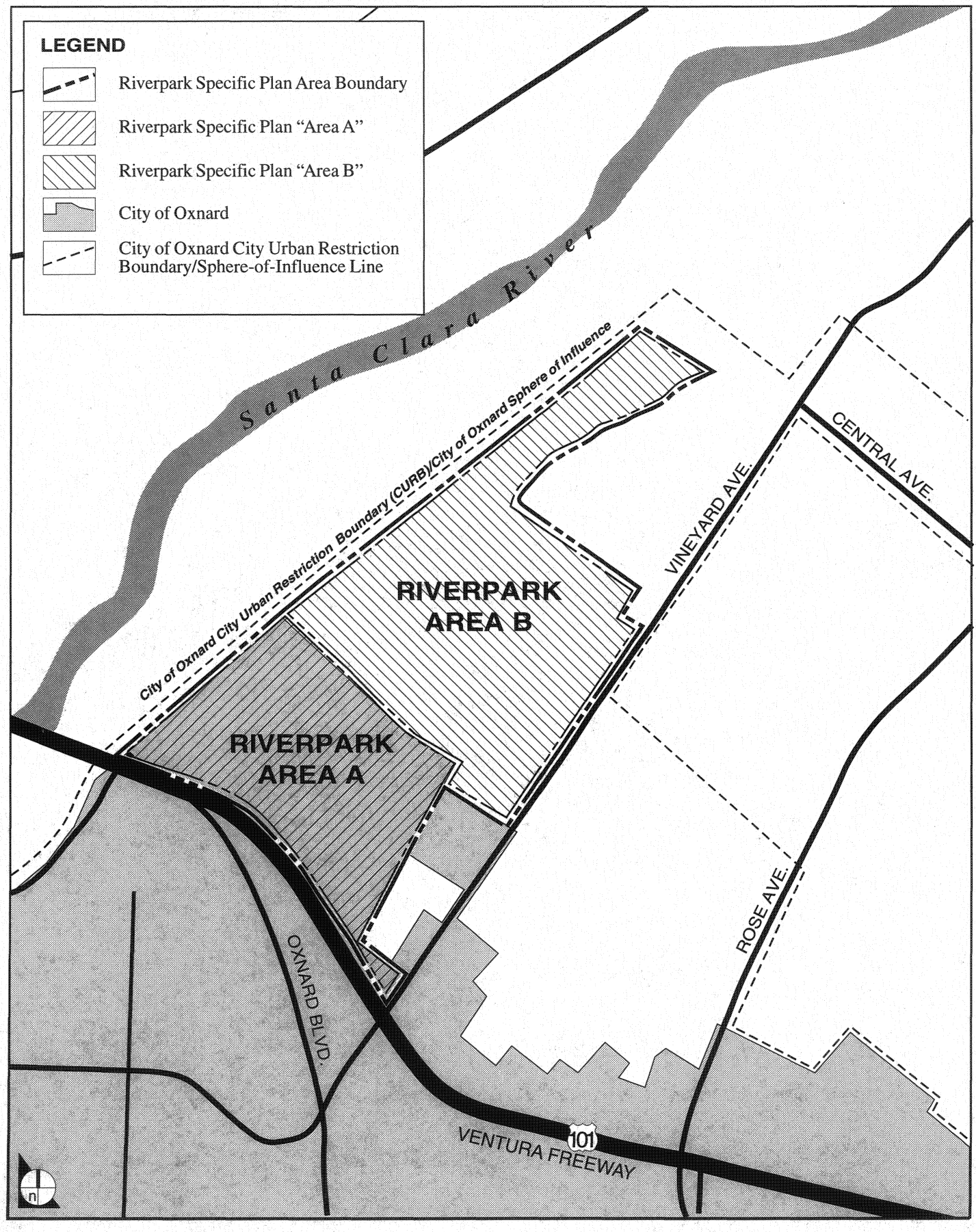


FIGURE 3

## Project Location

The existing Oxnard 2020 General Plan land use map designations for the site are shown in **Figure 4**. RiverPark Area A is currently designated for development of Regional Commercial, Commercial Office, and Business and Research Park Uses consistent with the adopted Oxnard Town Center Specific Plan. RiverPark Area B is currently designated as Open Space-Mineral Resource with a Planning Reserve Overlay on the Oxnard 2020 General Plan land use map, consistent with the previous mining activities on this part of the site. This Planning Reserve Overlay was placed on certain open space areas contiguous to developed portions of the City to indicate that these areas may be considered for urbanization during the term of the 2020 General Plan.

An aerial photograph of the project site and surrounding areas is provided in **Figure 5**. RiverPark Areas A and B are also identified on this photograph. As shown in this photograph, the southwestern corner of RiverPark Area A has been previously developed. The existing streets, two office buildings and other infrastructure facilities built in the southwestern corner of RiverPark Area A were built in conformance with the Oxnard Town Center Specific Plan. Immediately east of this developed area is a 14-acre area containing a complex of buildings housing various County of Ventura offices and facilities. The areas to the north and east of these developed portions of RiverPark Area A are currently in agricultural production. As discussed above, this part of the site was approved for urban use by the City of Oxnard in 1986.

Most of RiverPark Area B consists of the existing sand and gravel mine site. As shown in the photograph, this part of the site contains three existing mine pits, which are deeper than existing groundwater levels and partially filled with exposed groundwater. Currently, concrete and asphalt batch plants operate on this portion of the site. The mine site also includes associated administrative offices. RiverPark Area B also includes two existing retention basins built by the Ventura County Flood Control District to accept runoff from agricultural areas to the east of Vineyard Avenue located north of the existing community of El Rio. The North El Rio Detention Basin No. 1, built in 1995, is located adjacent to Vineyard Avenue. The larger North El Rio Detention Basin No. 2, located south and west of Basin No. 1, was built in 1997.

The Santa Clara River, located on the western edge of the project site, is separated from the site by an existing levee built by the Army Corps of Engineers. The California Department of Transportation (Caltrans) and the City of Oxnard are currently planning improvements to the Ventura Freeway in the vicinity of the project site. These improvements consist of a new bridge across the Santa Clara River to replace the existing bridge, widening of the freeway immediately east and west of the new bridge, and the construction of a new interchange between the freeway and Oxnard Boulevard, which would serve existing uses to the south of the interchange and this project site. A Supplemental EIR/EIS for this

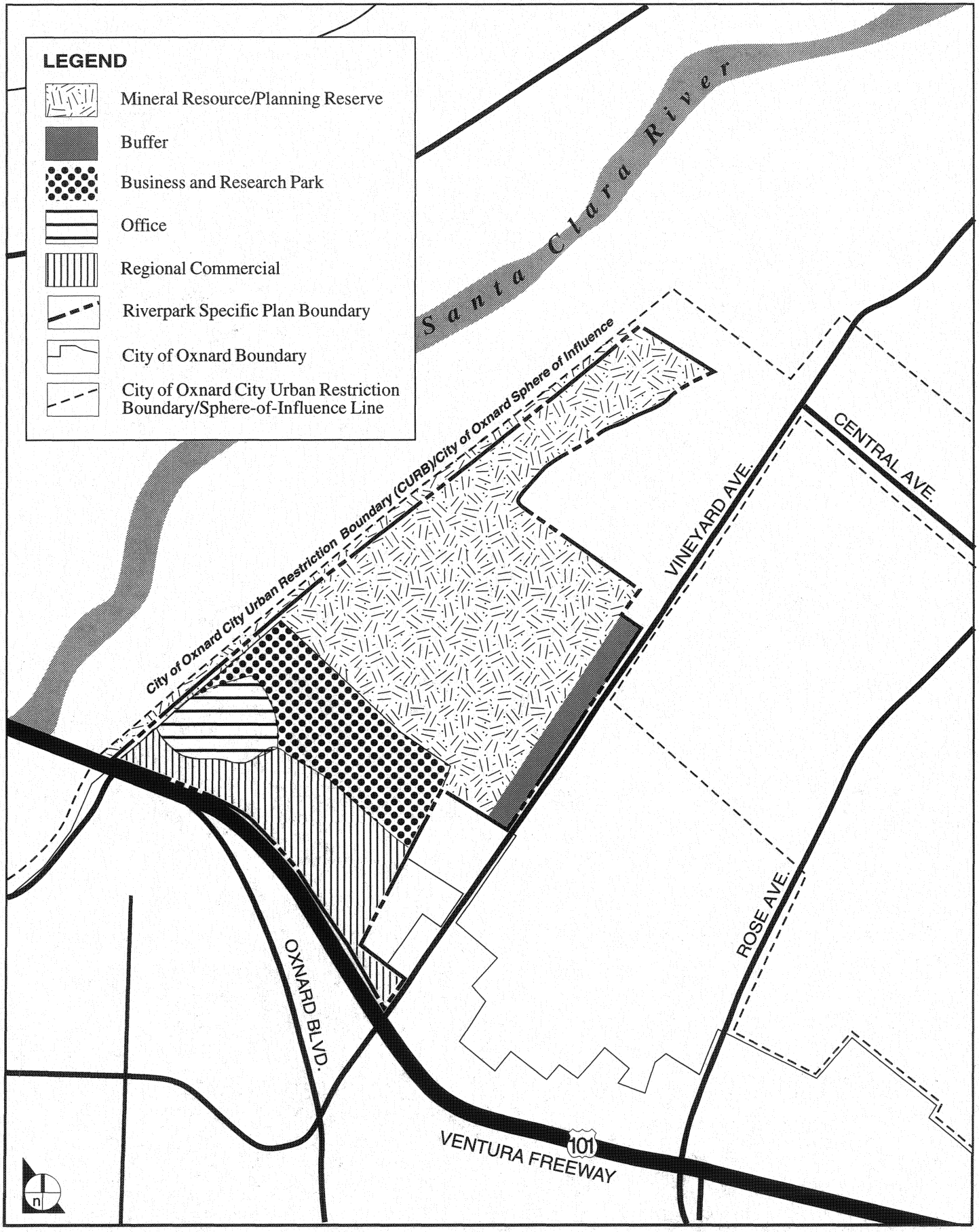


FIGURE 4

## Existing General Plan Land Use

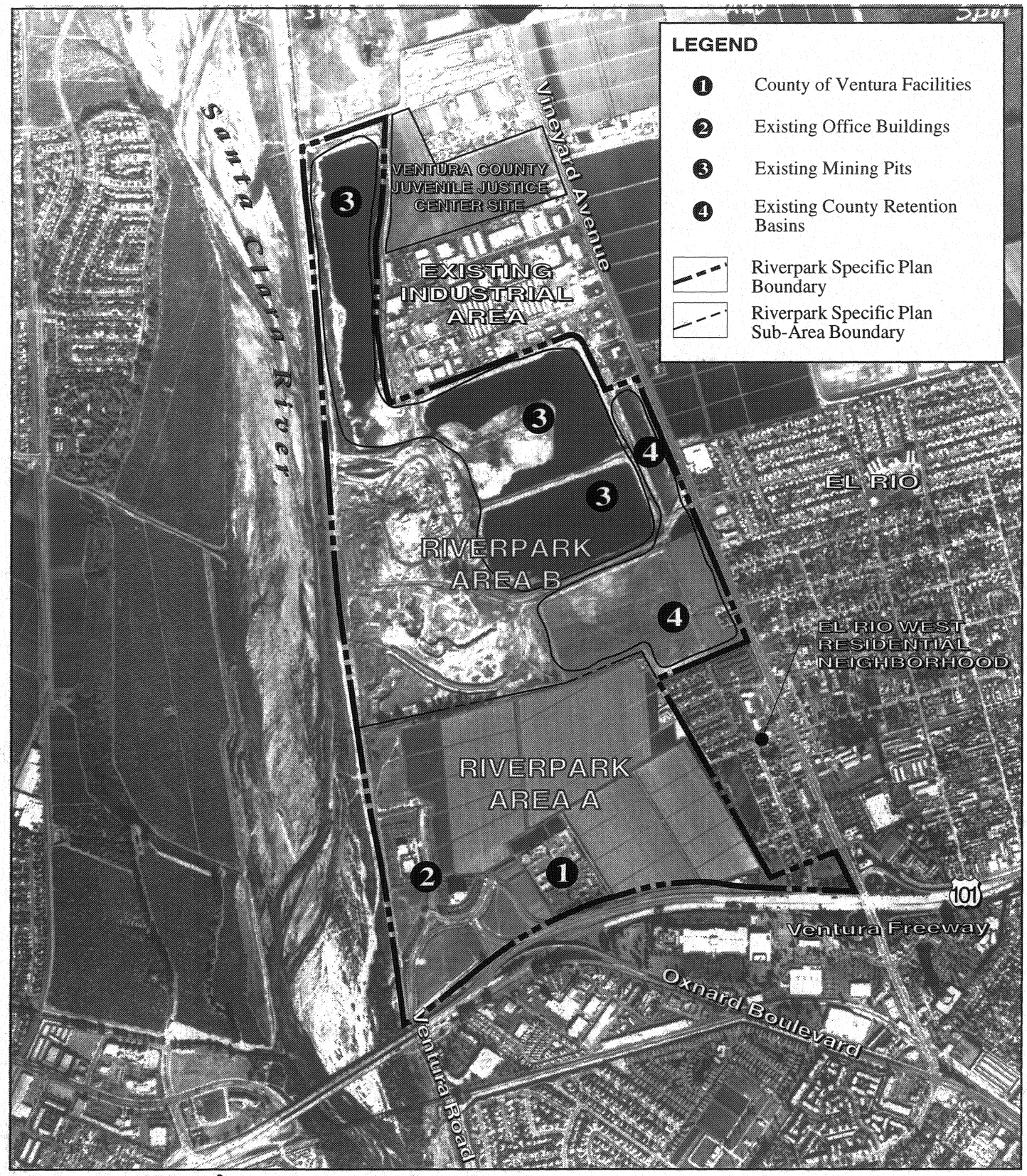


FIGURE 5

## Aerial Photograph

freeway improvement project was recently approved by Caltrans and the Federal Highway Administration.

Existing and planned land uses located immediately east and north of the project site are also identified on **Figure 5**. As shown, there are existing residential uses in the El Rio West neighborhood, located between the project site and Vineyard Avenue. This neighborhood also contains commercial uses fronting Vineyard Avenue and some vacant parcels. Currently, portions of this neighborhood are within the City of Oxnard and portions are outside of the City limits. Existing industrial uses are located to the north of the project site. In addition, the site of the planned County of Ventura Juvenile Justice Center is located north and east of the project site.

## PROJECT CHARACTERISTICS

The RiverPark Specific Plan (the "Specific Plan") is being prepared to guide the development of the project area as an integrated mixed-use community. One of the primary objectives of the proposed Specific Plan is to plan for the reclamation of the existing sand and gravel mine with appropriate open space uses that will be compatible with existing and planned surrounding land uses and ensure the protection of surface and groundwater quality.

The RiverPark Specific Plan is being developed concurrently with the EIR. The draft Specific Plan will be available for review at the same time the Draft EIR is released for public review. The Specific Plan will address all required items defined in Section 65451 of the Government Code including:

- Text and diagrams defining the distribution, location, and extent of the uses of land, including open space, within the area covered by the plan.
- Text and diagrams defining the proposed distribution, location, and extent of circulation, drainage, water and sewage facilities planned to support the land uses described in the plan.
- Standards and criteria by which development will proceed, including development standards, design guidelines and a phasing program.
- A program of implementation measures including regulations, programs and any necessary financing measures.

## REVISIONS TO THE PROJECT SINCE THE ISSUANCE OF THE MAY 2000 NOP

The City of Oxnard and the project applicants have consulted with interested public agencies about this proposed Specific Plan over the past year. In addition, environmental information has been collected and preliminary analysis has been completed. In response to comments from other public agencies and the

information collected to date, the proposed Specific Plan has been refined. A summary of the changes to the proposed project is presented below. A complete description of the project as currently proposed follows.

- The design of the proposed storm drain & water quality treatment system has been refined in response to comments from the United Water Conservation District (UWCD) and the County of Ventura.
- Additional land has been provided for school facilities to allow for development of a new elementary and middle school by the Rio School District. The site previously identified for school facilities has been enlarged by expanding this site eastward to Vineyard Avenue.
- The proposed reclamation plan for the existing mine site in RiverPark Area B has been revised to allow the existing mine pits to be used for groundwater recharge by the UWCD at some future date. The reclamation plan will now be approved and implemented by the City of Oxnard instead of the County of Ventura.
- Minor changes to the location and intensity of the proposed commercial and residential land uses have been made. Based on more detailed planning studies it has been determined that the size of the proposed Specific Plan Area is 694 acres, as opposed to 700 acres. The amount of land proposed for open space uses has increased slightly from 239 to 250 acres. The amount of land proposed for residential uses has decreased from 223 to 219 acres and the amount of proposed commercial land has decreased from 203 to 190 acres. The maximum number of residential units to be allowed by the proposed Specific Plan has been increased from 2,440 units to 2,761 units and the total amount of allowed commercial uses has increased from 2.95 to 3.00 million square feet.

**Proposed Land Uses**

The proposed RiverPark Specific Plan would allow the development of a new mixed-use community containing commercial, residential, recreation, education and open space uses within the proposed Specific Plan Area. The proposed land use plan for the project is presented in **Figure 6**. As shown, the Specific Plan is organized into 13 Planning Districts, designated by the letters A through M. Overall, the land use plan includes a unique mix of regional and community oriented commercial uses in the southern part of the Specific Plan Area and a new residential community to the north of the commercial uses. The existing mine pits would be reclaimed for use by the UWCD as basins for groundwater recharge. Native vegetation is proposed around the existing mine pits and along the western edge of the project to enhance the natural habitat values in the adjacent Santa Clara River. An open space network would link the various land use areas and facilitate pedestrian and bicycle circulation throughout the community. Mixed-use development is also proposed in some of the Planning Districts. In these mixed-use areas, second-story residential development would be allowed in the major Commercial Planning District and limited commercial uses would be allowed on the first floor of multi-family residential development in some of the residential Planning Districts. In addition, the proposed Specific Plan would provide for flexibility in the planned uses by allowing alternative uses in several of the Planning Districts subject to the approval of a Conditional Use Permit (CUP) by the City. A summary of the proposed land uses is provided in **Table 1** below.

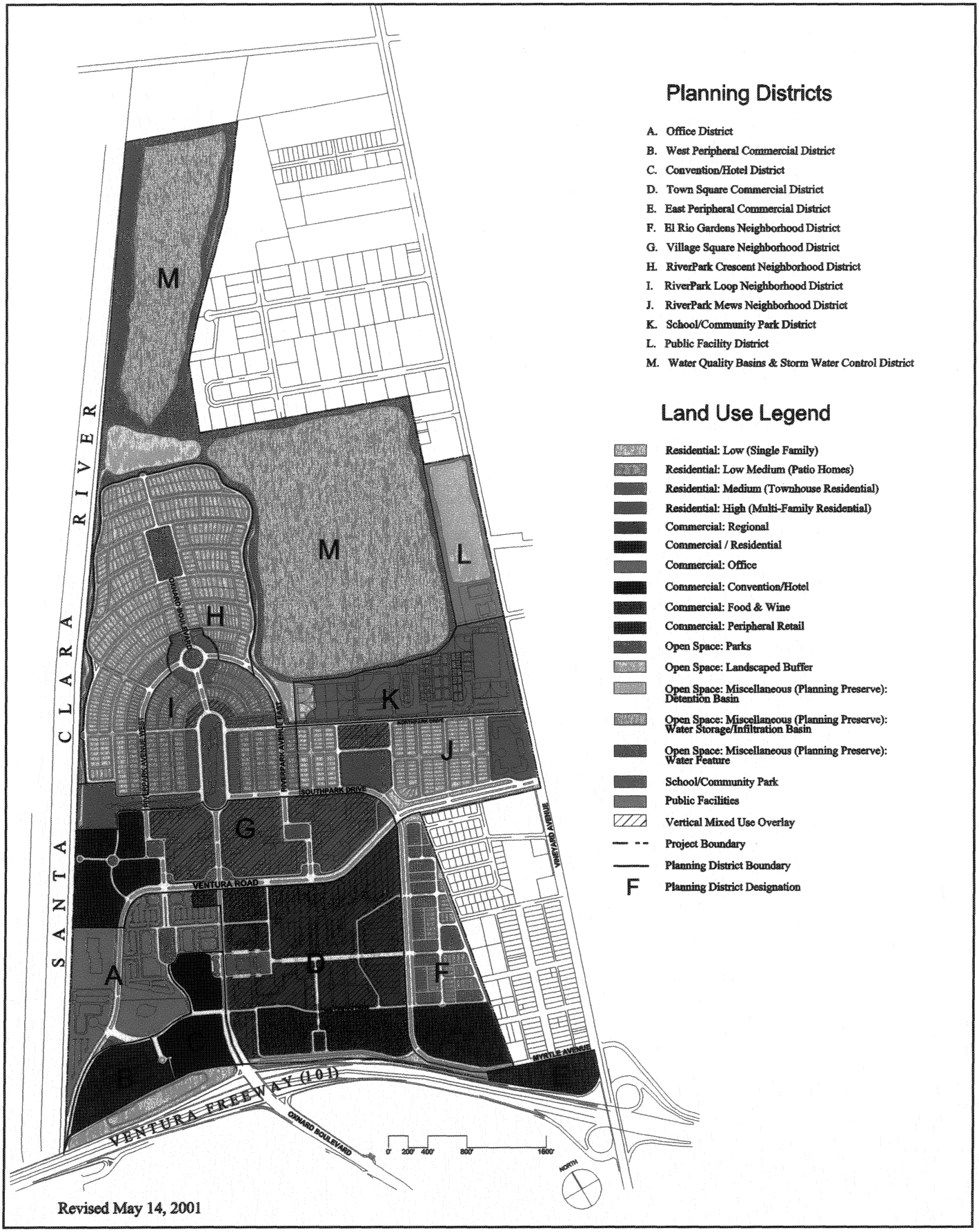


FIGURE 6

## Conceptual Land Use Plan

**Table 1**
**RiverPark Specific Plan**
**Summary of Proposed Land Uses**

| Uses | Acres | Sub-total | % | Amount | Sub-total |
|---|---|---|---|---|---|
| **Open Space Uses** | | **250** | **36%** | | |
| Water Quality Storage Basins | 125 | | | | |
| Trails & Maintenance Areas | 73 | | | | |
| Parks | 35 | | | | |
| Water Quality Control Basins | 13 | | | | |
| Landscape Buffers | 4 | | | | |
| **Residential Uses** | | **219** | **32%** | | **2,761 Units** |
| Single Family Residential | 97 | | | 582 Units | |
| Patio Homes | 43 | | | 391 Units | |
| Townhouse Residential | 21 | | | 311 Units | |
| Multi-Family | 58 | | | 1,127 Units | |
| Live/Work Units | N/A[1] | | | 350 Units | |
| **Commercial Uses** | | **190** | **27%** | | **3.0 million sq. ft.** |
| Office | 73 | | | 1,383,000 sq. ft. | |
| Retail & Entertainment | 82 | | | 955,000 sq. ft. | |
| Convention Center & Hotel | 15 | | | 510,000 sq. ft. | |
| Regional Retail Commercial | 20 | | | 195,000 sq. ft. | |
| **Public Facilities Uses** | | **35** | **5%** | | |
| Schools and Sports Fields | 31 | | | | |
| Public Facilities | 4 | | | | |
| **TOTAL** | **694** | | **100%** | | |

[1] The proposed specific plan allows development of up to 350 live/work units in second story space above commercial uses in the main commercial district

RiverPark Area A would contain a mix of retail commercial, commercial office, and hotel uses along the Ventura Freeway in Planning Districts A through G, with multi-family residential uses to the north in District G and various densities of residential uses to the east in District F. As previously discussed, development of approximately 4.4 million square feet of retail commercial uses in RiverPark Area A is currently allowed by the Oxnard Town Center Specific Plan. The proposed RiverPark Specific Plan would reduce the amount of commercial development allowed in RiverPark Area A by approximately 1.4 million square feet to 3.0 million square feet. In addition to general office and retail commercial development, uses in District D would include an entertainment-retail area emphasizing local and regional culture and interests. Development of up to 350 live/work units would be allowed on the second floors of buildings in this District. The Specific Plan also allows development of a 6,000-seat,

multi-use ballpark facility in this district, subject to the approval of a CUP. If the ballpark is developed in this district, the amount of the other allowed land uses in this district would be reduced by 10,000 square feet.

The Specific Plan would also allow, subject to approval of a Conditional Use Permit, additional multi-family residential development on the western end of District G and the southern end of District F if development of additional commercial uses in these locations is not viable from a market perspective.

RiverPark Area B would contain open space, residential and public facilities uses. The existing El Rio Detention Basin #2, located in Districts J and K, would be filled and reclaimed. Residential neighborhoods are proposed in Planning Districts H, I and J. Mixed-use commercial development would be allowed on the first floor of multi-family residential buildings in limited areas of Districts I and J. First floor commercial uses in multi-family residential buildings would also be allowed in District G.

District K is planned to contain new elementary and middle schools along with open space/parks that could be used by the City for organized sports leagues. District L would contain a water quality control basin and sites for a new City fire station and new administrative facilities for the Rio School District. District M contains the existing mine pits, which are proposed to be reclaimed for use as groundwater recharge basins subject to a new mine reclamation plan and the proposed Specific Plan. In addition, District M contains two water quality control basins.

The storm drain and water quality treatment system has been designed to accept and treat runoff from off-site tributary areas to the north and east of the Specific Plan Area and the residential neighborhoods in District H. This system has been designed to retain all first flush storm runoff. Runoff from larger storm events, up to a 10-year storm, will be treated by conveyance through dry swales and discharged to the existing Stroube Street drain system located in RiverPark Area A. This existing master-planned storm drain outlets to the Santa Clara River at the southwestern corner of the Specific Plan Area. Runoff from storm events larger than a 10-year frequency storm will be discharged into the existing mine pits. This drainage and water quality treatment system has been designed to protect the quality of the exposed groundwater in the existing mine pits and the surface water in the Santa Clara River.

**Proposed Project Actions**

At this time, the City of Oxnard has identified the following actions that will need to be taken by the City of Oxnard, acting as Lead Agency for this project, and Responsible Agencies identified to date.

*City of Oxnard*

The City of Oxnard will consider approval of the following actions to allow implementation of the proposed project:

- Approval of a General Plan Amendment consisting of changes to the 2020 General Plan Land Use Map designations for the project area and text changes to the definition of land use categories in the Land Use Element. The proposed revisions to the Land Use Map would change the existing designations of Regional Commercial, Office, Limited Industrial, Buffer, and Mineral Resource/Planning Reserve to Open Space/Miscellaneous, Open Space/Parks, Regional Commercial, Regional Commercial with a mixed use overlay, Public/Semi Public, Schools, Residential – Low, Residential – Low Medium, Residential – Medium, and Residential – High. Minor changes to the Regional Commercial, High Density Residential, and Public/Semi Public land use category definitions are also proposed to allow for additional flexibility within master planned projects subject to an adopted Specific Plan.
- Adoption the proposed RiverPark Specific Plan by ordinance.
- Approval of a new Reclamation Plan for the existing sand and gravel mine in RiverPark Area B.
- Initiate annexation of RiverPark Area B.
- Approval of a Tentative Tract Map for the Specific Plan Area.
- Approval of a Development Agreement with the Applicant.
- Approval of a Code Amendment related to the City's existing Multiplex Theater Ordinance to allow these facilities within master planned projects subject to an adopted Specific Plan.

*City of Oxnard Community Development Commission*

The City of Oxnard Community Development Commission, acting as a Responsible Agency, will consider approval of the following action to allow implementation of the proposed project:

- Approval of an Owner Participation Agreement for RiverPark Area A.

*Ventura County Local Agency Formation Commission (LAFCO)*

The Ventura County LAFCO, acting as a Responsible Agency, will consider approval of the following action to allow implementation of the proposed project:

- Annexation of RiverPark Area B to the City of Oxnard.

This EIR is also intended to serve as the primary source of environmental information for Trustee Agencies having jurisdiction over natural resources that may be affected by the project including, but not limited to, the following:

- California Department of Fish & Game
- State Mining and Geology Board
- Los Angeles Regional Water Quality Control Board

## TOPICS IDENTIFIED FOR STUDY IN THIS EIR

The City of Oxnard completed a preliminary review of the proposed project, as described in Section 15060 of the CEQA Guidelines, and has determined that an EIR should be prepared for the project. The scope of work for this EIR will involve research, analysis, and study of all environmental topics identified in Appendix G of the CEQA Guidelines. For this reason, no Initial Study has been prepared. The probable environmental effects of this proposed project and the proposed scope of study are identified in an attachment to this notice.

The City of Oxnard will consider the comments received in response to this Revised Notice of Preparation along with the comments received on the May 2000 NOP issued for this project in making a final determination of the scope and content of the EIR for this project. Any comments provided should identify specific topics of environmental concern and your reason for suggesting the study of these topics in the EIR.

Please provide your comments in writing by July 12, 2001 to:
Gary Y. Sugano, Senior Associate Planner
City of Oxnard
Planning and Environmental Services Division
305 West Third Street
Oxnard, CA 93030

Thank you for your participation in the environmental review of this project.

# PROBABLE ENVIRONMENTAL EFFECTS

## City of Oxnard
## RiverPark Specific Plan EIR

The City of Oxnard has reviewed the proposed project and identified the following probable environmental effects for study in the EIR:

Land Use and Planning - The EIR will evaluate the consistency of the proposed changes in the existing and planned land uses in the project area with applicable local and regional land use plans and policies. Consistency with the City's 2020 General Plan and the Oxnard Community Development Commission's Historic Enhancement and Revitalization of Oxnard Redevelopment Plan will be analyzed as will the consistency of the project with the Southern California Association of Governments Regional Comprehensive Plan & Guide. The relationship of the proposed project to the general plans of the City and County of Ventura will also be addressed. The consistency of the proposed annexation with applicable State laws and Ventura County LAFCO policies will also be provided. The compatibility of the proposed uses with existing and planned surrounding land uses will also be analyzed.

Aesthetics - Analysis of this topic will address the change in the visual character of the project site as viewed from surrounding neighborhoods, communities, streets and highways, and the visual character of the project as viewed from within the site. Potential light & glare and shade & shadow impacts will be addressed as will the consistency of the project with the policies in the Community Design Element of the General Plan.

Population and Housing - Analysis of the consistency of the project with adopted local and regional demographic projections and housing policies will be provided.

Transportation & Traffic - A comprehensive traffic analysis will be prepared for the project in accordance with the City's Traffic Impact Study Guidelines based on information generated by the City of Oxnard Computer Transportation Model. Changes in roadway and intersection traffic volumes will be studied at all roadway facilities in the area that may be significantly impacted by traffic that would be generated by the project. Impacts on transit service in the area will also be addressed. The traffic study will evaluate the relationship of the proposed circulation plan for the Specific Plan area with the improvements currently planned for the Ventura Freeway in this area. The City of Oxnard has consulted with both the City of Ventura and the County of Ventura regarding the scope of the traffic study.

Air Quality - The impacts of the project on air quality will be evaluated in accordance with the *Guidelines for the Preparation of Air Quality Impact Analyses* prepared by the Ventura County Air Pollution Control District. Specific items that will be addressed will include short term construction related impacts; long term operational impacts; any contribution to a carbon monoxide hot spot along streets and highways; consistency with the Air Quality Management Plan; and any potential impacts related to emissions from existing and planned surrounding uses.

Noise - Short term construction noise impacts that may effect existing and planned surrounding land uses will be evaluated along with the change in roadway noise levels that will result from the additional traffic that would be generated by the project. Noise associated with the proposed uses will also be assessed. Any potential impacts to the planned land uses from noise sources associated with surrounding land uses will also be addressed.

Earth Resources - The EIR will address the existing geologic and soils conditions on the site and the suitability of the site for development of the proposed uses. In addition, this section of the EIR will address the impact of the project on the sand and aggregate mineral resources present in RiverPark Area A.

Agricultural Resources – RiverPark Area A includes agricultural land. This section of the EIR will examine the existing soils characteristics and agricultural production occurring on this land and the direct and indirect impacts of converting this agricultural land to urban uses.

Hydrology and Water Quality - Comprehensive studies of potential impacts to ground and surface water quality and the hydrology and drainage characteristics of the area are being prepared. These studies are addressing the impacts of the changes to the existing drainage patterns and facilities and the impacts of the proposed reclamation plan for the mine pits. The effects of the project on groundwater recharge volume is also being studied. These studies will address the planned use of the pits for groundwater recharge by the UWCD. In order to use the pits as recharge basins, UWCD will need to build and operate conveyance channels and related facilities to bring water from the existing Freeman Diversion project to the mine pits. UWCD will be studying the environmental effects of these off-site facilities in a separate environmental document. This EIR will assess the impact of the use of pits for groundwater recharge.

Biological Resources - The project site consists of areas disturbed for mining, agriculture, urban development and construction of a detention basin. As a result of these existing conditions, the project site will result in impacts to small areas of native vegetation present within the Specific Plan Area. The existing mining pits and agricultural drainage ditches do not qualify as jurisdictional wetland features. The EIR will address the potential direct impact of the project on native vegetation and wildlife present on the site and the indirect effects of the project on the biological resources in the adjacent Santa Clara River, including the potential beneficial effects of the proposed native revegetation program.

Public Services - The EIR will address the needs of the project for police, fire, solid waste disposal, recreation and other public services from the City of Oxnard, and the ability of the City to meet this increased demand for services. The increased demand for school services provided by the Rio Elementary and Oxnard Union High School District will also be analyzed.

Utilities and Service Systems - The impacts of the project on existing and planned sewer, water and storm drain facilities in the area will be evaluated along with potential impacts to electric, natural gas and communication service systems in the area and available energy supplies.

Cultural Resources – A Phase I Archeaological Resource Study and a Historic Resources Study have been completed for the Specific Plan Area. These studies will be incorporated into the EIR.

Hazards & Hazardous Materials – This section will address the presence of any existing hazardous materials within the proposed Specific Plan Area and surrounding areas and any potential impacts.

Other Required Sections – The EIR will also address all other topics required by the CEQA Guidelines including Cumulative Impacts, Significant Effects Which Cannot be Avoided, Significant Irreversible Environmental Changes Which Would be Caused by the Proposed Project, Growth Inducing Impacts, Alternatives, and Mandatory Findings of Significance.

## Comment Letters on the June 12, 2001, Revised Notice of Preparation

## Comment Letters Received on the June 12, 2001, Revised RiverPark NOP


State of California Governor's Office of Planning and Research ..... June 20, 2001
The Gas Company ..... June 20, 2001
Southern California Association of Governments ..... June 22, 2001
California Regional Water Quality Control Board, Los Angeles Region ..... June 25, 2001
County of Ventura Resource Management Agency, Planning Division ..... June 27, 2001
State of California Department of Transportation ..... June 28, 2001
Ventura County Office of Agricultural Commissioner ..... June 28, 2001
State of California Native American Heritage Commission ..... July 5, 2001
Ventura County Air Pollution Control District ..... July 9, 2001
County of Ventura Public Works Agency, Flood Control Department ..... July 11, 2001
County of Ventura Resource Management Agency, Planning Division ..... July 12, 2001
Department of Toxic Substances Control ..... July 19, 2001
County of Ventura Public Works Agency, Transportation Department ..... July 20 and 24, 2001
United States Department of the Interior, Fish and Wildlife Service ..... August 29, 2001

The Gas Company®

RECEIVED
MAY 15 2000
PLANNING DIVISION
CITY OF OXNARD

May 10, 2000

Mr. Gary Sugano
CITY OF OXNARD
Planning and Environmental
305 West Third Street
Oxnard, CA 93030

**Southern California Gas Company**
*9400 Oakdale Avenue*
*Chatsworth, CA*
*91313-2300*

*Mailing Address:*
*Box 2300*
*Chatsworth, CA*
*91313-2300*

Subject: **Agency Comment Letter for NOP of DEIR for RiverPark Specific Plan, City of Oxnard, County of Ventura (Gas Atlas # VCO 1494, et.al.)**

This letter is not to be interpreted as a contractual commitment to serve this proposed project, but only as an information service. Its intent is to notify you that Southern California Gas Company, the sole utility provider of natural gas in this area, has facilities in the area where this project is proposed.. Gas service can be provided **without** significant impact on the environment and **without** additional conditions from **medium pressure mains in existing dedicated streets.**

Service would be in accordance with our policies and extension rules on file with the California Public Utilities Commission at the time contractual arrangements are made. The availability of natural gas service, as set forth in this letter, is based on present conditions of gas supply and regulatory policies. As a public utility, Southern California Gas Company is under the jurisdiction of the California Public Utilities Commission. We can also be affected by actions of federal regulatory agencies. Should these agencies take any action which affects gas supply or the condition under which service is available, gas service will be provided in accordance with the revised conditions.

When your project has final approval by the city or county engineer, please contact Mr. Dave Conway,New Business Project Manager at **(805) 385-4823**. It may require up to 90 days to process your application for the installation of gas lines in your project.

Sincerely,

Jim Hammel
Technical Services, Northern Region
818-701-3324
FAX: 818-701-3380

c: D. Conway, NBPM, Oxnard District
B. Huleis, Environmental Compliance
E. Wiegman, Engineering/Masterplan
City Correspondence File

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STATE OF CALIFORNIA

# Governor's Office of Planning and Research

## State Clearinghouse

Gray Davis
GOVERNOR

Steve Nissen
ACTING DIRECTOR

RECEIVED
MAY 17 2000
PLANNING DIVISION
CITY OF OXNARD

**Notice of Preparation**

May 12, 2000

To: Reviewing Agencies

Re: RiverPark Specific Plan
SCH# 2000051046

Attached for your review and comment is the Notice of Preparation (NOP) for the RiverPark Specific Plan draft Environmental Impact Report (EIR).

Responsible agencies must transmit their comments on the scope and content of the NOP, focusing on specific information related to their own statutory responsibility, within 30 days of receipt of the NOP from the Lead Agency. This is a courtesy notice provided by the State Clearinghouse with a reminder for you to comment in a timely manner. We encourage other agencies to also respond to this notice and express their concerns early in the environmental review process.

Please direct your comments to:

**Gary Y. Sugano**
**City of Oxnard**
**305 West Third Street**
**Oxnard, CA 93030**

with a copy to the State Clearinghouse in the Office of Planning and Research. Please refer to the SCH number noted above in all correspondence concerning this project.

If you have any questions about the environmental document review process, please call the State Clearinghouse at (916) 445-0613.

Sincerely,

Scott Morgan

Scott Morgan
Project Analyst, State Clearinghouse

Attachments
cc: Lead Agency

# Document Details Report
# State Clearinghouse Data Base

**SCH#** 2000051046
**Project Title** RiverPark Specific Plan
**Lead Agency** Oxnard, City of

**Type** nop Notice of Preparation

**Description** The proposed project consists of a proposed Specific Plan to regulate the use of land within an approximate 700-acre area located immediately north of the Ventura Freeway (US 101) between Vineyard Avenue (SR 232) and the Santa Clara River. Various land uses are proposed within the Specific Plan Area including residential, commercial, public facilities and open space uses.

## Lead Agency Contact

**Name** Gary Y. Sugano
**Agency** City of Oxnard
**Phone** 805-984-4658 **Fax**
**email**
**Address** 305 West Third Street
**City** Oxnard **State** CA **Zip** 93030

## Project Location

**County** Ventura
**City** Oxnard
**Region**
**Cross Streets** US 101/Vineyard Avenue/Santa Clara River/SR 232
**Parcel No.**
**Township** **Range** **Section** **Base**

## Proximity to:

**Highways** US 101/SR 232
**Airports**
**Railways**
**Waterways** Santa Clara River
**Schools**
**Land Use** Regional Commercial, Commercial Office, Business and Research Park Uses, Open Space-Mineral/Open Space-Buffer, Public Facilities

**Project Issues** Landuse; Aesthetic/Visual; Population/Housing Balance; Traffic/Circulation; Air Quality; Noise; Geologic/Seismic; Water Quality; Public Services; Drainage/Absorption; Wetland/Riparian; Agricultural Land; Sewer Capacity; Vegetation; Solid Waste; Soil Erosion/Compaction/Grading

**Reviewing Agencies** Resources Agency; California Coastal Commission; Department of Conservation; Department of Parks and Recreation; Department of Water Resources; Department of Fish and Game, Region 5; Native American Heritage Commission; State Lands Commission; Santa Monica Mountains Conservancy; Caltrans, District 7; California Highway Patrol; State Water Resources Control Board, Division of Water Rights; Regional Water Quality Control Board, Region 4

**Date Received** 05/12/2000 **Start of Review** 05/12/2000 **End of Review** 06/12/2000

Note: Blanks in data fields result from insufficient information provided by lead agency.

# NOP Distribution List

SCH# 2000051046

### Resources Agency

[X] **Nadell Gayou**
*Resources Agency*
1020 Ninth Street, Third Floor
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[ ] **Bill Curry**
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[ ] **Steve McAdam**
*S.F. Bay Conservation & Dev't. Comm.*
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[X] **Nadell Gayou**
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### Health & Welfare

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916/445-2519 Fax 916/327-6092

### Food & Agriculture

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### Fish and Game

[ ] **Joe Vincenty**
Department of Fish and Game
Environmental Services Division
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- ( ) **Rob Rogen** (airport projects)
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- ( ) **Redding Branch Office**
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  Redding, CA 96002
  530/224-4845 Fax 530/224-4857

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- ( ) **Victorville Branch Office**
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  Victorville, CA 92392-2359
  760/241-6583 Fax 760/241-7308

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Palm Desert, CA 92260-2564
760/346-7491 Fax 760/341-6820

[ ] **Santa Ana Region (8)**
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909/782-4130 Fax 909/781-6288

[ ] **San Diego Region (9)**
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San Diego, CA 92124-1331
858/467-2952 Fax 858/571-6972

SCAT
South Coast Area Transit

Committed to a Cleaner Environment

May 15, 2000

Mr. Gary Sugano, Sr. Associate Planner
Planning and Environmental Services Division
City of Oxnard
305 W. Third St.
Oxnard, CA 93030

RECEIVED
MAY 17 2000
PLANNING DIVISION
CITY OF OXNARD

Re: RiverPark Specific Plan

Dear Mr. Sugano:

The RiverPark Specific Plan as outlined in the Notice of Preparation dated May 9, 2000 outlines an extensive development in the area north of the Highway 101/Santa Clara River area. Although this area is not currently served by South Coast Area Transit (SCAT), it is in approximation to our El Rio bus service route. We subsequently anticipate there will be substantial demand for public transit as the project anticipates over 2,000 dwelling units and over 2.4 million sq. ft. of office and commercial development.

This is a very substantial project and we would anticipate that the City of Oxnard would include not only adequate roadway access for heavy-duty Compressed Natural Gas (CNG) buses, but enhanced street furniture necessary to facilitate the public's use of not only fixed route but paratransit bus service. Any and all facilitation for the use of public transit is anticipated in the preparation of this Draft Environmental Impact Report (DEIR). Such accommodation for preferential signalization, bus "cut outs" that would remove heavy-duty buses from any arterials or high speed service streets are examples of the foregoing. Accommodation for the physically and developmentally challenged is imperative in any development especially with such that would improve mobility through the use of public transit.

We anticipate the project would include any and all of the latest facilities' development that encourage use of alternative forms of transportation. Should you have any questions, please feel free to contact myself or SCAT's Director of Planning and Marketing, Ms. Laura J. Caskey.

Sincerely,

Peter G. Drake
General Manager

PGD/ph

CC: Mayor Manuel Lopez, SCAT Board Chair

301 East Third Street, Oxnard, CA 93030 ▪ Post Office Box 1146, Oxnard, CA 93032-1146
805-487-4222 or 805-643-3158 ▪ FAX 805-487-0925 ▪ www.scat.org

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STATE OF CALIFORNIA
GRAY DAVIS, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

May 16, 2000

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MAY 18 2000
PLANNING DIVISION
CITY OF OXNARD

File No. 183/56/E-405.7
Vineyard Avenue
Ventura County

Marilyn Miller, AICP
Planning & Environmental Services Manager
Oxnard Planning Commission
305 West Third Street
Oxnard, CA 93030

Dear Ms. Miller:

This is in response to your Notice of Preparation of a Draft Environment Impact Report for the RiverPark Specific Plan. We have reviewed your project description and note that the Union Pacific Railroad Company operates within the proposed project area. In view of this, the staff will be concerned with the traffic and circulation impacts as they relate to the railroad-highway grade crossings in the area. Specifically, we will be concerned with traffic volumes, circulation patterns, level of service, accident potential, safety hazards and any other impacts, which may affect any grade crossing or train operation in the area.

Thank you for allowing us the opportunity to comment on this matter.

Very truly yours,

(SONIA)

**Sonia Newell**
Utilities Engineer
Rail Safety and Carriers Division

**OXNARD UNION HIGH SCHOOL DISTRICT**
**BUSINESS SERVICES DEPARTMENT**
**309 South K Street**
**Oxnard, California 93030**
**(805) 385-2529**
**Fax (805) 483-3069**

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MAY 18 2000
PLANNING DIVISION
CITY OF OXNARD

May 17, 2000

Mr. Gary Sugano, Senior Associate Planner
Planning and Environmental Services Division
City of Oxnard
305 West Third Street
Oxnard, California 93030

Dear Mr. Sugano:

I am writing this letter in response to the Notice of Preparation of a Draft Environmental Impact Report for River Park Specific Plan.

Obviously, a project of this size will have an enormous impact on the Oxnard Union High School District. The high school students generated by this project would attend Rio Mesa High School, located at 545 Central Avenue, Oxnard, California 93030. The projected enrollment for RMHS for school year 2000-01 is 2,500 students. The design capacity for the school is approximately 2,250 students.

Pacifica High School, an OUHSD growth school, is under construction at this time and is scheduled to open in the fall of 2001. PHS is scheduled to relieve overcrowding on all five existing OUHSD comprehensive high schools. At its opening, PHS could be filled to its design capacity and all of the other OUHSD schools would still be at or over their respective design capacities.

Based upon the information provided by your NOP of the draft EIR, and using OUHSD's student generation factors, we would anticipate at its completion, the River Park project would generate 371 additional high school students who would attend RMHS.

Obviously, this would create a negative impact on the already overcrowded schools in the OUHSD. The OUHSD is aware of projects planned or in progress in the cities of Oxnard, Hueneme and Camarillo that will generate 1,218 high school students in the next two to three years and a total of 2,498 new students by the year 2005.

The only known mitigation for this type of increase in student population is the construction of new high schools. As previously mentioned, PHS is scheduled to open in the fall of 2001. Another new growth school is being planned for construction in the City of Camarillo.

Because the OUHSD has met the conditions of the law (SB 50), it presently levies both Level 1 and Level 2 developer fees. This is an indication of the serious concerns the OUHSD faces regarding any new housing developments.

Please note the OUHSD's concerns with the proposed project and the number of students that will be generated by said project.

Sincerely,

Eric M. Ortega
Assistant Superintendent-Business Services

EMO/cz
xc: Bill Studt
Lou Cunningham

5-17-00

RECEIVED
MAY 24 2000
PLANNING DIVISION
CITY OF OXNARD

City of Oxnard
305 W. 3rd Street
Oxnard, Ca. 93030
Att: Gary Sugano

Dear Gary:

Regarding the "Riverpark Specific Plan" project, I would like to give notice of interest in this project.
I am a Ventureno/Barbareno Chumash with extensive background in cultural resources.
I have some concerns for impact to village sites in the area in question. We have literally dozens of sites in the area and as we are talking about river property, it is bound to be culturally significant.
Our villages were not widely scattered but were, in most instances, inter-linked along the coast and inland for more than 100 miles so it is conceivable that this project could be detrimental to sacred Chumash lands.
Preservation is of the utmost importance and many times preservation means covering over with concrete to protect what remains and I would like some assurances that there would indeed be a Chumash monitor on site throughout the grading process.
I would make myself available for this project as I am a resident of the City of Oxnard and as well, I am recognized by the Native American Heritage Commission as a Most Likely Descendant to the Ventura and Santa Barbara County areas.
If you should need further information, please don't hesitate to call me at the number listed below.
I thank you in advance for your attention in this matter.

In good spirit,

R. Washti

Regina Washtiqoliqol
2431 Miramar Pl.
Oxnard, Ca. 93035
(805) 984-2519

SOUTHERN CALIFORNIA

ASSOCIATION of GOVERNMENTS

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**San Bernardino County:** Kathy Davis, San Bernardino County • Bill Alexander, Rancho Cucamonga • Jim Bagley, Twentynine Palms • David Eshleman, Fontana • Lee Ann Garcia, Grand Terrace • Gwenn Norton Perry, Chino Hills • Judith Valles, San Bernardino

**Ventura County:** Judy Mikels, Ventura County • Donna De Paola, San Buenaventura • Glen Becerra, Simi Valley • Toni Young, Port Hueneme

**Riverside County Transportation Commission:** Robin Lowe, Hemet

**Ventura County Transportation Commission:** Bill Davis, Simi Valley

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May 19, 2000

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MAY 22 2000

PLANNING DIVISION
CITY OF OXNARD

Mr. Gary Sugano
Senior Associate Planner
Planning and Environmental Services Division
City of Oxnard
305 West Third Street
Oxnard, CA 93030

RE: **Comments on the Notice of Preparation for a Draft Environmental Impact Report for the RiverPark Specific Plan – SCAG No. I 20000229**

Dear Mr. Sugano:

Thank you for submitting the **Notice of Preparation for a Draft Environmental Impact Report for the RiverPark Specific Plan** to SCAG for review and comment. As areawide clearinghouse for regionally significant projects, SCAG assists cities, counties and other agencies in reviewing projects and plans for consistency with regional plans.

In addition, The California Environmental Quality Act requires that EIRs discuss any inconsistencies between the proposed project and the applicable general plans and **regional plans (Section 15125 [d])**. If there are inconsistencies, an explanation and rationalization for such inconsistencies should be provided.

Policies of SCAG's Regional Comprehensive Plan and Guide, which may be applicable to your project, are outlined in the attachment. **We expect the Draft EIR to specifically cite the appropriate SCAG policies and address the manner in which the Project is consistent with applicable core policies or supportive of applicable ancillary policies. Please use our policy numbers to refer to them in your Draft EIR. Also, we would encourage you to use a side-by-side comparison of SCAG policies with a discussion of the consistency or support of the policy with the Proposed Project.**

Please provide a minimum of 45 days for SCAG to review the Draft EIR when this document is available. If you have any questions regarding the attached comments, please contact Jeffrey Smith, Senior Planner, at (213) 236-1867. Thank you.

Sincerely,

J. DAVID STEIN
Manager, Performance Assessment and Implementation

**COMMENTS
ON THE PROPOSAL TO DEVELOP A
DRAFT ENVIRONMENTAL IMPACT REPORT
FOR THE
RIVERPARK PLAN
SCAG NO. I 20000229**

## PROJECT DESCRIPTION

The purpose of the proposed Project is to facilitate the development of a complimentary and successful pattern of land uses that will occur over a period of time. The proposed Project would allow for a new integrated mixed-use community containing residential commercial, open space and public facility uses. A system of roadways and a network of open spaces would link the proposed uses.

The Project area encompasses 700 acres. Approximately 272 acres of the Project area are located within the City of Oxnard. This portion of the project area is referred to as "RiverPark Area A." The remaining 428 acres of the site are currently located outside of the City of Oxnard. This portion of the project area is referred to as "RiverPark Area B." The Project area is generally located north of the Ventura Freeway (US 101), between Vineyard Avenue and the Santa Clara River in the City of Oxnard.

## CONSISTENCY WITH REGIONAL COMPREHENSIVE PLAN AND GUIDE POLICIES

The **Growth Management Chapter (GMC)** of the Regional Comprehensive Plan and Guide (RCPG) contains the following policies that are particularly applicable and should be addressed in the Draft EIR for the RiverPark Specific Plan.

*3.01 The population, housing, and jobs forecasts, which are adopted by SCAG's Regional Council and that reflect local plans and policies, shall be used by SCAG in all phases of implementation and review.*

Regional Growth Forecasts

The Draft EIR should reflect the most current SCAG forecasts which are the 1998 RTP (April 1998) Population, Household and Employment forecasts for the Ventura Council of Governments (VCOG) subregion and the City of Oxnard. These forecasts follow:

| VCOG Subregion Forecasts | 2000 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| Population | 712,800 | 745,000 | 804,300 | 861,700 | 932,900 |
| Households | 237,500 | 252,400 | 274,700 | 297,500 | 326,400 |
| Employment | 306,600 | 343,200 | 394,800 | 438,200 | 485,600 |

| City of Oxnard Forecasts | 2000 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| Population | 151,700 | 156,700 | 166,000 | 174,900 | 186,900 |
| Households | 42,200 | 44,400 | 47,600 | 50,900 | 55,000 |
| Employment | 42,300 | 49,100 | 58,800 | 66,900 | 75,800 |

*3.03 The timing, financing, and location of public facilities, utility systems, and transportation systems shall be used by SCAG to implement the region's growth policies.*

## REGIONAL TRANSPORTATION PLAN POLICIES

The **Regional Transportation Plan** (RTP) also has policies pertinent to this proposed project. This chapter links the goal of sustaining mobility with the goals of fostering economic development, enhancing the environment, reducing energy consumption, promoting transportation-friendly development patterns, and encouraging fair and equitable access to residents affected by socio-economic, geographic and commercial limitations. Among the relevant policies of this chapter are the following:

Core Regional Transportation Plan Policies

*4.01 Transportation investments shall be based on SCAG's adopted Regional Performance Indicators.*

*Mobility - Transportation Systems should meet the public need for improved access, and for safe, comfortable, convenient and economical movements of people and goods.*

- *Average Work Trip Travel Time in Minutes – 22 minutes*
- *PM Peak Highway Speed – 33 mph*
- *Percent of PM Peak Travel in Delay (All Trips) – 33%*

*Accessibility - Transportation Systems should ensure the ease with which opportunities are reached. Transportation and land use measures should be*

*employed to ensure minimal time and cost.*

- *Work Opportunities within 25 Minutes – 88%*

*Environment - Transportation Systems should sustain development and preservation of the existing system and the environment. (All Trips)*

- *Meeting Federal and State Standards – Meet Air Plan Emission Budgets*

*Reliability - Reasonable and dependable levels of service by mode. (All Trips)*

- *Transit – 63%*
- *Highway – 76%*

*Safety - Transportation Systems should provide minimal, risk, accident, death and injury. (All Trips)*

- *Fatalities Per Million Passenger Miles – 0.008*
- *Injury Accidents – 0.929*

*Livable Communities - Transportation Systems should facilitate Livable Communities in which all residents have access to all opportunities with minimal travel time. (All Trips)*

- *Vehicle Trip Reduction – 1.5%*
- *Vehicle Miles Traveled Reduction – 10.0%*

*Equity - The benefits of transportation investments should be equitably distributed among all ethnic, age and income groups. (All trips)*

- *Low-Income (Household Income $12,000)) Share of Net Benefits – Equitable Distribution of Benefits*

*Cost-Effectiveness - Maximize return on transportation investment. (All Trips)*

- *Net Present Value – Maximum Return on Transportation Investment*
- *Value of a Dollar Invested -- Maximum Return on Transportation Investment*

*4.02 Transportation investments shall mitigate environmental impacts to an acceptable level.*

*4.04 Transportation Control Measures shall be a priority.*

*4.06 Implementing transit restructuring, including Smart Shuttles, freight improvements, advanced transportation technologies, airport ground access and traveler information services are RTP priorities.*

*4.11 All existing and new public transit services, facilities and/or systems shall evaluate the potential for private sector participation through the use of competitive*

*procurement.*

*4.12 New freeway facilities shall be open for goods movement except where safety prohibits this.*

*4.16 Maintaining and operating the existing transportation system will be a priority over expanding capacity.*

*4.17 Alternatives to highway expansion must be evaluated before giving regional approval to expand single occupancy lanes.*

## GMC POLICIES RELATED TO THE RCPG GOAL TO IMPROVE THE REGIONAL STANDARD OF LIVING

The Growth Management goals to develop urban forms that enable individuals to spend less income on housing cost, that minimize public and private development costs, and that enable firms to be more competitive, strengthen the regional strategic goal to stimulate the regional economy. The evaluation of the proposed project in relation to the following policies would be intended to guide efforts toward achievement of such goals and does not infer regional interference with local land use powers.

*3.04 Encourage local jurisdictions' efforts to achieve a balance between the types of jobs they seek to attract and housing prices.*

*3.05 Encourage patterns of urban development and land use, which reduce costs on infrastructure construction and make better use of existing facilities.*

*3.08 Encourage subregions to define an economic strategy to maintain the economic vitality of the subregion, including the development and use of marketing programs, and other economic incentives, which support attainment of subregional goals and policies.*

*3.09 Support local jurisdictions' efforts to minimize the cost of infrastructure and public service delivery, and efforts to seek new sources of funding for development and the provision of services.*

*3.10 Support local jurisdictions' actions to minimize red tape and expedite the permitting process to maintain economic vitality and competitiveness.*

## GMC POLICIES RELATED TO THE RCPG GOAL TO IMPROVE THE REGIONAL QUALITY OF LIFE

The Growth Management goals to attain mobility and clean air goals and to develop urban forms that enhance quality of life, that accommodate a diversity of life styles, that preserve open space and natural resources, and that are aesthetically pleasing and preserve the character of communities, enhance the regional strategic goal of maintaining the regional quality of life. The evaluation of the proposed project in relation to the following policies would be intended to provide direction for plan implementation, and does not allude to regional mandates.

*3.11 Support provisions and incentives created by local jurisdictions to attract housing growth in job rich subregions and job growth in housing rich subregions.*

*3.12 Encourage existing or proposed local jurisdictions' programs aimed at designing land uses which encourage the use of transit and thus reduce the need for roadway expansion, reduce the number of auto trips and vehicle miles traveled, and create opportunities for residents to walk and bike.*

*3.13 Encourage local jurisdictions' plans that maximize the use of existing urbanized areas accessible to transit through infill and redevelopment.*

*3.14 Support local plans to increase density of future development located at strategic points along the regional commuter rail, transit systems, and activity centers.*

*3.15 Support local jurisdictions strategies to establish mixed-use clusters and other transit-oriented developments around transit stations and along transit corridors.*

*3.16 Encourage developments in and around activity centers, transportation corridors, underutilized infrastructure systems, and areas needing recycling and redevelopment.*

*3.17 Support and encourage settlement patterns, which contain a range of urban densities.*

*3.18 Encourage planned development in locations least likely to cause environmental impact.*

*3.19 SCAG shall support policies and actions that preserve open space areas identified in local, state, and federal plans.*

*3.20 Support the protection of vital resources such as wetlands, groundwater recharge areas, woodlands, production lands, and land containing unique and endangered plants and animals.*

*3.21 Encourage the implementation of measures aimed at the preservation and protection of recorded and unrecorded cultural resources and archaeological sites.*

*3.22 Discourage development, or encourage the use of special design requirements, in areas with steep slopes, high fire, flood, and seismic hazards.*

*3.23 Encourage mitigation measures that reduce noise in certain locations, measures aimed at preservation of biological and ecological resources, measures that would reduce exposure to seismic hazards, minimize earthquake damage, and to develop emergency response and recovery plans.*

## GMC POLICIES RELATED TO THE RCPG GOAL TO PROVIDE SOCIAL, POLITICAL, AND CULTURAL EQUITY

The Growth Management Goal to develop urban forms that avoid economic and social polarization promotes the regional strategic goal of minimizing social and geographic disparities and of reaching equity among all segments of society. The evaluation of the proposed project in relation to the policy stated below is intended guide direction for the accomplishment of this goal, and does not infer regional mandates and interference with local land use powers.

*3.24 Encourage efforts of local jurisdictions in the implementation of programs that increase the supply and quality of housing and provide affordable housing as evaluated in the Regional Housing Needs Assessment.*

*3.27 Support local jurisdictions and other service providers in their efforts to develop sustainable communities and provide, equally to all members of society, accessible and effective services such as: public education, housing, health care, social services, recreational facilities, law enforcement, and fire protection.*

## AIR QUALITY CHAPTER CORE ACTIONS

The **Air Quality Chapter** core actions related to the proposed project includes:

*5.07 Determine specific programs and associated actions needed (e.g., indirect source rules, enhanced use of telecommunications, provision of community based shuttle*

*services, provision of demand management based programs, or vehicle-miles-traveled/emission fees) so that options to command and control regulations can be assessed.*

*5.11 Through the environmental document review process, ensure that plans at all levels of government (regional, air basin, county, subregional and local) consider air quality, land use, transportation and economic relationships to ensure consistency and minimize conflicts.*

## WATER QUALITY CHAPTER RECOMMENDATIONS AND POLICY OPTIONS

The **Water Quality Chapter** core recommendations and policy options relate to the two water quality goals: to restore and maintain the chemical, physical and biological integrity of the nation's water; and, to achieve and maintain water quality objectives that are necessary to protect all beneficial uses of all waters.

*11.02 Encourage "watershed management" programs and strategies, recognizing the primary role of local governments in such efforts.*

*11.06 Clean up the contamination in the region's major groundwater aquifers since its water supply is critical to the long-term economic and environmental health of the region. The financing of such clean-ups should leverage state and federal resources and minimize significant impacts on the local economy.*

*11.07 Encourage water reclamation throughout the region where it is cost-effective, feasible, and appropriate to reduce reliance on imported water and wastewater discharges. Current administrative impediments to increased use of wastewater should be addressed.*

## OPEN SPACE CHAPTER ANCILLARY GOALS

### Outdoor Recreation

*9.01 Provide adequate land resources to meet the outdoor recreation needs of the present and future residents in the region and to promote tourism in the region.*

*9.02 Increase the accessibility to open space lands for outdoor recreation.*

*9.03 Promote self-sustaining regional recreation resources and facilities.*

Public Health and Safety

*9.04 Maintain open space for adequate protection of lives and properties against natural and man-made hazards.*

*9.05 Minimize potentially hazardous developments in hillsides, canyons, areas susceptible to flooding, earthquakes, wildfire and other known hazards, and areas with limited access for emergency equipment.*

*9.06 Minimize public expenditure for infrastructure and facilities to support urban type uses in areas where public health and safety could not be guaranteed.*

Resource Production

*9.07 Maintain adequate viable resource production lands, particularly lands devoted to commercial agriculture and mining operations.*

Resource Protection

*9.08 Develop well-managed viable ecosystems or known habitats of rare, threatened and endangered species, including wetlands.*

## CONCLUSIONS

All feasible measures needed to mitigate any potentially negative regional impacts associated with the proposed project should be implemented and monitored, as required by CEQA.

ENDNOTE

## SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS

*Roles and Authorities*

SCAG is a ***Joint Powers Agency*** established under California Government Code Section 6502 et seq. Under federal and state law, SCAG is designated as a Council of Governments (COG), a Regional Transportation Planning Agency (RTPA), and a Metropolitan Planning Organization (MPO). SCAG's mandated roles and responsibilities include the following:

SCAG is designated by the federal government as the Region's ***Metropolitan Planning Organization*** and mandated to maintain a continuing, cooperative, and comprehensive transportation planning process resulting in a Regional Transportation Plan and a Regional Transportation Improvement Program pursuant to 23 U.S.C. □134(g)-(h), 49 U.S.C. □1607(f)-(g) et seq., 23 C.F.R. □450, and 49 C.F.R. □613. SCAG is also the designated ***Regional Transportation Planning Agency***, and as such is responsible for both preparation of the Regional Transportation Plan (RTP) and Regional Transportation Improvement Program (RTIP) under California Government Code Section 65080.

SCAG is responsible for developing the demographic projections and the integrated land use, housing, employment, and transportation programs, measures, and strategies portions of the ***South Coast Air Quality Management Plan***, pursuant to California Health and Safety Code Section 40460(b)-(c). SCAG is also designated under 42 U.S.C. □7504(a) as a ***Co-Lead Agency*** for air quality planning for the Central Coast and Southeast Desert Air Basin District.

SCAG is responsible under the Federal Clean Air Act for determining ***Conformity*** of Projects, Plans and Programs to the Air Plan, pursuant to 42 U.S.C. □7506.

Pursuant to California Government Code Section 65089.2, SCAG is responsible for ***reviewing all Congestion Management Plans (CMPs) for consistency with regional transportation plans*** required by Section 65080 of the Government Code. SCAG must also evaluate the consistency and compatibility of such programs within the region.

SCAG is the authorized regional agency for ***Inter-Governmental Review*** of Programs proposed for federal financial assistance and direct development activities, pursuant to Presidential Executive Order 12,372 (replacing A-95 Review).

SCAG reviews, pursuant to Public Resources Code Sections 21083 and 21087, ***Environmental Impact Reports*** of projects of regional significance for consistency with regional plans [California Environmental Quality Act Guidelines Sections 15206 and 15125(b)].

Pursuant to 33 U.S.C. □1288(a)(2) (Section 208 of the Federal Water Pollution Control Act), SCAG is the authorized ***Areawide Waste Treatment Management Planning Agency***.

SCAG is responsible for preparation of the ***Regional Housing Needs Assessment***, pursuant to California Government Code Section 65584(a).

SCAG is responsible (with the San Diego Association of Governments and the Santa Barbara County/Cities Area Planning Council) for preparing the ***Southern California Hazardous Waste Management Plan*** pursuant to California Health and Safety Code Section 25135.3.

Ventura
Local Agency Formation Commission

May 22, 2000

Mr. Gary Sugano
Senior Associate Planner
Planning and Environmental Services Division
City of Oxnard
305 West Third Street
Oxnard, CA 93030

**RE: NOTICE OF PREPARATION – RIVERPARK SPECIFIC PLAN**

Dear Mr. Sugano:

This letter is in response to the Notice of Preparation received by the Ventura Local Agency Formation Commission for the RiverPark Specific Plan project. I first want to thank the City of Oxnard for coordinating with the County of Ventura to provide responsible and interested agencies with a briefing about the project. The comments included with this letter on behalf of LAFCO are essentially the same as I expressed at the briefing session.

The Ventura LAFCO, as indicated in the NOP, is a responsible agency for the proposed annexation to the City of Oxnard of the area initially described as RiverPark Area B. As such, the following comments are submitted:

1. Among other factors, LAFCO has the responsibility as a part of any proposed annexation to consider the logical extension of boundaries, the efficient provision of services and the impacts on prime agricultural land, if any. Each of these factors should be fully discussed in the appropriate sections of the EIR.
2. In terms of the annexation, a change to the project boundaries should be fully analyzed in the EIR (including recommended mitigation measures, if any) to include:
   - The Vineyard Avenue right of way adjacent to the project, provided no islands of unincorporated territory are created; and,
   - The area northerly of the project to the limits of the Oxnard Sphere of Influence line, specifically including the existing industrial parcels and the area proposed for the County Juvenile Justice Facility.

   This may mean the analysis of a new project alternative.
3. The EIR should also address all components of the possible reorganization actions necessary to annex Area B to the City of Oxnard. This means the EIR should discuss and analyze the impacts of possible sphere of influence changes and/or annexations to special districts which may provide future services to the area (such as water districts, etc.), and also detachments from any districts (e.g. the County Fire Protection District, drainage districts, etc.). The boundary changes necessary

for these related sphere of influence changes, annexations or detachments should be fully discussed for the preferred project and for any project alternatives. Also, I believe that any special districts affected by these annexations or detachments should potentially be identified as responsible agencies and provided an opportunity to comment on the NOP and the subsequent draft EIR.

Again I want to thank the City of Oxnard for the extra efforts being taken to provide information about this project. If you have any questions about any of the comments in this letter, please contact me.

Sincerely,

Everett Millais
Executive Officer

cc: Impact Sciences, Inc.
Donald Kendall, Calleguas Municipal Water District
Joseph Eisenhut, L#1740 – RMA Reference # 00-056
John Crowley, Interim Director, Public Works Agency
Terry Dryer, Deputy Administrative Officer

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-4082
(916) 657-5390 - Fax

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MAY 24 2000
PLANNING DIVISION
CITY OF

May 22, 2000

Gary Y. Sugano
City of Oxnard
305 West Third Street
Oxnard, CA 93030

RE: SCH # 2000051046– River Park Specific Plan

Dear Mr. Sugano:

The Native American Heritage Commission has reviewed the above mentioned NOP. To adequately assess the project-related impact on archaeological resources, the Commission reccomends the following action be required:

1. Contact the appropriate Information Center for a records search. The record search will determine:
   - Whether a part or all of the project area has been previously surveyed for cultural resources.
   - Whether any known cultural resources have already been recorded on or adjacent to the project area.
   - Whether the probability is low, moderate, or high that cultural resources are located within the project area.
   - Whether a survey is required to determine whether previously unrecorded cultural resources are present.

2. The final stage of the archaeological inventory survey is the preparation of a professional report detailing the findings and recommendations of the records search and field survey.
   - Required the report containing site significance and mitigation be submitted immediately to the planning department.
   - Required site forms and final written report be submitted within 3 months after work has been completed to the Information Center.

3. Contact the Native American Heritage Commission for:
   - A Sacred Lands File Check.
   - A list of appropriate Native American Contacts for consultation concerning the project site and assist in the mitigation measures.

Lack of surface evidence of archeological resources does not preclude the existence of archeological resources. Lead agencies should include provisions for accidentally discovered archeological resources during construction per California Environmental Quality Act (CEQA) §15064.5 (f). Health and Safety Code §7050.5 and Public Resources Code §5097.98 mandates the process to be followed in the event of an accidental discovery of any human remains in a location other than a dedicated cemetery and should be included in all environmental documents. If you have any questions, please contact me at (916) 653-4038.

Sincerely,

Debbie Pilas-Treadway
Associate Governmental Program Analyst

CC: State Clearinghouse

# California Regional Water Quality Control Board

## Los Angeles Region

**Winston H. Hickox**
*Secretary for Environmental Protection*

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640
Internet Address: http://www.swrcb.ca.gov/~rwqcb4

**Gray Davis**
*Governor*



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MAY 25 2000

PLANNING DIVISION
CITY OF OXNARD


Gary Sugano
Senior Associate Planner
City of Oxnard
Planning and Environmental Services
305 West Third Street
Oxnard, CA 93030

Dear Mr. Sugano,

Re: Response to Notice of Preparation of a Draft Environmental Impact Report Oxnard River Park Specific Plan (SCH# 2000051046)

We appreciate the opportunity to comment on the above mentioned project. For your information a list of permitting requirements and Regional Board Contacts is provided in Attachment A hereto.

The project site lies in the Santa Clara watershed that was listed as being impaired pursuant to Section 303 (d) of the Clean Water Act. Impairments listed in reaches downstream from the proposed project include nutrients and their effects, salts, coliform bacteria, and historic pesticides. The Los Angeles Regional Water Quality Control Board will be developing Total Maximum Daily Loads (TMDLs) for the watershed, but the proposed project is expected to proceed before applicable TMDLs are adopted. In the interim, the Regional Board must carefully evaluate the potential impacts of new projects that may discharge to impaired waterbodies. Please provide the following additional information for both the construction and operational phases of the project.

- For each constituent listed above, please provide an estimate of the concentration (ppb) and load (lbs/day) from non-point and point source discharges.

- Estimates of the amount of additional runoff generated by the project during wet and dry seasons.

- Estimate of the amount of increased or decreased percolation due to the project.

- Estimates of the net change in cubic feet per second of groundwater and surface water contributions under historic drought conditions (as compiled by local water purveyors, the Department of Water Resources, and others), and 10-year 50-year, and 100-year flood conditions.

If you have any questions please call Elizabeth Erickson at (213) 576 6683.

Sincerely,

Melinda Merryfield-Becker
Chief, TMDL Unit
Los Angeles Regional Water Quality Control Board
State Clearinghouse

EE:mmb
Attachments (1)
cc: file

## ATTACHMENT A

✓ If the proposed project is subject to a **federal license or permit**, and will result in a **discharge (dredge or fill) into a surface water**, including a dry streambed, the project may require a *Section 401 Water Quality Certification*, or waiver thereof. For further information, please contact:

Alex Fu at (213) 576-6692, or Anthony Klecha at (213) 576-6785, Nonpoint Source Unit

✓ If the project involves **inland disposal of nonhazardous contaminated soils and materials**, the proposed project may be subject to *Waste Discharge Requirements*. For further information, please contact:

Rodney Nelson, Landfills & Cleanup Unit, at (213) 576-6719

✓ If the overall project area is **larger than five acres**, the proposed project may be subject to the State *Board's General Construction Activity Storm Water Permit*. For further information, please contact:

Wayne Chiou, Los Angeles Inland Unit, at (213) 576-6664:
Los Angles County watersheds draining to Long Beach and San Pedro

Carlos Urrunaga, Los Angeles Coastal Unit, at (213) 576-6655:
Los Angeles County watersheds draining to Santa Monica Bay and Palos Verdes Peninsula
Ventura County watersheds draining to Malibu Creek watershed

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657:
Watersheds draining to Ventura County coastline

✓ If the project involves a facility that is proposing to discharge storm water associated with **industrial activity** (e.g., manufacturing, recycling and transportation facilities, etc.), the facility may be subject to the State Board's *General Industrial Activities Storm Water Permit*. For further information, please contact:

Robert Tom, Nonpoint Source Unit, at (213) 576-6789:
Watersheds draining to Los Angeles County coastline

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657:
Watersheds draining to Ventura County coastline

✓ If the proposed project involves any construction and/or groundwater **dewatering to be discharged to surface waters** or storm drains, including dry streambeds, the project may be subject to *NPDES/Waste Discharge Requirements*. For further information, please contact:

Wayne Chiou, Los Angeles Inland Unit, at (213) 576-6664:
Los Angles County watersheds draining to Long Beach and San Pedro

Mazhar Ali, Los Angeles Coastal Unit, at (213) 576-6652:
Los Angeles County watersheds draining to Santa Monica Bay and Palos Verdes Peninsula
Ventura County watersheds draining to Malibu Creek watershed

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657:
Watersheds draining to Ventura County coastline

✓ If the proposed project involves any construction and/or groundwater **dewatering to be discharged to land or groundwater**, the project may be subject to *Waste Discharge Requirements*. For further information, please contact:

Jau Ren Chen, Los Angeles Coastal Unit, at (213) 576-6656:
Watersheds draining to Los Angeles County coastline

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657:
Watersheds draining to Ventura County coastline

✓ The proposed project shall also comply with the local regulations associated with the applicable **Regional Board stormwater permit**:

Los Angeles County and co permittees:
NPDES No. CAS614001
Waste Discharge Requirements Order No. 96-054

Ventura County and co-permittees:
NPDES No. CAS063339
Waste Discharge Requirements Order No. 94-082

# CITY OF SAN BUENAVENTURA

CITY COUNCIL

Sandy E. Smith, Mayor
Donna De Paola, Deputy Mayor
Brian Brennan, Councilmember
Ray Di Guilio, Councilmember
James J. Friedman, Councilmember
James L. Monahan, Councilmember
Carl E. Morehouse, Councilmember

June 1, 2000

Mr. Gary Sugano, Senior Associate Planner
Planning and Environmental Services Division
City of Oxnard
305 West Third Street
Oxnard, CA 93030

**RE: NOTICE OF PREPARATION OF DRAFT ENVIRONMENTAL IMPACT REPORT**

Dear Mr. Sugano:

Thank you for the Notice of Preparation of a Draft Environmental Impact Report (DEIR) for the proposed RiverPark Specific Plan Project.

Our comments at this time are as follows:

- Please coordinate with the City of Ventura regarding trip distribution assumptions for the project
- The DEIR should address regional traffic impacts and mitigation

We look forward to receiving a copy of the DEIR.

Sincerely,

Dennis R. Mackay

Dennis R. Mackay, AICP
Planning Manager

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Office Of
**AGRICULTURAL COMMISSIONER**

P.O. Box 889, Santa Paula, CA 93061
815 East Santa Barbara Street
Telephone: (805) 933-3165
(805) 647-5931
FAX: (805) 525-8922

# MEMORANDUM

**TO:** **Joseph Eisenhut**
**Ventura County Planning Division**

**FROM:** Julie Bulla
Senior Planner

**DATE:** June 1, 2000

**SUBJECT:** **Notice of Preparation for the RiverPark Specific Plan EIR (RMA Reference No. 00-056)**

Thank you for the opportunity to review the Notice of Preparation for the proposed RiverPark EIR. The Preliminary Scope of Work for the document states that the compatibility of the RiverPark development with existing agricultural operations in the project vicinity, and impacts to onsite agricultural uses will be assessed. The Draft EIR should specifically address the following issues:

- The type of agricultural crops, estimated crop yields and crop value of the agricultural acreage that will be converted to urban uses under the proposed Specific Plan, based on the 1998 (or 1999, if available) Ventura County *Annual Crop Report*. The significance of this loss in the context of the economic value of agricultural production and support businesses in the county should also be addressed.
- Identification of significance thresholds from the *Ventura County Initial Study Guidelines* (November 1992; note that the guidelines are currently undergoing revisions) used to assess project and cumulative impacts on agricultural resources, including the loss of prime soils.
- Discussion of the consistency of the proposed development with the agricultural policies of the Ventura County General Plan.
- Discussion of potential land use conflicts associated with development of the proposed uses and existing agricultural operations to the east of Vineyard Avenue. The EIR should address whether the minimum 300 foot buffer (recommended by the County Agricultural Policy recommended by the County Agricultural Policy Advisory Committee, Advisory Committee for various residential and school projects) would be provided between existing agricultural operations and proposed non-agricultural uses.

Mitigation measures that would partially or fully reduce the significant effects of the development on agricultural resources to less than significant also should be evaluated. These measures may include the placement of equivalent agricultural soils and acreage into cultivation that historically have not be used for agricultural production

Gary Lysons

# PUBLIC WORKS AGENCY
# county of ventura

Director
**Arthur E. Goulet**

Deputy Directors of Public Works
**Wm. B. Britt**
Transportation
**John C. Crowley**
Water Resources & Engineering
**Kay Martin**
Solid Waste Management
**Jeff Pratt**
Flood Control
**Paul W. Ruffin**
Central Services

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PLANNING DIVISION
CITY OF OXNARD

June 2, 2000

City of Oxnard
Marilyn Miller, AICP, Manager
Planning and Environmental Services
305 West Third Street
Oxnard, California 93030

SUBJECT: RMA 00-056, NOP of EIR, Riverpark Specific Plan

Dear Ms. Miller :

This letter is in response to the request for review of the above mentioned project. The Flood Control District has reviewed the submittal and offers the following comments.

The draft EIR should address the impact that the project will have on surface water quality both during construction and throughout the life of the project. Specific water quality issues that need to be addressed include the following :

1. Coverage of the project area to be constructed under the National Pollutant Discharge Elimination System (NPDES) State General Construction Permit and the preparation of a Stormwater Pollution Control Plan, or equivalent document, covering water quality protection during the construction phase of the project.
2. Project components need to incorporate applicable Best Management Practices (BMPs) such as landscaped areas for infiltration, filters and/or basins, and/or other approved methods that intercept stormwater and effectively prohibit pollutants from discharging to the storm drain system. Permanent BMPs including those developed by the Ventura Countywide Stormwater Quality Management Program should be evaluated for appropiateness.

The project site contains several VCFCD jurisdictional channels and easements as well as some parcels that have the VCFCD as the fee title holder. Any work in these areas will require permitting and approval by the VCFCD

If you have questions regarding this subject please call the undersigned at 654-2011 or for water quality questions call Vicki Musgrove at 654-5051.

Very truly yours,

Fred Boroumand, P.E.
Manager
Permit & Regulatory Section
Flood Control Department

Tt

c: Sally Coleman, City of Oxnard
Joseph Eisenhut, RMA Planning, County of Ventura

**DEPARTMENT OF TRANSPORTATION**
DISTRICT 7, ADVANCE PLANNING
IGR OFFICE 1-10C
120 SO. SPRING ST.
LOS ANGELES, CA 90012
TEL: (213) 897-0486 ATSS: 8- 647-0486
FAX: (213) 897-8906
E-mail: :NoraPiring/CAGOV@DOT

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JUN 7 2000
PLANNING DIVISION
CITY OF OXNARD

June 2, 2000

MS. MARILYN MILLER
City of Oxnard
305 West Third Street
Oxnard, CA 93030

***Re:*** ***IGR/CEQA #000564/NP***
***Notice of Preparation***
***RiverPark Specific Plan***
***City of Oxnard***
***Vic. Ven-101/232-20.14***

Dear Ms. Miller:

Thank you for the opportunity to provide comments on the above-named document. The proposed project consists of a proposed Specific Plan to regulate the use of land within an approximate 700-acre area located immediately north of the Ventura Freeway (US101) between Vineyard Avenue (SR232) and the Santa Clara River.

Our review indicates, a full traffic study is needed in advance of the DEIR to analyze the following information:

1) Assumptions and methods used to develop trip generation/distribution, percentages and assignments.
2) An analysis of ADT, AM & PM peak-hour volumes for both the existing and future (year 2020) conditions. This is to include mainline freeways (Routes 101 & 232) and affected ramps, streets, crossroads and controlling intersections.
3) This analysis to address year 2020 conditions including project traffic, cumulative traffic generated for all approved developments in the area, interchange utilization (I.C.U.) and level of service (LOS) of affected freeway ramp intersections on the State highways, and indicating existing + project(s) + other projects LOS (existing and future).

4) Discussion of mitigation measures to alleviate traffic impacts. This mitigation discussion to include, but not be limited to, the following:
   * financing
   * scheduling considerations
   * implementation responsibilities
   * monitoring plans

5) Applicant's percent share of the cost, as well as plan of realistic mitigation measures under the control of the applicant to be addressed. Any assessment fees for mitigation to be of such proportion as to cover the mainline highway deficiencies that occur as a result of the additional traffic generated by the project.

A Caltrans encroachment permit will be processed for work within the State right-of-way, such as signalization, grading, widening, drainage or mainline improvements, etc. A Caltrans Project Study Report (PSR) will be prepared for any work, which exceeds $1,000,000.00 not including right-of-way.

A Caltrans transportation permit will be required for any transportation of heavy construction equipment, which requires the use of over-sized transport vehicles on State highways. We recommend trucks be limited to off-peak commute periods.

We look forward to receiving the DEIR. We expect to receive a copy from the State Clearinghouse. However, to expedite the review process, you may send two (2) copies in advance to the undersigned at the following address:

STEPHEN J. BUSWELL
Program Manager
Caltrans, District 07, IGR/CEQA 1-12G
120 South Spring Street
Los Angeles, CA 90012

If you have any questions regarding this response, please feel free to contact the undersigned at (213) 897-4429 and refer to IGR/CEQA #000564/NP.

Sincerely,

STEPHEN J. BUSWELL
Program Manager
IGR/CEQA

cc: Scott Morgan
State Clearinghouse

STATE OF CALIFORNIA - THE RESOURCES AGENCY
GRAY DAVIS, *Governor*

**DEPARTMENT OF WATER RESOURCES**
SOUTHERN DISTRICT
770 FAIRMONT AVENUE, SUITE 102
GLENDALE, CA 91203-1035

RECEIVED
JUN 8 2000
JUN 7 2000
PLANNING DIVISION
CITY OF OXNARD

Mr. Gary Y. Sugano
City of Oxnard
305 West Third Street
Oxnard, California 93030

NOP for RiverPark Specific Plan SCH# 2000051046

Dear Mr. Sugano:

Thank you for the opportunity to review and comment on the Notice of Preparation for the draft Environmental Impact Report for the RiverPark Specific Plan. In addition to the topics indicated in the NOP, the Department of Water Resources thinks that topics which should be addressed in the EIR are: the water supply for the project, quality of the surface and groundwater of the entire site, potential for high groundwater, seismic hazards, liquefaction potential, and flood hazards.

Because the proposed project will undoubtedly have impacts on the water resources of the State, the Department should have the opportunity to review and comment on all phases of the project.

If you have any questions, call me at (818) 543-4610.

Sincerely,

Charles R. White, Chief
Southern District

cc: Governor's Office of Planning and Research
State Clearinghouse
1400 Tenth Street
Sacramento, California 95812-3044

RESOURCE MANAGEMENT AGENCY

county of ventura

Environmental Health Division
Donald W. Koepp
Director

Resource Management Agency

ENVIRONMENTAL HEALTH DIVISION

# MEMORANDUM

**DATE:** June 7, 2000

**TO:** Joseph Eisenhut

**FROM:** Melinda Talent MT

**SUBJECT:** **NOTICE OF PREPARATION OF DRAFT EIR FOR RIVERPARK SPSECIFIC PLAN IN THE CITY OF OXNARD**

The Environmental Health Division (EHD) has reviewed the information submitted for the subject document and provides the following comments:

1. Water impoundment(s) should be maintained in a manner, which will not create mosquito breeding sources.

2. EHD recommends consultation with the Vector Control Section of EHD regarding a mosquito abatement/control plan. The following items are recommended to be included in the plan:

    - Proposed physical control measures that will be utilized to promote drainage.
    - Proposed chemical and biological control measures to be utilized if mosquito breeding occurs.
    - Mosquito monitoring program.
    - Design details, including cross-sections of all salt marsh and drainage areas.

If you have any questions, please call me at 654-2811.

**PUBLIC WORKS AGENCY**
**TRANSPORTATION DEPARTMENT**
**Traffic and Planning & Administration**

**MEMORANDUM**
June 8, 2000

**TO:** Resource Management Agency, Planning Division
Attention: Joseph Eisenhut

**FROM:** Nazir Lalani, Principal Engineer NL

**SUBJECT:** Review of Document 00-056
Notice of Preparation of a Draft Environmental Impact Report (DEIR)
The RiverPark Specific Plan
Applicant: City of Oxnard

Lead Agency: City of **Oxnard**

The Transportation Department has reviewed the subject Notice of Preparation of a Draft Environmental Impact Report (DEIR). The proposed project consists of a Specific Plan to regulate the use of land within a 700-acre area. Various land uses are proposed within the Specific Plan Area including residential, commercial, public facilities and open space uses. The project site is located immediately north of the Ventura Freeway (US 101) between Vineyard Avenue and the Santa Clara River. A portion of the site is located within the County boundary. We offer the following revised observations:

1) The County maintenance yard is located within the RiverPark Specific Plan area and is identified as a facility to be relocated. The DEIR should adequately evaluate the size, accessibility and location of existing versus proposed facilities. The proposed new location off Vineyard Avenue will not provide the desired accessibility needed for such a maintenance facility.

2) The County General Plan shows Kimball Road and State route 118 running through the proposed site. The DEIR should address the conflict between the County General Plan and the Oxnard RiverPark Specific Plan and provide a solution and/or alternatives.

3) The mitigation improvements that were committed as a result of the previous Auto Center and Home Base improvements were never implemented. This project shall address completion of these previous committed improvements.

4) The Transportation section of DEIR should evaluate the site-specific impacts this project would have on the County's Regional Road Network.

JUN 0 8 2000

5) This project has the potential to create a cumulative adverse traffic impact on County roads. The DEIR should identify and provide mitigation measures to address the cumulative impact of additional traffic on County roads through payment of an appropriate traffic impact mitigation fee. If the project cumulative impacts are not mitigated by payment of a traffic mitigation fee, current General Plan policy will require County opposition to this project.

6) Impacts to residential streets in the El Rio area should be addressed. Mitigation measures to prevent project traffic using these streets to access the commercial businesses between Rose Avenue and Rice Avenue should be identified.

7) Our review is limited to the impacts this project may have on the County's Regional Road Network.

Please call me at 654-2080 if you have questions.

c: Rich Guske
Kim Rodriguez
Ken Gordon

NL-RH-BE:aar

f:\common\transpor\wpwin\memos\00-056 rev

RESOURCE MANAGEMENT AGENCY
county of ventura

Planning Division
Keith A. Turner
Director

June 8, 2000

Marilyn Miller
City of Oxnard

FAX #: 385-7417

Subject: River Park Specific Plan/NOP

Thank you for the opportunity to review and comment on the subject document. Attached are the comments that we have received resulting from intra-county review of the subject document.

Your proposed responses to these comments should be sent directly to the commentator, with a copy to Joseph Eisenhut, Ventura County Planning Division, L#1740, 800 S. Victoria Avenue, Ventura, CA 93009..

If you have any questions regarding any of the comments, please contact the appropriate respondent. Overall questions may be directed to Joseph Eisenhut at (805) 654-2464.

Sincerely,

Keith Turner
County Planning Director

*f:\rma\wpc\winword\1e28-700*

Attachment

County RMA Reference Number 00-056

# COUNTY OF VENTURA
## RESOURCE MANAGEMENT AGENCY
### PLANNING DIVISION

## MEMORANDUM

**DATE:** June 8, 2000

**TO:** Joseph Eisenhut, Coordinator
Outside Environmental Documents

**FROM :** Patrick Richards, Manager
Commerical & Industrial Permits Section

**SUBJECT: NOTICE OF PREPARATION FOR THE RIVERPARK SPECIFIC PLAN EIR (YOUR REFERENCE NUMBER 00-056)**

---

This memorandum is in response to the Notice of Preparation received May 9, 2000, for the RiverPark Specific Plan project proposed by the City of Oxnard. The collective comments of the Planning Division are as follows:

1. The proposed EIR should analyze the project against all Goals, Policies and Programs of the Ventura County General Plan and specifically the El Rio / Del Norte Area Plan so as to determine consistency between the County's General Plan and the proposed project.

2. The proposed EIR needs to analyze the effects upon the existing Kimball Road extension shown on the County's 2010 Regional Road Network.

3. Inasmuch as the project site includes "prime" agricultural land, there is a need to analyze the impacts cause by the reduction or elimination of this agricultural resource.

4. Although a requirement of CEQA, the NOP did not address how or under what condition(s) various alternatives were going to be considered. The selection of alternatives for the proposed project should consider the feasibility factors such as economic, social, environmental, technical and legal. Clearly writing the projects objectives will help to focus the range of reasonable alternatives.

5. The proposed project should consider the potential to size the sewer trunk line sufficiently to include the ability to serve the El Rio community in the future. In order that groundwater nitrate levels be reduced in compliance with recent RWQCB mandates; the use of septic systems in the El Rio area will sunset in the near future.

6. The "environmental setting" for the mine area (including the existing pits) should be analyzed in conjunction with the current County approved reclamation plan. Baseline information needs to

be established as if the pits had been reclaimed in accordance with the approved Reclamation Plan.

7. The proposed EIR should address the slope stability issue surrounding the open mine pits. Also, a determination will need to be made as to the required setback needed from the edge of the open pit based upon the type of land use proposed.

8. At the present time, a Santa Clara River Plan is being created by a number of interested parties which is purported to include regional trails, habitat protection and the like. This proposed EIR should address its relationship to any such plan.

9. An increase to the local ambient noise level is possible due the planned project. The EIR should analyze the possible effects of such on existing land uses, especially the residential uses in the surrounding area.

10. The EIR should address when various infrastructure improvements are proposed to be accomplished. Specifically, the various local roadway and freeway improvements should be timed so they are in place prior to the demand need.

11. Inasmuch as the mine pits will remain within the proposed project and various land uses are proposed to be adjacent; the EIR should analyze the potential effects a seiche hazard to surrounding land uses.

12. The RiverPark proposal includes a future elementary school site located adjacent to one of the open water mine pits. Coordination should be accomplished with the State Department of Education as to the appropriateness of locating a school in proximity to an open water filled pit.

13. The EIR should analyze the impacts of the proposed project on the jobs/housing balance of the City of Oxnard. Analysis should include the kinds of jobs that will become available in the commercial and industrial areas and the City's ability to accommodate the residential needs of all income levels of the anticipated labor force, including low-income workers.

14. The EIR should address long term ownership responsibilities of the two open pits, various parks, future trails, town square, wetlands habitat, etc.

15. The EIR will need to identify the responsible party for the mine reclamation within Area "B" under the provisions of SMARA.

16. The Existing Community areas located in unincorporated areas of El Rio on the west side of Vineyard Avenue (zoned Urban Residential on the southeast and Industrial on the northeast) should be considered for annexation to the City of Oxnard. These areas are within the City's Sphere of Influence, and their identification with the unincorporated El Rio Community will be reduced by their proximity to the proposed project.

Thank you and the City of Oxnard for the additional efforts made towards collecting environmental comments in advance of preparation of the EIR. Should you or the City have any questions regarding the above, please call me at 805-654-5192 or Staff Planner, Kim Rodriguez at 805-662-6521.

*CC: Keith Turner, Bruce Smith, Todd Collart, Nancy Francis, Nancy Settle, Kim Rodriguez*

# VENTURA COUNTY
# AIR POLLUTION CONTROL DISTRICT
Memorandum

TO: Joseph Eisenhut, Planning DATE: June 8, 2000

FROM: Molly Pearson

SUBJECT: Notice of Preparation of a Draft Environmental Impact Report for RiverPark Specific Plan, City of Oxnard (Reference No. 00-056)

Air Pollution Control District staff has reviewed the Notice of Preparation (NOP) of a Draft Environmental Impact Report (EIR) for the subject project. The proposed project is a Specific Plan for a 700-acre area located immediately north of the Ventura Freeway (US 101) between Vineyard Avenue and the Santa Clara River. Various land uses are proposed within the Specific Plan area including residential, commercial, public facilities, and open space uses.

District staff concurs with the items identified for air quality in the "Preliminary Scope of Study" on Page 15 of the NOP. In addition to those items identified in the Preliminary Scope of Study, the District recommends that the following items be considered in the Specific Plan and EIR:

Asbestos

The EIR should address potential asbestos impacts that may result from any building demolition that may occur as part of project construction.

Specific Plan – Air Quality Mitigation Program

Due to its similarities with the Ahmanson Ranch Specific Plan, the District recommends that the RiverPark Specific Plan include a comprehensive air quality mitigation program to minimize the project's air quality impacts. The Ahmanson Ranch Specific Plan Resource Management Program (RMP) contains such a program called the *Air Quality Mitigation/Transportation Management Program*. This program (Section 2.10 of the Ahmanson Ranch RMP) contains a number of measures relating to land-use design, alternative transportation, transportation management, jobs/housing balance, energy conservation, day care, construction emissions, and Transportation Demand Management (TDM) fund contributions that could be included in the air quality mitigation program for the RiverPark Specific Plan. These measures should be applied to each project developed under the Specific Plan. Before approval of each such project, the feasibility of each measure in the air quality mitigation program should be evaluated, and all feasible measures should be applied to that project.

A number of other mitigation measures that could be included in the air quality mitigation program for the project are identified in the District's 1989 *Guidelines for the Preparation of Air Quality Impact Analyses*. Furthermore, the District has recommended mitigation measures for

the Newhall Ranch Specific Plan that could be included in the air quality mitigation program for the RiverPark Specific Plan. These measures are included in the following list.

(1) Establish and fund a utility equipment exchange program for the Oxnard Plain/West Ventura County region. Such a program would exchange old, gasoline-powered utility equipment, such as lawnmowers, for electric-powered models.

(2) Establish and fund an outboard engine exchange program for the Oxnard Plain/West Ventura County region. Such a program would exchange old, two-stroke engines for new, less polluting, four-stroke engines.

(3) Fund and implement a program to convert industrial, oil field, and agricultural engines in the Oxnard Plain/West Ventura County region to electric motors.

(4) Design and construct all residential, commercial, and industrial structures within the Specific Plan area to be at least 20 percent more energy efficient than required by the energy efficiency standards of the *State Building Code*, published in Title 24 of the California Code of Regulations.

(5) Ensure that there will be adequate child-care facilities and services to serve the Specific Plan area.

(6) Ensure that each of the land-use components within the Specific Plan area has adequate food service, postal, copying, and banking services.

(7) Establish and ensure ongoing funding for clean-fuel shuttle vans/buses to serve the Specific Plan area.

(8) Incorporate a recycling center into the Specific Plan.

(9) Incorporate employee locker/shower/changing facilities into all non-residential buildings in the commercial portions of the Specific Plan area.

(10) Incorporate an Affordable Housing component within the Specific Plan area to provide housing for lower-income employees within the Specific Plan area.

(11) Include a fuel cell demonstration program for one or more commercial buildings within the Specific Plan area.

(12) Plant and maintain shade trees and shrubs to reduce heat build-up on structures.

(13) Only clean-fuel trash trucks should serve the Specific Plan area.

(14) All school buses and vans that operate within the Specific Plan area should be clean-fuel models.

(15) The project proponent shall work with Caltrans to establish a park-and-ride lot in or near the Specific Plan. The park-and-ride lot shall constructed per Caltrans specifications.

(16) Establish, staff, and provide ongoing funding for a Transportation Management Association (TMA) for the Specific Plan area. The purpose of the TMA is to develop and promote programs to reduce project-related, peak-hour vehicle trips. Such programs could include coordinating public transit and implementing measures such as carpooling and vanpooling programs within the Specific Plan area.

District staff believes that these air quality mitigation measures are currently feasible and can be included in an air quality mitigation program for the RiverPark Specific Plan. Many are fairly standard statewide and have been applied in Ventura County and elsewhere, including in the South Coast Air Basin. The EIR should explicitly state that these air quality mitigation measures will be implemented unless a feasibility analysis shows them to be infeasible or other (currently unknown) more effective air quality mitigation measures become available and are applied to the project.

The South Coast Air Quality Management District (SCAQMD)'s CEQA Air Quality Handbook (November 1993) also identifies a number of mitigation measures that should be considered for inclusion in the air quality mitigation program for the RiverPark Specific Plan.

All of the mitigation measures and project design elements that are incorporated into the Specific Plan should be considered when evaluating and presenting the air quality impacts of the project in the EIR. The air pollutant emissions calculations included in the EIR should reflect the incorporation of these mitigation measures and design elements.

Mitigation Agreement

If the applicant and the City of Oxnard determine that project air quality impacts should be mitigated through a monetary contribution to the City's Transportation Demand Management (TDM) Fund, the District recommends that the City and the project applicant enter into a formal TDM Fund agreement The agreement should include the protocol for determining the amount of monetary contribution to the TDM Fund and the framework for use of the TDM Fund monies. An example of such an agreement is the "Air Quality Mitigation Agreement by and among Ventura County Air Pollution Control District, the County of Ventura, and the Ahmanson Land Company." A copy of this agreement is available from the District upon request.

If you have any questions, please call me at 645-1439.

**DEPARTMENT OF CONSERVATION**
801 K Street, MS 24-02
Sacramento, CA 95814
(916) 445-8733 Phone
(916) 324-0948 Fax
(916) 324-2555 TDD

RECEIVED
JUN 14 2000
PLANNING DIVISION
CITY OF OXNARD

June 9, 2000

Mr. Gary Y. Sugano
City of Oxnard
305 West Third Street
Oxnard, CA 93030

Subject: Notice of Preparation (NOP) of a Draft Environmental Impact Report (DEIR) for the RiverPark Specific Plan (SP) – **SCH #2000051046**

Dear Mr. Sugano:

The California Department of Conservation's Division of Mines and Geology (DMG) has reviewed the referenced NOP. DMG is responsible for investigating, mapping and classifying mineral resource deposits in California. In addition, the State Mining and Geology Board (SMGB) designates significant mineral resource deposits based on the quality and volume of the deposit, the threat of land use changes, regional supply and demand, and other factors. We offer the following comments on the NOP for your consideration.

The proposed project site includes the southwestern part of an aggregate resource deposit designated by the SMGB as Sector B, an area of regional significance for aggregate resources. (See DMG Open-File Report 93-10, *Update of Mineral Land Classification of Portland Cement Concrete Aggregate in Ventura, Los Angeles, and Orange Counties, California -- Part I, Ventura County*, 1993). Portions of Sector B have been subject to urban development subsequent to designation of the Sector by the SMGB. Gravel mining has also been permitted in portions of Sector B in the SP area. While these operations are now undergoing reclamation following cessation of mining, there remain areas that have not yet been mined and that are currently non-urbanized.

The RiverPark project would result in development over some of the areas with remaining mineral resource deposits in the southwest corner of Sector B. Although these areas are relatively small in extent, the volume of aggregate could be significant to the region. Therefore, we recommend that the DEIR rely on Open-File Report 93-10, as well as production information, to characterize the remaining mineral resource deposit in the project area. The description of the project setting should include a discussion of the City's general plan mineral resource policies (California Public Resources Code Section 2762 and California Code of Regulations Section 3675). In addition, the amount of the resource deposit that will be lost due to project

implementation, and the short and long-term impacts of the loss of these resources in relation to long-term need and availability of alternative aggregate supplies, should be described. In describing these impacts, the DEIR should include the analysis required by Public Resources Code Section 2763 and California Code of Regulations Section 3676. This analysis requires a weighing of the public benefits of the proposed alternative use(s) against the benefits of preserving the mineral resources. Finally, we recommend that the DEIR propose mitigation measures and project alternatives that will avoid or lessen identified project impacts on the future availability of the designated mineral resources.

Thank you for the opportunity to review and comment on the NOP. If you have questions about our comments, or require technical assistance or information, please contact Mr. Robert L. Hill, Senior Geologist, DMG, 801 K Street, MS 8-38, Sacramento, CA 95814; or, phone (916) 327-0791. You may also call me at (916) 445-8733.

Sincerely,

for Jason Marshall
Assistant Director

cc: Robert L. Hill

RIO SCHOOL DISTRICT
3300 CORTEZ ST., OXNARD, CALIF. 93030
TELEPHONE 805-485-3111
FAX 805-983-0221

**Board of Education**

George Perez
President

Simon Ayala
Clerk

Ernest Almanza
Ron Mosqueda
Anthony M. Ramos

**Superintendent**
Yolanda M. Benítez

RECEIVED
JUN 16 2000
PLANNING DIVISION
CITY OF OXNARD

June 12, 2000

City of Oxnard
Planning and Environmental Services Division
305 West Third Street
Oxnard, CA 93030

Attn: Mr. Gary Sugano
Senior Associate Planner

Subject: NOP Comments – RiverPark Specific Plan

Dear Mr. Sugano,

Based on the proposed housing development for the RiverPark Specific Plan, the District anticipates a need for an elementary and junior high school site. Per the California Department of Education, a ten (10) acre site is recommended for an elementary school site and twenty (20) acres for a junior high school site.

Utilizing our current Student Generation Factor (SGF) per housing unit of 0.545, we anticipate the following student growth from the proposed residential units delineated on page 12 of the NOP:

| housing units | total students | elementary students | junior high students |
|---|---|---|---|
| • 2,175 | 1,175 | 823 | 352 |
| • 2,900 | 1,581 | 1,107 | 474 |

However, in the Northeast community we are experiencing growth at about 0.75 to 1.0 per housing unit. This would increase the numbers of total students as follows:

| | 0.75 sgf | 1.0 sgf |
|---|---|---|
| • 2,175 units | 1,631 | 2,175 |
| • 2,900 units | 2,175 | 2,900 |

The District will be updating its facility master plan in 2001. This new study will more accurately indicate growth in our District.

Currently, our Maintenance Yard is inadequate. With the anticipated growth from this project, the District will have to relocate this facility to house the growing transportation and maintenance divisions.

The impact of this project is significant and will need to be mitigated.

Should you have any questions, please feel free to call me at (805) 485-3111, extension 123.

Very Truly Yours,

Salvador Godoy, AIA
Director of School Facilities and Classified Services

Cc: Yolanda M. Benítez, Superintendent
Ed Sotelo, City of Oxnard – City Manager
Paul Keller, President – Keller CMS, Inc.
Governing Board

| Post-it® Fax Note 7671 | Date 6-16-00 | # of pages ▶ 2 |
|---|---|---|
| To M. Miller | From J. Eisenhut | |
| Cc./Dept. OXNARD PLNG | Co. Ventura County | |
| Phone # | Phone # 654-2464 | |
| Fax # 385-7417 | Fax # | |

ATTACHED - TAKEN BY MESSENGER

June 14, 2000

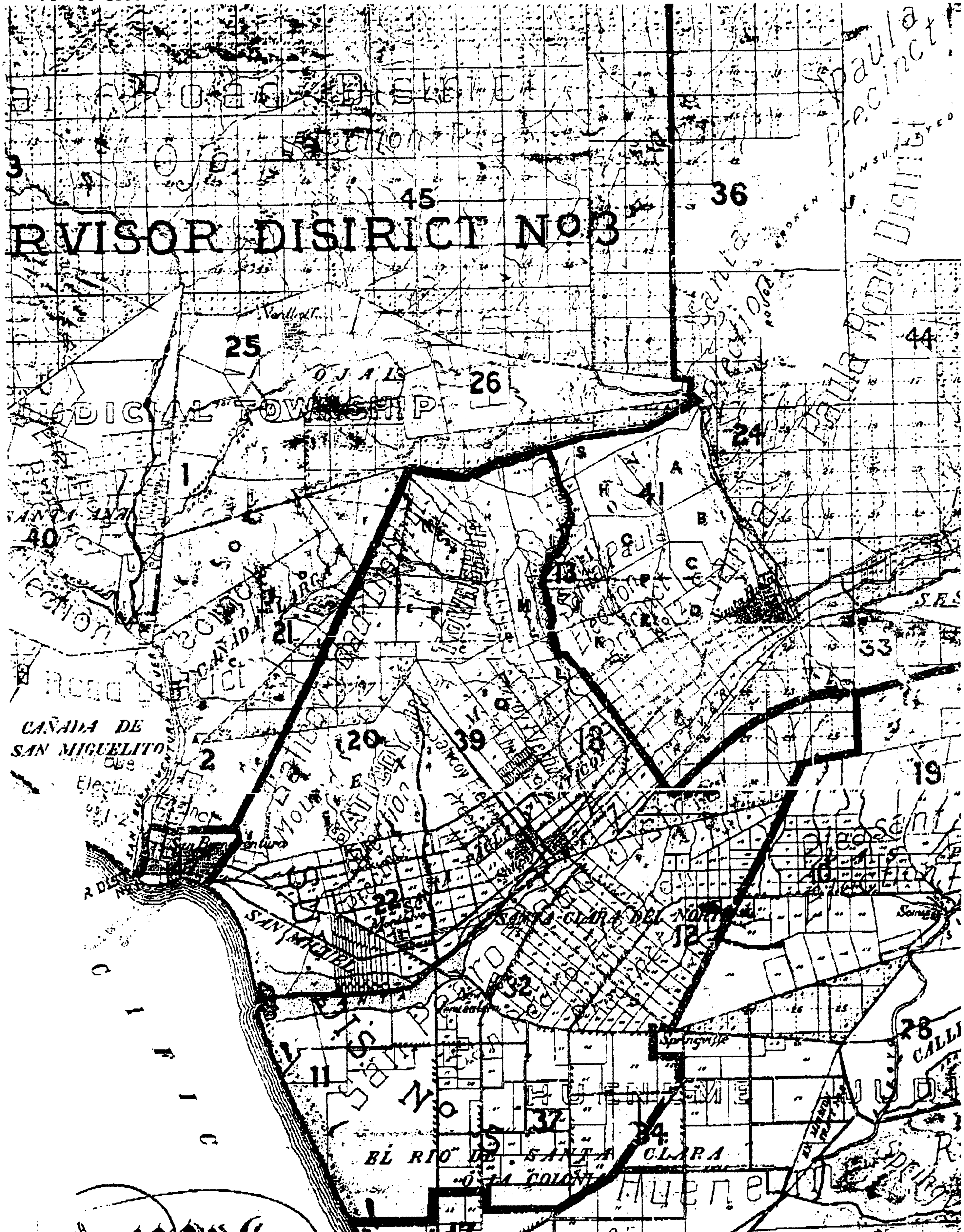
To: Joseph Eisenhut
From: Kim Hocking, Staff to Ventura County Cultural Heritage Board
SUBJECT: Oxnard River Park Specific Plan Ref 00-056

Cultural Resources are not included as a topic in the NOP and should be. The area at the southeast corner of the project was the site of New Jerusalem as shown on a copy of the enclosed 1897 Official Map of Ventura County. New Jerusalem existed even before any development in or near the yet to be formed City of Oxnard. The project will intrude onto the old site and also border it.

1. Care should be taken as for an archaeological site to watch for historic artifacts and to stop work if encountered. Experts should be brought in and the recovered materials should be salvaged by qualified museum personnel. The current CEQA Guidelines pursuant to this subject should be followed.

2. The site should be declared a Point of Interest and a plaque erected. The Ventura County Cultural Heritage Board will officially consider this soon.

RECD JUN 16 2000 J. Eisenhut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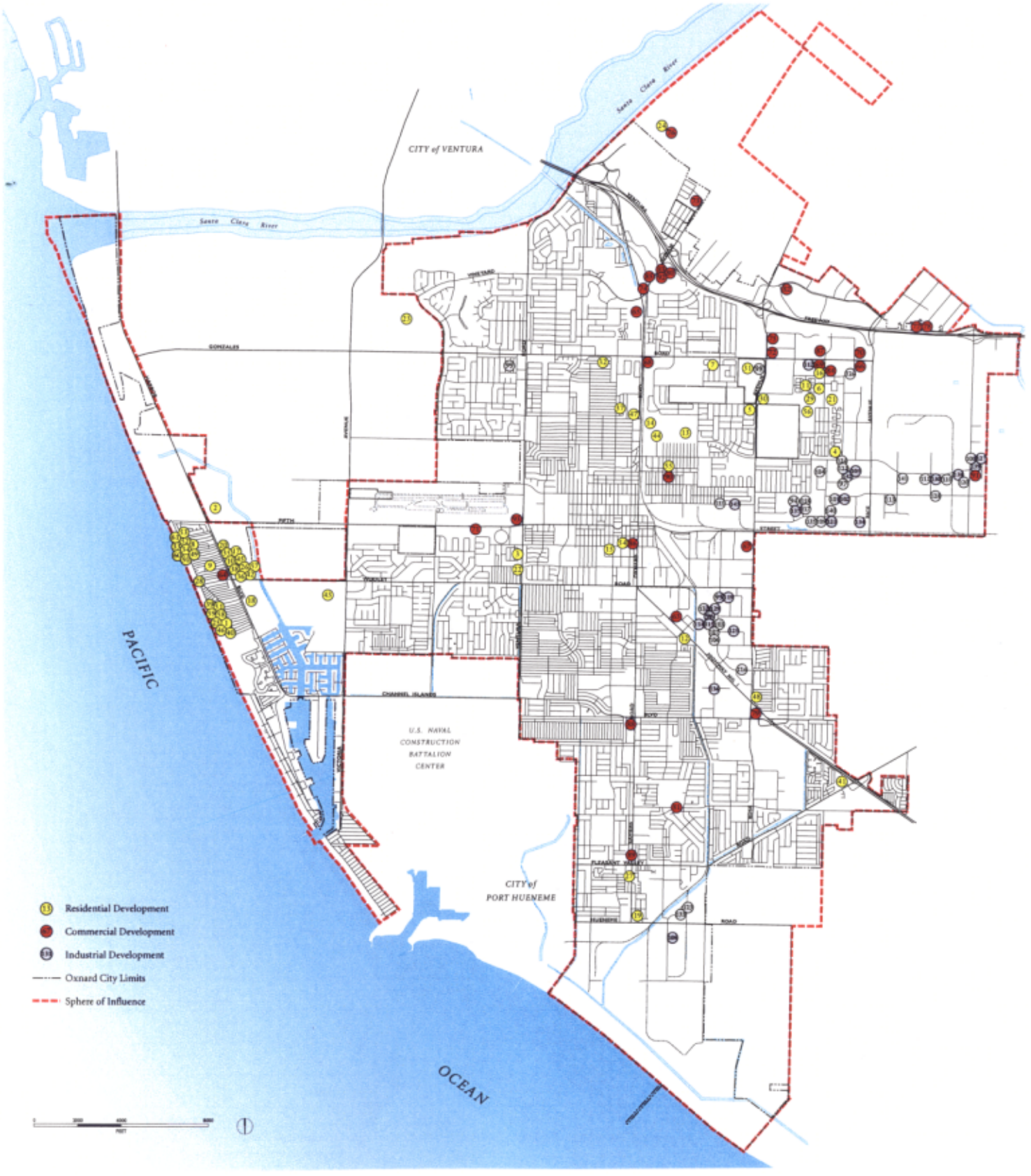
# APPENDIX 4.0
## Related Projects List




City of Oxnard
"The City That Cares"

PLANNING AND ENVIRONMENTAL SERVICES

# Development Summary

September 13, 2001

## New Residential Development

| Proj # | Developer's Name Phone Number | Project Name | Description | Number of single-family units | Number of multi-family units | Location | Status Tract # | Planning File Date Received |
|---|---|---|---|---|---|---|---|---|
| 1 | Harwood Homes (818)981-7969 | The Monterey Collection | 12 single family coastal | 12 | | Mandalay Beach Road between Amalfi & Shoreline | 4 T4777 | CDP 91-3 7/3/91 |
| 2 | Ron Smith (949)644-5133 | North Shore | 333 single family (detached) | 333 | | NE corner of Fifth and Harbor Blvd | 2 T5060 | PD 96-5-75-79 12/24/96 |
| 3 | Concordia Homes (909)988-9000 | Pacific Breeze | 120 single family (detached) | 120 | | 801 S Ventura Rd | 4 T5137 | PD 98-5-18 3/11/98 |
| 4 | Centex Homes (805)288-5777 | Sunset Sunrise Pointe | 273 single family (detached) | 273 | | Camino Del Sol W of Graves | 4 T5136 | PD 98-5-20 3/12/98 |
| 5 | Standard Pacific (805)495-6647 | Villa Carmel Villa Santa Cruz | 331 single family (detached) | 331 | | N/W Camino De La Luna & Rose Ave | 4 T5135 | PD 98-5-27 3/16/98 |
| 6 | Essex (818)223-3434 | Tierra Vista | 404 unit apartment complex | | 404 | Lombard & Wankel | 4 T4317 | PD 98-5-62 6/15/98 |
| 7 | Shea Homes (805)557-2100 | Aldea Del Mar | 238 single fam. det. 56 duplex | 238 | 56 | 52 ac South of Gonzales & Snow Ave | 4 T5148 | PD 98-5-75 7/22/98 |
| 8 | City of Oxnard (805)385-7858 | none | 12 single family coastal | 12 | | West of Harbor Bl between Breakers Wy & Reef Wy | 1 T5063 | CDP 98-5-106 10/12/98 |
| 9 | City of Oxnard (805)385-7858 | none | 14 single family coastal | 14 | | North of Whitecap St East of Mandalay Beach Rd | 1 T5064 | CDP 98-5-107 10/12/98 |
| 10 | Fred Hanson (805)647-0786 | none | Oxnard Dunes duplex | | 2 | 4830 Dunes St | 3 98-4636 | CDP 99-5-3 1/13/99 |
| 11 | Trammel Crow Res. (714)966-9355 | Parc Rose Apartments | 373 unit apartment complex | | 373 | S/E Corner of Williams Dr and Wankel Way | 4 99-2572 | PD 99-5-5 1/21/99 |
| 12 | Bialosky Peikert Arch. (805)963-8283 | Gateway Apartments | 106 unit apartment complex | | 106 | 1719 S. Oxnard Bl | 4 99-3732 | PD 99-5-9 2/1/99 |
| 13 | John Laing Homes (818)830-3360 | Sueno/ Promesa | 179 single family (detached) | 179 | | S/W Rose Ave & Gonzales Rd | 4 T5198 | PD 99-5-15 2/10/99 |
| 14 | DR Horton (805)654-6977 | Sea Wind | 65 condos (detached) | 65 | | S/W Rose Ave & Gonzales Rd | 4 T5198 | PD 99-5-15 2/10/99 |
| 15 | Bialosky Peikert Arch. (805)963-8283 | Palm Terrace | 22 apt complex w/ day care center | | 22 | 711 S "C" St | 4 00-333 | SUP 99-5-52 4/8/99 |
| 16 | Silverado Senior Living (949)831-5999 | Silverado Senior Living Alzheimer Care Facility | senior living facility | | | 1701, 1751, 1801 Lombard Av | 2 | SUP 99-5-59 4/15/99 |
| 17 | Patriot Properties (805)523-7995 | none | Oxnard Dunes duplex | | 2 | 4940 Dunes Circle | 3 00-1580 | CDP 99-5-60 4/21/99 |
| 18 | Suncal Mandalay LLC (818)772-2077 | Westport @ Mandalay Bay | 218U SFR/ duplex/ townhomes | 218 | | S/E Wooley Rd & Edison Channel | 2 T5196 | CDP 99-5-61 5/13/99 |
| 19 | Pacific Com. Builders (949)660-8988 | Pacific Cove | 121 single family (detached) | 121 | | N/E Saviers Rd & Hueneme Rd | 3 T5171 | PD 99-5-74 6/1/99 |
| 20 | Tom Staben (805)523-7995 | none | Oxnard Dunes duplex | | 2 | 831 Dunes St | 3 00 556 | CDP 99-5-109 1/13/99 |
| 21 | Lauterbach & Assc. (805)988-0912 | Mayfield Village | 90 unit condo. (detached) | 90 | | S/W Corner of Graves Ave & Santiago Court | 2 T5294 | PD 99-5-116 8/26/99 |
| 22 | Valle Verde Corp. (818)410-7271 | Valle Verde | 3 unit complex | | 3 | 901 S Ventura Rd | 3 00 2917 | SUP 99-5-140 10/25/99 |
| 23 | Centex Homes (661)288-5777 | Northwest Golf Course Community | 418 sfr 54 apt | 418 | 54 | N/W Patterson Rd and Victoria Avenue | 2 T5238 | PZ 99-5-145 11/15/99 |
| 24 | Riverpark, LLC (213)346-9030 | Riverpark | 2,901 units | PROPOSED PROJECT | | Proj bounded; Vineyard Ave, 101 Fwy, Santa Clara River | 1 | PZ 99-5-158,159 12/21/99 |
| 25 | Voss Development (805)985-5810 | none | single family residential | 1 | | 1425 Marine Way | 4 00 2248 | CDP 00-5-9 1/27/00 |
| 26 | Patriot Properties (805)523-7995 | none | Oxnard Dunes duplex 6,574sf | | 2 | 1020 Catamaran Street | 3 01 572 | CDP 00-5-10 2/1/00 |
| 27 | Abacus Development (818)887-7521 | none | 10 unit condo (attached) | | 10 | 5220 Saviers Rd | 1 | SUP 00-5-22 10/25/99 |
| 28 | Martha Piccioti (805)983-3955 | none | Beachfront House | 1 | | 1085 Mandalay Beach Rd | 3 | CDP 01-5-5 1/25/01 |
| 29 | Shea Homes (805)557-2100 | Sonrisa II | 84 unit condo. (detached) | 84 | | Williams & Soccorro | 1 T5293 | PD 00-5-25 2/28/00 |
| 30 | William Lyon Homes (818)342-9868 | | 113 sfr det condos | 113 | | Soccorro Way And Rose Ave | 3 T5214 | PD00-5-31 3/29/00 |

*Residential Development (continued on next page)*

*Revised: April 24, 2001*

**STATUS KEY: 1 PROPOSED 2 APPROVED 3 PLAN CHECK 4 UNDER CONSTRUCTION**

## New Residential Development (continued)

| Proj # | Developer's Name Phone Number | Project Name | Description | Number of single-family units | Number of multi-family units | Location | Status Tract # | Planning File Date Received |
|---|---|---|---|---|---|---|---|---|
| 31 | William Lyon Homes (818)342-9868 | | 197 sf & condo 37.3 ac site | 197 | | SW corner of Rose and Gonzales Rd | 1 T5228 | PD00-5-34 3/29/00 |
| 32 | Aegis Assisted Living (949)253-5730 | Aegis Assisted Living | 77 unit facility 58,071 sf | | | 457 W Gonzales Rd | 2 | SUP00-5-46 4/10/00 |
| 33 | James Sandefer (805)643-0202 | none | Beachfront Home | 1 | | 811 Mandalay Beach Rd | 4 00 3771 | CDP00-5-50 4/13/00 |
| 34 | James Sandefer (805)643-0202 | none | Beachfront Home | 1 | | 815 Mandalay Beach Rd | 4 00 3770 | CDP00-5-51 4/13/00 |
| 35 | Tom Staben (805)523-7995 | none | duplex | | 2 | 923/925 Dunes St | 2 01- 652 | CDP 00-5-58 5/4/00 |
| 36 | Tom Staben (805)523-7995 | none | duplex | | 2 | 4951 / 4953 Dunes St | 2 | CDP 00-5-59 5/4/00 |
| 37 | Vinzon Florentino (805)984-2127 | none | single family (det) 3,385 sf | 1 | | 1024 N "C" st | 4 01 120 | MNMD:U444 5/4/00 |
| 38 | Marty Ingraham (805)957-0090 | none | duplex | | 2 | 4840/4842 Dunes St | 4 00 4123 | CDP00-5-61 5/5/00 |
| 39 | Chris Succa (805)657-9161 | none | 3 unit condo 3,350sf | | 3 | 5131 Neptune Dr | 2 | CDP 00-5-64 5/11/00 |
| 40 | Roy Milbrandt (805)639-0185 | | single family (det) 4,540 sf | 1 | | 1069 Mandalay Beach Rd | 4 00 6620 | CDP 00-5-68 6/20/00 |
| 41 | Viderikson & Co. (805)987-1002 | | 60 senior unit condo | | 60 | N/W Pleaseant Valley and Highway 1 | 1 | PD 00-5-77 7/11/00 |
| 42 | Tom Staben (805)523-7995 | none | duplex | | 2 | 4960 Dunes St | 1 | CDP 00-5-79 6/20/00 |
| 43 | Mandalay Bay Partners (949)888-6653 | Toscana Bay | 520-550 units (mixed res. units) | 550 | | S/W Victoria Ave & Wooley Rd | 1 T5266 | PZ00-5-85 7/18/00 |
| 44 | Viderikson & Co. (805)987-1002 | Daily Ranch | 200 single family + 175 d.u. overlay | 200 | | N/E Camino Del Sol and Oxanrd Blvd | 1 | PD 00-5-94 8/16/00 |
| 45 | Walt Phillip (805)6541181 | | duplex | | 2 | 4962, 4966 Dunes Cr | 3 01 1541 | CDP 00-5-102 8/30/00 |
| 46 | Milbrandt Architects (805)639-0185 | | single family (det) 6,100 sf | 1 | | 1551 Mandalay Beach Rd | 3 00 2055 | CDP 00-5-110 8/30/00 |
| 47 | Lauterbach & Assc. (805)988-0912 | Mercy Housing | 72 unit affordable housing | | 72 | N/W Robert Ave and "A" St | 2 | PD 00-5-118 9/25/00 |
| 48 | The Lee Group (310)827-0171 | Channel Pointe | 142 single family | 142 | | 2800 South Rose Ave | 2 | SUP00-5-122 10/9/00 |
| 49 | James Sandefer (805)207-4894 | none | Beachfront 3,600 sf | 1 | | 925 Mandalay Beach Rd | 1 | CDP 00-5-124 10/19/00 |
| 50 | James Sandefer (805)207-4894 | none | Beachfront 3,600 sf | 1 | | 931 Mandalay Beach Rd | 1 | CDP 00-5-125 10/19/00 |
| 51 | Roy Milbrandt Architect (805)639-0185 | none | Beachfront 3,700 sf | 1 | | 1429 Marine Wy | 1 | CDP 00-5-127 10/20/00 |
| 52 | Phillip Jon Brown (818)247-0725 | none | Beachfront 3,073 sf | 1 | | 801 Mandalay Beach Rd | 2 | CDP 00-5-131 11/1/00 |
| 53 | Phillip Jon Brown (818)247-0725 | none | Beachfront 3,097 sf | 1 | | 741 Mandalay Beach Rd | 2 | CDP 00-5-132 11/1/00 |
| 54 | Michael Faulconer (805)486-4549 | Oxnard Hotel | MIX USE: 38 unit apartment/32,300 ret | | 38 | 201 W Seventh St | 1 | SUP00-5-140 11/13/00 |
| 55 | Juan Gonzalez (805)487-4196 | | MIX USE: 2 res units + restaurant | | 2 | 506 Cooper Rd | 1 | SUP00-5-152 12/26/00 |
| 56 | Newport Homes (909)584-1195 | Cameron Ranch | 35 single family | 35 | | 214-020-54-5 Kohala Street | 1 T5296 | PD 00-5-153 12/27/00 |
| 57 | Marty Ingraham (805)957-0090 | none | Oxnard Dunes duplex 3,450 sf | | 2 | 1040 Canal St | 1 | CDP 01-5-2 1/18/01 |
| 58 | Ybanez Residence (805)639-0185 | none | Beachfront 5,000 sf | 1 | | 1421 Marine Way | 1 | CDP 01-5-14 2/15/01 |
| 59 | James Rassmussen (805)370-0075 | none | Beachfront | 1 | | 1413 Marine Way | 1 | CDP 01-5-16 3/5/01 |
| 60 | Phillip Brown Architect (310)247-0725 | none | Beachfront 3,216sf | 1 | | 827 Mandalay Beach Road | 1 | CDP 01-5-17 3/12/01 |
| 61 | James Sanderfer (805)643-0202 | none | Beachfront 3,100sf | | | 791 Mandalay Beach Road | 1 | CDP 01-5-30 4/16/01 |
| | TOTAL | | | 3,760 | 1,223 | | | |

**STATUS KEY: 1 PROPOSED 2 APPROVED 3 PLAN CHECK 4 UNDER CONSTRUCTION**

*Revised: April 24, 2001*

## Commercial Development

| Proj # | Developer Phone Number | Project Name | Description | Building Sq. ft. | Location | Status Pmt. # | Planning File Date Received |
|---|---|---|---|---|---|---|---|
| 63 | Mario Vasquez (805)483-2623 | La Paloma | Auto Repair | 3,080 | 1312 Commercial Ave | *3 00-446 | SUP96-5-47 9/4/96 |
| 64 | Hobbs Marlow (805)484-9025 | Oxnard Shores Shops | Renov: 17,840 & Add 8,216 | 8,216 | 1001-1035 S Harbor Blvd | *3 00-1613 | CDP 97-5-01 1/9/97 |
| 65 | Finn Moller (310)998-3380 | Arco Gas Station | Reconstruct Prev. Chevron | 4,350 | 2251 N Oxnard Bl | 4 98-2447 | MJMD: SUP 479 3/23/98 |
| 66 | Robert Jacobs & Assoc. (818)222-6050 | Pacific West Corporation Center | Office Complex | 98,500 | 2240 E. Gonzales Rd | 4 00-6204 | DDR 98-5-127 12/31/98 |
| 67 | David Delrahim (818)889-3334 | Gas Station | Gas Station w/ Mini Mart | 14,402 | 605 S. Rose Ave | 2 | DDR 99-5-8 1/29/99 |
| 68 | Michael Faulconer (805)486-4549 | Express Lube | Auto Service | 3,000 | 600 S Victoria Ave | 1 | PD 99-5-65 5/13/99 |
| 69 | Vincent Dyer (818)882-5250 | none | 2 Story Comm. Bldg | 21,596 | 1851 Lombard | 4 00-44 | DDR 99-5-83 6/8/99 |
| 70 | T.M. Miam (972)641-6641 | Hilton | Hotel with Restaurant | 90,137 | 2000 Solar Dr | 3 99-4227 | SUP 99-5-89 6/28/99 |
| 71 | Ebbie Videriksen (805)987-1002 | Boys & Girls Club | Recreation Center | 28,384 | 2500 W. Fifth St | 4 00-3785 | SUP 99-5-93 7/6/99 |
| 72 | Michael Penrod (805)373-8808 | Rose Crossing | Commercial Building | 54,000 | NE corner of Gonzales Rd and Rose Ave | 3 01-128 | SUP99-5-128 10/4/99 |
| 73 | West Construction, Co. (805)482-7251 | Palm West Plaza | Retail & Service Station | 18,631 | SW corner of Collins St and Vineyard Ave | 3 00-6626 | SUP99-5-134 10/13/99 |
| 74 | Chip Erickson (415)445-7800 | Walgreens | pharmacy w/ drive-thru | 14,715 | 2255 Vineyard Ave | 4 00-2720 | SUP99-5-136 10/18/99 |
| 75 | Chevron Product Co. (562)694-7917 | Chevron | Gas Station | 2,877 | 1900 N Rose Ave | 3 00-4624 | SUP99-5-138 10/21/99 |
| 76 | Riverpark, LLC (213)346-9030 | Riverpark | Commercial, office 2,470,000 sq. ft. | PROPOSED PROJECT | Proj Bounds:101 Fwy, Sta. C. River, Vineyard Ave | 1 | PZ 99-5-158,159 12/21/99 |
| 77 | Delta Inn (503)641-5200 | Marriott Fairfield | Hotel - 100 rooms | WITHIN PROPOSED PROJECT SITE | 2775 N Ventura Bl | 1 | SUP99-5-142 10/28/99 |
| 78 | Delta Inn (503)641-5200 | Marriott Courtyard | Hotel - 140 rooms | WITHIN PROPOSED PROJECT SITE | 2775 N Ventura Bl | 1 | SUP99-5-149 10/28/99 |
| 79 | Michael Faulconer (805)486-4549 | none | Commercial (TM, ZC, GPA) | 43,000 | NE corner Rose & Channel Islands | 1 | 99-5-164 12/30/99 |
| 80 | Tiger Ventura County (805)485-3193 | Financial Tower II | 14 Story Office/ Parking Garage | 309,429 | 450 E Esplanade Dr | *1 | MJMD: U1423 2/10/00 |
| 81 | David Stillmunks (805)240-1300 | Jehovah's Witness Kingdom Hall | addition to existing church | 5,500 | 601 E Bard Rd | 1 | MJMD: U1010 4/21/00 |
| 82 | Whitfield Associates (949)234-1950 | Buick/GMC Truck | New auto dealership | 33,140 | 1600 Auto Center Dr | 4 00-6044 | DDR00-5-63 5/11/00 |
| 83 | M & H Realty (805)350-1977 | Esplanade | Shopping center | 385,000 | 301 West Esplanade Dr | 4 00-4750 | PD00-5-75 7/10/00 |
| 84 | Lauterbach and Associates (805)988-0891 | San Wall II | Adult Day Care, Office, Retail | 13,250 | 2221 Wankel Way | 2 | SUP00-5-97 8/21/00 |
| 85 | West Construction (805)482-2688 | Mobil | Service Station | 12,000 | 2441 N Vineyard Ave | 1 | SUP00-5-133 11/3/00 |
| 86 | Michael Faulconer (805)486-4549 | Oxnard Hotel | MIX USE: Retail/ Residential 38 res units | 2,880 | 201 W Seventh St | 1 | SUP00-5-140 11/21/00 |
| 87 | CBC Fed Credit Union (805)984-3050 | CBC Federal Credit Union | Credit Union / Office | 30,300 | 1901 Outlet Center Dr | 1 | SUP00-5-142 11/30/00 |
| 88 | Israel Linder (818)535-7277 | Brake Masters | Automotive Brake Service | 3,340 | 2931 Saviers Rd | 1 | SUP00-5-146 12/12/00 |
| 89 | USA Gasoline Corp. (818)865-9200 | USA Gasoline | Remodel existing gasoline station | N/A | 5040 Saviers Rd | 1 | SUP00-5-151 12/21/00 |
| 90 | Juan Gonzales (805)487-4196 | none | MIX USE: Restaurant/Residential 2 res units | N/A | 506 Cooper Rd | 1 | SUP00-5-152 12/26/00 |
| 91 | Mac Valley Oil (805)485-6900 | Service Station | Food, gas, gen retail, truck wash | 4,681 | 200 Del Norte Blvd | 1 | SUP01-5-20 3/19/01 |
| 92 | M&H Realty (858)350-1977 | Esplanade | Phase II | 119,000 | 301 West Esplanade Dr | 1 | MJMD: 00-5-75 4/10/01 |
| 93 | RHL Design Group (562)902-8023 | Seven Eleven | Retail Store and Fuel Station | 6,540 | 1501 West Fifth Street | 1 | SUP01-5-32 4/17/01 |
| | TOTAL | | | 1,321,732 | | | Revised: April 24, 2001 |

**STATUS KEY: 1 PROPOSED 2 APPROVED 3 PLAN CHECK 4 UNDER CONSTRUCTION**

## Industrial Development

| Proj # | Developer/ Phone Number | Project Name | Description | Building Sq. ft. | Location | Status Pmt. # | Planning File Date Received |
|---|---|---|---|---|---|---|---|
| 94 | Jeff Conrad (805)983-0057 | Saddletree/Lainer Brothers | New tilt-up | 8,925 | 300 Hearst Dr | 3 99-2823 | DDR 88-22 |
| 95 | Russel Tyner (310)827-5009 | Channel Is. Bus Center Accurate Engineering | 9 Industrial Buildings | 170,000 | 1201-1445 Stellar 1250-1440 Pacific Av | 4 | SUP 96-5-61,71-73 10/31/96 |
| 96 | Peter Faxen (805)487-8501 | Coastal Multichrome | Industrial Building | 22,207 | 1051 Yarnell Pl | 2 | SUP 97-5-15 3/20/97 |
| 97 | James Searl/Architects (805)484-3714 | Moen Development | Industrial Building | 67,500 | 2221 Celsius Ave | *3 00-5944 | DDR 97-5-37 5/28/97 |
| 98 | Houston/Tyner (310)827-3289 | CIBC | Industrial Building | 129,482 | 1551 S Rose Ave | 3 98-1113 | SUP 97-5-50 7/8/97 |
| 99 | Alexander Semchenko (805)650-5054 | CI Voss Development | Industrial Building | 21,000 | 1700 Jones Way | 4 98-2732 | SUP97-5-99 12/2/97 |
| 100 | Dal/Lyn International (805)388-2724 | None | Industrial Building | 6,285 | 401 Spectrum Circle | 1 | DDR 98-5-9 2/10/98 |
| 101 | Michael Schau (310)379-9760 | None | 3 Industrial Buildings | 30,000 | 2301 Sturgis Rd | 3 98-3874 | DDR 98-5-29 3/16/98 |
| 102 | Michael Schau (310)379-9760 | None | 3 Industrial Buildings | 30,000 | 2301 Sturgis Rd | 3 | DDR 98-5-30 3/16/98 |
| 103 | JDO Associates (818) 706-3997 | McGarrey Development | Industrial Building | 11,562 | 1300 Yarnell Pl | 4 98-3841 | SUP 98-5-57 5/14/98 |
| 104 | JDO Associates (818) 706-3997 | None | Industrial Building | 11,880 | 321 Bernoulli Circle | 3 99-1777 | DDR 98-5-89 8/19/98 |
| 105 | Grimco Dev. & Brokerage (818)341-3236 | None | Industrial Building | 44,202 | 301 Todd Court | 3 00-1587 | DDR 98-5-96 9/8/98 |
| 106 | Stockton Architects (323)848-6304 | None | Industrial Building | 16,200 | 1551 Pacific Ave | 3 99-20 | SUP 98-5-99 9/14/98 |
| 107 | Stockton Shindelus Arch. (818)996-1040 | None | Industrial Building | 16,200 | 1501 Pacific Ave | 3 99-21 | SUP 98-5-100 9/14/98 |
| 108 | Anshen & Aleen L.A (323)525-0500 | Testing Center | Industrial Building | 67,454 | 5650 Arcturus Ave | 4 00-428 | MJMD: U1245 11/24/98 |
| 109 | Price & Metzger (818)991-8215 | None | Industrial Building | 52,000 | 1901 Eastman Ave | 4 00-6077 | SUP99-5-6 1/26/99 |
| 110 | Caldwell / Mitchell (805)981-4500 | None | Industrial Building | 23,610 | 3100 Camino Del Sol | 4 99-4781 | DDR99-5-56 4/14/99 |
| 111 | Caldwell / Mitchell (805)981-4500 | None | 4 Industrial Building | 39,333 | 301, 311 Kinetic Dr & 3050 Camino Del Sol | 4 99-4776-80 | DDR99-5-57 4/14/99 |
| 112 | Vincent Dyer (818)882-5250 | None | 2 Story Industrial Bldg. | 21,596 | 1851 Lombard | 4 00-44 | DDR 99-5-83 6/8/99 |
| 113 | Michael Faulconer (805)486-4549 | Purepak | Industrial Expansion | 17,000 | 2640 Sturgis Rd | 3 00-602 | SUP99-5-119 9/9/99 |
| 114 | Brett Shaw Architects (310)284-8388 | None | Industrial Building | 10,500 | 1000 Yarnell Pl | 4 00-215 | SUP99-5-122 9/15/99 |
| 115 | Brett Shaw Architects (310)284-8388 | None | Industrial Building | 10,500 | 1050 Yarnell Pl | 3 00-216 | SUP99-5-123 9/15/99 |
| 116 | Brett Shaw Architects (310)284-8388 | Oxnard Millenium | 4 Industrial Buildings | 34,033 | 1730, 1720, 1740 Ives | 3 00-2245-48 | SUP99-5-125 9/22/99 |
| 117 | Brett Shaw Architects (310)284-8388 | None | Industrial Building | 10,050 | 310 Irving Dr | 4 00-1294 | DDR99-5-153 12/8/99 |
| 118 | Brett Shaw Architects (310)284-8388 | None | Industrial Building | 9,675 | 300 Irving Dr | 4 00-1293 | DDR99-5-154 12/8/99 |
| 119 | Martin Teitelbaum (818) 991-3289 | None | 5 Industrial Bldgs | 115,675 | 1201, 1251, 1245 Stellar Dr 1200 Pacific Ave | 1 | SUP00-5-4 1/19/00 |
| 120 | Lenvik & Minor Arch. (805)963-3357 | Pacific Beverage Co. | Bev. Distributor, Wholesale | 125,687 | 401 Del Norte Bl | 3 00-5628 | SUP00-5-14 2/9/00 |

*Industrial Development (continued on next page)*

*Revised: Arpil 24, 2001*

**STATUS KEY: 1 PROPOSED 2 APPROVED 3 PLAN CHECK 4 UNDER CONSTRUCTION**

## Industrial Development (continued)

| Proj # | Developer/ Phone Number | Project Name | Description | Building Sq. ft. | Location | Status Pmt. # | Planning File Date Received |
|---|---|---|---|---|---|---|---|
| 121 | Marlin Oxnard Prop (818)716-4144 | None | Industrial Building | 19,509 | 1910 Eastman Ave | 3 00-4461 | DDR00-5-44 4/6/00 |
| 122 | JDO and Associates (818)706-3997 | None | Industrial Building | 46,445 | 500 Graves Ave | 2 | SUP00-5-49 4/19/00 |
| 123 | Johnson Muller Arch. (805)983-7411 | Select 1 Transport | Vehicle Transport and Storage | 29,751 | 700,720,730 Arcturus Ave | 1 | SUP00-5-53 4/19/00 |
| 124 | Vincent Dyer (818)882-5250 | None | Industrial Building | 53,270 | 300, 310 Graves Ave | 1 98-1110 | DDR00-5-66 5/19/00 |
| 125 | Golrich and Kest | None | Industrial Building | 39,128 | 1621/1651 Beacon Pl | 3 00-5495 | SUP00-5-67 6/5/00 |
| 126 | Sunbelt Properties (805)531-6500 | None | Industrial Building | 45,505 | 1701 Solar Dr | 4 00-5321 | SUP00-5-69 6/22/00 |
| 127 | GK Development (818)707-0650 | None | 5 tili-up Builsing | 53,934 | 400,410,420 Spectrum Cr | 3 00-5718 | DDR00-5-72 6/30/00 |
| 128 | GK Development (818)707-0650 | None | Industrial Building | 20,219 | 200 Kinetic Dr | 3 00-5723 | DDR00-5-73 6/30/00 |
| 129 | Vincent Dyer (818)882-5250 | Krasnoff | 12 Unit Ind. Building | 52,518 | 1400-1550 Mariner Dr | 2 | SUP00-5-76 7/11/00 |
| 130 | Leeds Engineering (805)482-7477 | None | Tilt-up Ind. Building | 87,028 | 3250 Camin Del Sol | 4 00-6213 | DDR00-5-86 7/19/00 |
| 131 | Fisher & Sons Architects (360)757-4094 | Terminal Freezers | Industrial Building | 129,523 | 1300 E Third St | 3 00-5309 | SUP00-5-93 8/10/00 |
| 132 | Trilliad Development (805)379-9800 | None | Industrial Building | 86,727 | 1401 Mariner Dr | 1 | SUP00-5-98 8/22/00 |
| 133 | John Dianna (805)523-0990 | None | Industrial Building | 17,293 | 701 Arcturus Ave | 2 | SUP00-5-101 8/29/00 |
| 134 | Hiji Bros & Nishimori Bros. (805)483-2515 | None | Industrial Building | 39,298 | 2450 Eastman Ave | 1 | DDR00-5-112 9/11/00 |
| 135 | Rice Development (310)275-1982 | None | 2 Story Warehouse Bldg | 118,600 | 1801,1811,1821,1831 Eastman Ave | 1 | SUP00-5-134 11/3/00 |
| 136 | Dean Maulhardt (805)4856678 | Quality Packaging | Industrial Building | 35,000 | Statham Blvd/Statham Pkwy 220-021-215 | 3 01-881 | SUP00-5-137 11/7/00 |
| 137 | Heck Gordon (805)981-2177 | Mirror Metals | Industrial Building | 8,428 | 360 Hearst Dr | 1 | DDR00-5-144 12/6/00 |
| 138 | Vincent Dyer (818)882-5250 | None | Industrial Building | 49,000 | 3400 Camino Del Sol | 1 | DDR01-5-6 1/25/01 |
| 139 | Vincent Dyer (818)882-5250 | None | Industrial Building | 36,500 | 300 Del Norte Blvd | 1 | DDR01-5-7 1/25/01 |
| 140 | Oxnard Merchant (805)383-2221 | None | 3 Industrial Buildings | 56,168 | 380 Lombard St | 1 | DDR01-5-10 1/30/01 |
| 141 | Kit Wong | None | Truck Dock and Office | 19,260 | 2900 Camino Del Sol | 1 01-1699 | DDR01-5-12 2/5/01 |
| 142 | Southern California Builders (805)497-4497 | None | 2 Industrial Buildings | 22,253 | 900 Graves Avenue | 1 | SUP01-5-18 3/13/01 |
| 143 | Harry Ross (310)317-1915 | None | Industria Building | 255,729 | 1500 E Third St | 1 | SUP01-5-28 4/4/01 |
| | TOTAL | | | 2,443,642 | | | |

**STATUS KEY: 1 PROPOSED 2 APPROVED 3 PLAN CHECK 4 UNDER CONSTRUCTION**

*Revised: April 24, 2001*

# APPENDIX 4.3
## Geology Reports

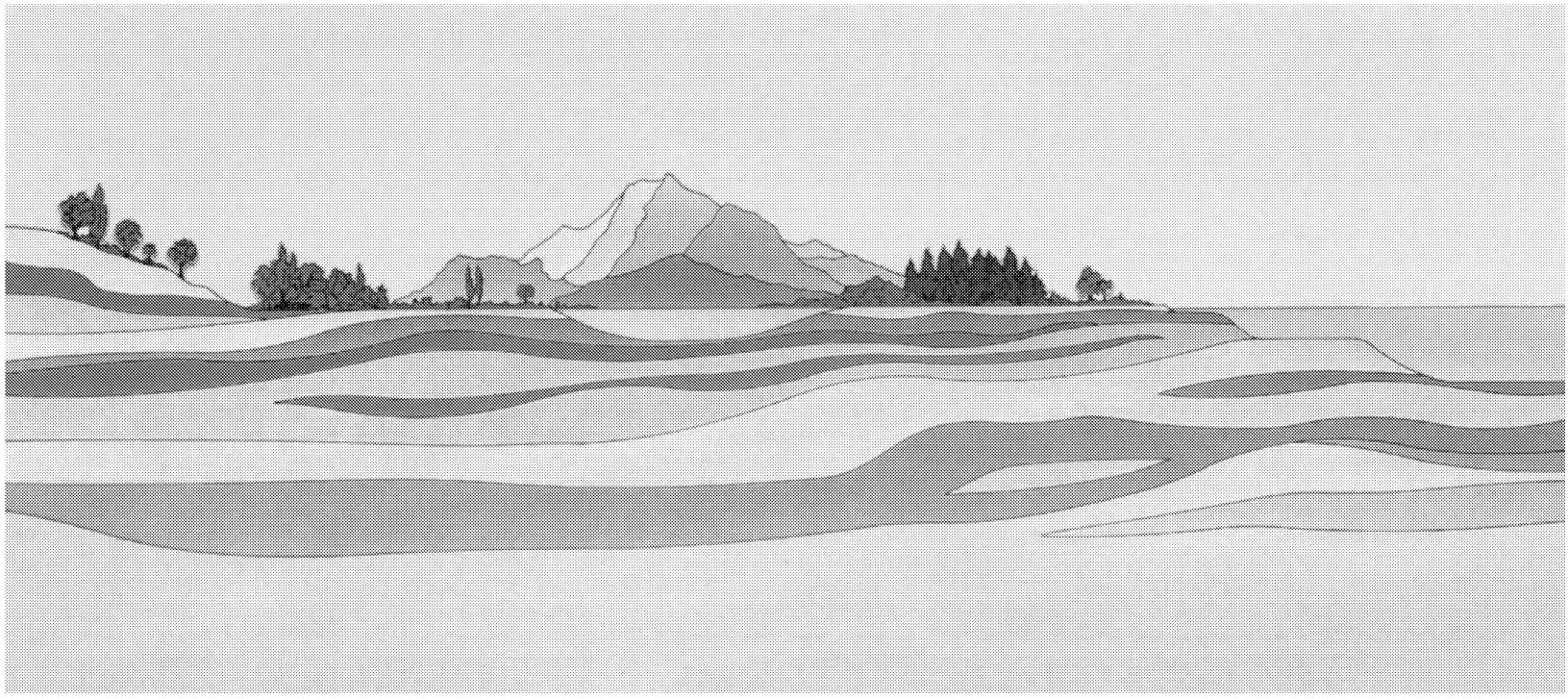
Geotechnical and Geological Input
for the EIR, RiverPark 'A' and 'B'
(Fugro West, Inc., May 2000)

FUGRO WEST, INC.

# GEOTECHNICAL AND GEOLOGICAL INPUT FOR THE ENVIRONMENTAL IMPACT REPORT, RIVERPARK A AND B, CITY OF OXNARD AND EL RIO AREA OF VENTURA COUNTY, CALIFORNIA

Prepared for:
KELLER EQUITY GROUP, INC.

May 2000



**FUGRO WEST, INC.**

4820 McGrath Street, Suite 100
Ventura CA 93003-7778
**Tel: (805) 650-7000**
Fax: (805) 650-7010

May 10, 2000
Project No. 99-42-0023

Keller Equity Group, Inc.
304 South Broadway, Suite 400
Los Angeles, California 90013

Attention: Mr. Jim Bond

Subject: Geotechnical and Geological Input for the Environmental Impact Report (EIR), RiverPark A and B, City of Oxnard and El Rio Area of Ventura County, California

Dear Mr. Bond:

Fugro is pleased to submit the geotechnical engineering and geological input for the Environmental Impact Report for the proposed RiverPark A and B developments in the City of Oxnard and the County of Ventura, California. Our understanding of the proposed project, and the scope of our geotechnical and geological services are based on our proposal dated March 15, 2000. This study was authorized by Mr. Paul Keller of Keller Equity Group, on March 16, 2000, by the execution of our Agreement for Professional Services, received by Fugro on March 27, 2000.

We appreciate the opportunity to provide continuing services to Keller Equity Group, Inc. on this phase of the RiverPark project. Please call if we can provide further information or clarify any findings or recommendations.

Sincerely,

FUGRO WEST, INC.

Carole Wockner
Project Engineer

Thomas F. Blake, G.E., C.E.G.
Geotechnical Services Manager

Copies submitted: Addressee (7)
Alan Eide, ASL Consulting Engineers (2)
Tony Locacciato, Impact Sciences (1)

# CONTENTS

Page

INTRODUCTION ..... 1
General Statement ..... 1
Site Setting ..... 1
Purpose ..... 1
Authorization ..... 2
Project Description ..... 2
Data and Aerial Photograph Review ..... 2
SITE CONDITIONS ..... 3
Topography ..... 3
Drainage ..... 3
SITE HISTORY ..... 3
GEOLOGIC CONDITIONS ..... 4
Regional Geology ..... 4
Earth Materials ..... 4
Artificial Fill (Af) ..... 5
Alluvium (Qal) ..... 5
Engineering Properties ..... 5
GROUNDWATER CONDITIONS ..... 5
GEOHAZARDS AND SEISMICITY ..... 6
Potential Seismicity ..... 6
Nearby Fault Sources ..... 7
POTENTIAL GEOTECHNICAL HAZARDS AND POSSIBLE MITIGATIVE MEASURES ..... 8
Earthquake-Induced Hazards ..... 8
Ground Rupture Potential ..... 8
Potential for Strong Ground Motion ..... 9
Liquefaction Potential ..... 9
Lateral Spreading ..... 10
Seismically Induced Settlement ..... 11
Tsunamis and Seiches ..... 12
Geotechnical and Other Hazards ..... 15
Hydroconsolidation ..... 15
Subsidence ..... 15
Expansive Soil ..... 15

## CONTENTS -- CONTINUED

Page

Artificial Fill ..... 16
Basal Inclinations of Fill Placed Over Native Slopes ..... 17
Levee Slopes ..... 17
Flooding ..... 18

LIMITATIONS ..... 18

REFERENCES ..... 19

## TABLES

Page

1 Summary of Nearby Faults ..... 7

## PLATES

Plate

Vicinity Map ..... 1
Site Plan ..... 2
Geologic Map ..... 3

# INTRODUCTION

## GENERAL STATEMENT

Fugro is pleased to submit this draft geotechnical impacts study to be included in an Environmental Impact Report (EIR) for the proposed RiverPark A and B property in the El Rio area of Ventura County. The site consists of about 587 acres located in the city of Oxnard (at its western end) and in the county of Ventura (at its eastern end). Approximately 230 acres of the property are planned for development. The development will consist of single and multifamily residences, retail buildings, a school, streets, and a greenbelt. The RiverPark site is bounded on the northwest by the Santa Clara River levee, on the southwest by the Oxnard Town Center development, on the southeast by residential development along Vineyard Avenue, and on the northeast by the Montgomery Avenue industrial tract (Tract 4210). The general location of the RiverPark property is shown on Plate 1 - Vicinity Map. The site layout is shown on Plate 2 - Site Plan.

## SITE SETTING

As shown on Plate 2, the western portion of the RiverPark property has been designated RiverPark "A" and is located adjacent to the Oxnard Town Center to the west, residential development along Vineyard Avenue to the southeast, Highway 101 to the south, the Santa Clara River to the northwest, the Hanson Aggregate plant property to the north, and a County of Ventura flood control detention basin to the northeast.

The eastern portion of the subject property has been designated RiverPark "B" and comprises the existing Hanson Aggregate plant property and two County of Ventura flood control detention basins. One of the flood control detention basins (the North El Rio Drain Basin No. 2), located adjacent to the northeastern corner of the proposed RiverPark A, will be filled and will become a part of the RiverPark development. The RiverPark B property is bounded on the northwest by the Santa Clara River levee, on the northeast by the Vulcan Materials plant property, on the east by the Giocopuzzi property, and on the southeast by a second, smaller detention basin (the North El Rio Drain Basin No. 1) on County property adjacent to Vineyard Avenue. That smaller detention basin will remain; however, we understand that it will be deepened.

## PURPOSE

The purpose of this EIR-level geotechnical study is to identify potentially adverse geologic and geotechnical constraints that could impact the proposed RiverPark site, and to develop possible mitigative measures to reduce those impacts. The following geologic and geotechnical concerns have been evaluated for this study:

- Generalized engineering properties of soils
- Generalized soil and groundwater conditions, including the presence of artificial fill
- Geologic setting and geologic hazards, including liquefaction, seismic shaking, fault rupture, seismically induced settlement of dry sands, seismically induced lateral movements, hydroconsolidation, subsidence, and expansion potential

Specifically excluded from this study is the evaluation of the stability of the slopes in the pits located on the Hansen Aggregate plant property that, along with the larger of the two county detention basins, comprises the proposed RiverPark B site. Areas beyond the top of the pit slopes affected by their stability are also excluded. We understand that the stability of the pit slopes and adjacent areas impacted by those slopes are being evaluated by others.

## AUTHORIZATION

The scope of work for this study was set forth in a Fugro proposal dated March 15, 2000, to Keller Equity Group, Inc. This study was authorized as an extension of our existing Agreement for Professional Services by Keller Equity Group, on March 16, 2000, and forwarded to Fugro on March 27, 2000.

## PROJECT DESCRIPTION

On the basis of a preliminary conceptual plan received from Keller Equity Group in August 1999, we understand that the RiverPark A and B development will consist of the following:

- **Residential.** Single family residences are planned on about 62 acres of the 230 acres of development area. Zero-lot-line residences are planned on approximately 39 acres, and multifamily residences are planned on about 21 acres.
- **Retail.** Retail buildings are planned on approximately 4 acres.
- **Elementary School.** An elementary school is planned on about 10 areas of the development area.
- **Greenbelt.** Greenbelt areas are planned on approximately 17 acres of the development property.
- **Streets.** Approximately 77 acres of the development area will be used for streets.

## DATA AND AERIAL PHOTOGRAPH REVIEW

Existing available geologic and geotechnical data pertinent to the study were compiled from various sources and reviewed. Those data include published and unpublished geologic and geotechnical maps, geotechnical reports for portions of the subject site and for adjacent

properties, literature, and research data, along with pertinent well logs and historical stereo aerial photographs. References utilized and photographs reviewed are listed in the References section following the text.

## SITE CONDITIONS

### TOPOGRAPHY

Natural elevations across the RiverPark A site vary from about El. 75 feet (MSL) adjacent to the base of the southwestern end of the river levee to about El. 90 feet at the eastern end of the property.

The RiverPark B site, through excavation of detention basins (County) and mining pits (Hanson Aggregate) and the stockpiling of excavated and imported materials, varies in elevation from about sea level (or possibly deeper) in the mining pits to roughly El. 138 feet on a stockpile in the plant area.

### DRAINAGE

The subject property lies within the floodplain of the Santa Clara River. The levee along the northwestern boundary of the site was constructed by the U.S. Corps of Engineers in about 1961 to protect the southern bank of the Santa Clara River from the "Standard Project Flood,"(i.e., peak flow 225,000 cfs [Simons, Li and Associates; 1991]) flooding. The levee along the western end of the property is approximately 10 feet high, with a slope gradient of about 1.5h:1v. The levee height varies by several feet and its slope gradient also varies between about 1.5h:1v and 2h:1v along the length of the RiverPark river frontage.

Drainage within the project area occurs as sheet flow and through numerous man-made diversion and catchment structures. Topographically, the general drainage direction appears to be toward the southwest and west in the RiverPark A area. The general drainage direction on the RiverPark B site, which was originally toward the southwest and west, has been disrupted by numerous mining pits and material stockpiles on the Hanson Aggregate property, and by the County of Ventura water detention basins adjacent to the Hanson property along Vineyard Avenue.

## SITE HISTORY

The site was has been used for agricultural purposes, which presently continue as row-crop farming on the RiverPark A property. That portion of the RiverPark B site where the Hanson Aggregate plant is located was converted to mining in the late 1940s and early 1950s (possibly earlier).

The Hanson Aggregate plant property consists of several mining pits, the plant area, and a stockpile area that locally was mined and refilled in various stages beginning in the mid-1960s and continuing to the present. Additionally, the plant property is bounded on the southwest by an approximately 40-acre, 10- to 20-foot-deep water retention basin and on the east by an approximate 10-acre water retention basin. Both basins were constructed and are maintained by the County of Ventura.

## GEOLOGIC CONDITIONS

### REGIONAL GEOLOGY

The RiverPark A and B property is situated in the southern portion of the Transverse Ranges geomorphic province of California. The province is characterized by east-west-trending mountain ranges composed of sedimentary and volcanic rocks ranging in age from Cretaceous to Recent. Major east-trending folds, reverse faults, and left-lateral strike-slip faults reflect regional north-south compression and are characteristic of the Transverse Ranges. The Transverse Ranges Geomorphic Province is bounded on the north by the Santa Ynez fault, on the east by the San Bernardino Mountains, on the south by the Transverse Ranges frontal fault zone, and on the west by the Pacific Ocean.

The Ventura basin, including its offshore continuation in the Santa Barbara Channel, is the dominant structural element of the western Transverse Ranges. The basin is filled with a thick sequence of Cenozoic sedimentary rocks estimated to be more than 20,000 feet in total thickness.

The site is located along the Santa Clara River channel, which is underlain by a 1,000- to 2,000-foot-thick sequence of recent (Quaternary age) alluvium and terrace deposits, which generally are unconsolidated to partially consolidated. The alluvial materials generally consist of older stream channel ($Q_{os}$) and floodplain deposits ($Q_{fp}$) of sand, gravel, cobbles, silt, and clay, which are generally stratified and locally cross-bedded. Plate 3 - Geologic Map, shows the surface distribution of sediments in the project area.

Aerial photographs reveal a wide and braided channel morphology that historically has encroached on the northwestern end of the subject property.

### EARTH MATERIALS

On the basis of data from numerous borings drilled both on and near the subject property and data from CPT soundings advanced on the Hanson Aggregate plant property (Fugro, 1999), the general native soil profile consists predominantly of alluvial (i.e., river bed and floodplain) deposits. The alluvial materials consist of silty sand to well-graded sand with varying amounts of gravel and cobbles and with scattered thin layers of silt or clayey silt. Artificial fill materials

were estimated in the plant stockpile area to depths generally between about 20 to 50 feet, and in some areas as deep as 65 to 85 feet, or more. Artificial fill in the plant area was estimated to depths of between a few feet and about 20 feet (Fugro, 1999). In the areas surrounding the RiverPark property, artificial fill associated with agriculture (e.g., from discing, etc.) was estimated to be generally between about 2 and 5 feet in depth. Fill materials appeared to be derived from surficial onsite silty sands, well-graded sands, sandy silts, and clayey silts.

**Artificial Fill (Af)**

As suggested by the boring and CPT data compiled for this study, the artificial fill appears to consist predominantly of silty sand to well-graded sand with varying amounts of gravel. At some locations in the plant stockpile area, including the south end of that area, the fill materials consisted predominantly of silt and clay in the upper 20 to 40 feet.

**Alluvium (Qal)**

The alluvium appears to consist primarily of silty to well-graded sand with varying amounts of gravel and cobbles, and scattered thin silt and clay layers. Along the river levee in the stockpile area, alternating native clay and silt layers are common below a depth of about 30 feet.

**Engineering Properties**

**Alluvium (Qal).** On the basis of descriptions and sampler blow counts from borings drilled on the subject site and adjacent properties, the natural silty sand to well-graded sand (with varying amounts of gravel and cobbles) materials generally appear to range from medium dense to very dense. Those sandy materials are anticipated to be non-expansive. Natural fine-grained clay and clayey silt lenses are anticipated to be thin and discontinuous in the upper 30 feet. Those materials generally have been found to range from medium stiff to medium dense.

**Artificial Fill (Af).** Surficial artificial fill materials, generally consisting of sandy silt and silty sand are anticipated to be loose because of agricultural discing. Deeper artificial fill materials, associated with filling mining excavations in the stockpile area of the Hanson Aggregate property, have been found to range from loose silts and clayey silts to loose to dense sands.

## GROUNDWATER CONDITIONS

Groundwater was reported as shallow as 11 feet (Buena Engineers, 1984), or about elevation 65 feet, at the Oxnard Town Center site located adjacent to the west end of the RiverPark A site. At the State Compensation Fund building site, located just west of the westernmost end of the RiverPark A site and adjacent to the levee along the Santa Clara River,

groundwater was encountered at depths of about 25 to 26 feet (i.e., between elevations of about 50 and 52 feet; Law/Crandall and Associates, 1991). Along the southeastern boundary of the RiverPark A portion of the subject site, groundwater was encountered at a depth of about 30 feet (i.e., about elevation 60 feet; Geolabs, 1998).

On the RiverPark B site, groundwater was encountered as shallow as about El. 64 feet (Fugro, 1999) in the Hanson plant area and about El. 65 feet at the northeastern end (Earth Systems Consultants, 1997a,b) of the Hanson property. The historical high groundwater levels range from roughly El. 76 feet at the northernmost end of the Hanson property to roughly El. 60 feet toward the State Fund Insurance building at the southwesternmost end of the property (Fugro, 1997).

Because the site is located adjacent to an active river channel, the groundwater level is anticipated to fluctuate significantly over the seasons and from one year to the next, depending on rainfall, runoff volumes, recharge, and irrigation. The highest historical groundwater elevation for the Hanson plant and pit area was estimated by Fugro (1997) to be about El. 78 feet.

## GEOHAZARDS AND SEISMICITY

The project site is located in a seismically active region and, as such, can be expected to be subjected to strong ground shaking during its design life. Analyses of seismicity for the project site were conducted to estimate strong ground motion hazards and to develop preliminary input parameters to be used for the seismic design of the proposed facilities. The analyses essentially consisted of: 1) estimating and tabulating the distance to nearby fault sources and 2) estimating ground motion from the State of California's published regional probabilistic seismic hazard evaluation. Results of the analyses are summarized below.

### POTENTIAL SEISMICITY

Ventura is the only county in southern California that has not directly experienced the effects of a devastating historical earthquake on a fault within its borders (Weber and Kiessling, 1975). That quiescence is in clear conflict with the active tectonic framework of the county, because there are numerous regional and local active faults in the county that pose a seismic risk to the area.

Geodetic surveys indicate that the Ventura basin is experiencing crustal shortening at an annual rate of about 1 centimeter (cm) per year in a north-south direction. Because no historical earthquakes have been recorded in the area over the course of at least 200 years (aside from the 1812 and 1857 earthquakes occurring on the San Andreas fault, occurrences that probably did little to relieve crustal strain in the Ventura basin), the Ventura region is likely to experience a large earthquake, or a cluster of large earthquakes, in the near future.

On the basis of the crustal shortening rate noted above, the Ventura region should have experienced the equivalent of two moment magnitude 7.5 earthquakes during the last 200 years. However, no large-magnitude earthquakes have occurred historically along the Simi-Santa Rosa, Oak Ridge, San Cayetano, Ventura, or any other major fault in the county. Obviously, portions of Ventura County have been affected by earthquakes occurring in other geographic regions, such as the damage in Fillmore and Simi Valley that resulted from the January 17, 1994, Northridge earthquake (magnitude 6.7). However, no earthquakes with magnitudes larger than 6.0 have occurred historically on faults in Ventura County.

The relative earthquake quiescence in Ventura County is disconcerting because portions of Ventura County exhibit some of the greatest Quaternary deformation rates in California and the world. For instance, the Ventura anticline, located about 12 miles north of the project site, has exhibited uplift rates of about 6 millimeters per year (mm/yr) for the last 40,000 to 100,000 years. That rate compares with typical coastal terrace uplift rates in other areas of California of about 0.1 to 0.5 mm/yr. That high deformation rate implies a high tectonic activity rate for the region, which has not been experienced historically.

## NEARBY FAULT SOURCES

Table 1 - Summary of Nearby Faults, presents a summary of the distances to the project site and the maximum magnitude of some of the nearby fault sources that may cause future shaking at the project site.

Plate 3 shows the proximity of the RiverPark site to the Oak Ridge (onshore) fault. The closest portion of the Oak Ridge fault system to the project is along the inferred McGrath fault trace, located approximately 1,500 feet northwest of the site.

**Table 1. Summary of Nearby Faults**

| Fault Name | Distance Between Site and Surface Projection of Earthquake Rupture Area (miles) | Estimated Maximum Earthquake |
|---|---|---|
| Oak Ridge (onshore) | 0.25 | 6.9 |
| Simi-Santa Rosa | 3 | 6.7 |
| Ventura-Pitas Point | 4 | 6.8 |
| Channel Island Thrust (Eastern) | 5 | 7.4 |
| Montalvo-Oak Ridge Trend | 6 | 6.6 |
| Anacapa-Dume | 6 | 7.3 |
| Oak Ridge (Blind Thrust) Offshore | 7 | 6.9 |
| Red Mountain) | 11 | 6.9 |
| San Cayetano | 14 | 6.8 |
| Santa Ana | 14 | 6.7 |
| Malibu Coast | 18 | 6.7 |
| San Andreas | 41.5 | 7.8 |

# POTENTIAL GEOTECHNICAL HAZARDS AND POSSIBLE MITIGATIVE MEASURES

The potential geotechnical hazards that may impact the RiverPark site consist of primary seismically induced hazards such as fault rupture and strong ground motions, and their secondary effects such as liquefaction, lateral spreading, settlement in dry sands, tsunamis, and seiches. Other geotechnical hazards or concerns not related to earthquakes that have been evaluated include hydroconsolidation, subsidence, expansive soils, artificial fills, basal fill inclinations, proximity of levee slopes, and flooding. Note that although the stability of the existing mining pit slopes under both static and seismic conditions is of significant, if not paramount concern, the evaluation of the stability of those slopes is not a part of this study. We understand that the evaluation of the pit slopes and subsequent recommendations for mitigation will be performed by others.

The geotechnical hazards and concerns are identified individually below. A brief description of each evaluation of the particular hazard or concern at the project location is followed by possible mitigative measures, if needed. Note that the hazard evaluations presented below are preliminary and should be confirmed with a site-specific geotechnical study.

## EARTHQUAKE-INDUCED HAZARDS

### Ground Rupture Potential

**General.** Ground rupture caused by movement along a fault could likely result in catastrophic structural damage to buildings constructed along that fault trace. Consequently, the State of California, through the Alquist-Priolo Earthquake Fault Zoning Act, prohibits the construction of occupied structures within a designated fault zone without demonstrating that the structure does not encroach a 50-foot setback from the fault trace. Local government, such as the County of Ventura, identifies other faults, in addition to those faults mandated by the State, for which minimum construction setback requirements must be maintained.

**Evaluation.** The fault located closest to the site is the McGrath fault, which is a part of the Oak Ridge (onshore) fault system. The inferred trace of the McGrath fault (Weber et al., 1973) is approximately estimated within the Santa Clara River channel, about 1/4 mile north of the project.

Because the project is not located within a designated Alquist-Priolo Earthquake Hazard Zone and because no known active or potentially active faults are believed to exist or trend toward the site, the potential for primary ground surface rupture due to faulting is considered to be low.

**Mitigation.** On the basis of the preliminary fault-rupture evaluation, no fault-rupture-hazard mitigation appears necessary.

## Potential for Strong Ground Motion

**General.** The energy released during an earthquake propagates from its rupture surface in the form of seismic waves. The resulting strong ground motion from seismic wave propagation can cause significant damage to structures. At any location, the intensity of the ground motion is a function of the distance to the fault rupture, the local soil/bedrock conditions, and the earthquake magnitude (among others).

**Evaluation.** A published regional probabilistic seismic hazard map prepared by the California Division of Mines and Geology (CDMG, 1999) estimates that a peak horizontal ground acceleration (PGA) on the order of 0.7 g should have about a 10-percent probability of exceedance in a 50-year exposure period. That level of ground shaking generally corresponds to the level of ground motion that would have a return period of about 475 years and a probable moment magnitude of about 7.0.

Recent studies by Bozorgnia et al. (1999) have observed that at close distances (i.e., to Oak Ridge fault) and for such large earthquakes, the peak vertical acceleration can be about 1.6 times the peak horizontal acceleration.

As with most southern California sites, earthquake-related ground shaking could cause structural damage to on-site improvements.

**Mitigation.** Similar to other southern California sites that are located near earthquake sources, structures within the site would be required to be constructed in conformance with the Uniform Building Code (UBC). Project compliance with the UBC would reduce impacts associated with strong ground motion; although, the risk of damage would not be completely eliminated. The implementation of UBC standards for new construction is the procedure that is commonly applied in southern California to mitigate earthquake shaking hazards to an acceptable level.

## Liquefaction Potential

**General.** Soil liquefaction results from the earthquake-induced temporary buildup of excess pore water pressure, which can result in a condition of near-zero effective stress and the temporary loss of strength. Soil materials considered to be susceptible to liquefaction include loose, saturated sands, and non-plastic silts. Clay soil or sand and silt with more than 15 percent clay-sized particles (particles less than 0.005 mm) typically are considered to be non-liquefiable.

**Evaluation.** Groundwater has been observed on-site in past studies in the upper 50 feet of soils. On the basis of the estimated high groundwater levels, there may be a potential for liquefaction in loose to medium dense silty sand and sand layers that may exist below depths of about 11 feet at the western end of the RiverPark A area, and below about 17 feet on the RiverPark B site. However, loose to medium dense sands, gravelly sands, or silty sands also

must be present for liquefaction to occur. The blow count data from logs for borings drilled on or adjacent to the subject site suggest that the native granular soils are predominantly dense. Dense sands typically are not susceptible to liquefaction. However, the loose to medium dense sandy artificial fill materials encountered in the stockpile area of the Hanson Aggregate plant property (Fugro, 1999) appear to be susceptible to liquefaction.

**Impacts.** The liquefaction potential for the typically dense native submerged sands, gravelly sands, and sandy silts present at the site appears to be low. Therefore, liquefaction-induced settlements in native granular soil deposits are anticipated to be minor. Liquefaction-induced settlements in granular, submerged artificial fill materials could be significant and somewhat proportionate to the fill thickness.

We note that this preliminary evaluation and impact assessment for liquefaction at the project site is based on data from relatively few exploration locations in native materials on and near the project site. The available data is limited in depth, frequency, and location relative to the project site to reasonably characterize the density, composition, and variability of the natural alluvial materials at the project site. Therefore, we recommend that a site-specific study be performed on the RiverPark property to further evaluate the potential for liquefaction.

**Mitigation.** Liquefaction-related settlement in native sand materials could be reduced by constructing a layered geogrid-reinforced compacted fill mat beneath structures. Alternately, structure foundations could be designed to withstand the estimated differential settlements. The need for ground improvement or deep foundations to mitigate significant impacts from liquefaction-induced settlement in native soil materials has not been demonstrated in previous studies on or adjacent to the subject site.

Removal of artificial fill materials and replacement as a controlled, compacted fill would reduce the potential for liquefaction in those materials. Alternately, ground improvement techniques such as vibroflotation, stone columns, deep dynamic compaction, or compaction grouting may be feasible for reducing the potential for liquefaction-induced settlement in some homogeneous artificial fills. However, existing artificial fills need to be further characterized to assess feasibility of ground improvement techniques. For example, the deep fills in the stockpile area of the Hanson Aggregate plant property were considered not conducive to ground improvement because of their heterogeneity and variable thickness (Fugro, 1999).

## Lateral Spreading

**General.** Lateral spreading movement may occur when a soil mass slides laterally on liquefied soil layers, moving downslope or toward a free face. The magnitude of lateral spreading movements depends on earthquake magnitude, distance between the site and the seismic event, thickness of the liquefied layer, ground slope or ratio of free-face height to distance between the free face and structure, fines content and average particle size of the material comprising the liquefied layer, and N-value. We note that widespread lateral spreading

is generally not applicable to fine-grained soil, nor to sandy soil where: 1) blow count values are greater than about 15, and 2) where blow count values are less than 15 and the potentially vulnerable layer is less than 1 meter thick.

**Evaluation.** The mining pit slopes on the Hanson property, which range up to roughly 90 feet, or more, in height in some areas, and to a lesser degree, the embankment slopes adjacent to the Santa Clara River, are two examples of free-faces on or adjacent to the subject property. If continuous layers of submerged loose native sands with blow counts less than about 15 are present on the site in the upper 90 feet (or so), there may be a potential for lateral spreading. However, on the basis of the blow count data from the boring logs reviewed for this study, the potential for lateral spreading appears to be low in the native materials.

There may be a potential for lateral movement in the loose artificial fill materials in the stockpile area of the Hanson Aggregate plant and in other unexplored fill areas. Note that the potential for lateral spreading in the pit slope areas should be evaluated as a part of the slope stability study. That study is not a part of this geotechnical summary and will be presented under separate cover. Because the data obtained from borings excavated on nearby properties is limited in depth, frequency, and location to fully characterize site conditions, a site-specific study is recommended to further evaluate the potential for lateral movements in the fill and native alluvial materials at the RiverPark site.

**Mitigation.** The existing data from logs of borings on and adjacent to the RiverPark site do not suggest that there is a potential for significant lateral movements in the native materials. However, if susceptible areas are identified in subsequent studies, options for mitigation may consist of ground improvement or elimination of free faces by filling the pits to a level above which there is no potential for lateral movement. Note that the evaluation and mitigation of lateral spreading in slope areas is not a part of this study.

The potential for lateral movements in the artificial fill can be mitigated by removal and compaction of the fill materials or possibly by ground improvement in homogeneous materials.

**Seismically Induced Settlement**

**General.** Seismically induced settlement can occur during earthquake shaking in sandy soils that are loose to medium dense and above the water table. Seismically induced settlement differs from settlement resulting from liquefaction of saturated granular materials. In southern California, seismically induced settlement of dry and partly saturated sand was observed during the 1971 San Fernando and 1994 Northridge earthquakes.

**Evaluation.** The upper 10 to 20 feet of soil at the subject site is anticipated, for the most part, to remain above the groundwater level. Artificial fills encountered in the stockpile and plant areas of the Hanson plant property typically were loose to medium dense. Native sands and sandy silts encountered in the upper 20 feet on and adjacent to the project site typically were

medium dense. The loose to medium dense materials are susceptible to seismically induced settlement. The amount of settlement generally is inversely proportional to the relative density of the sand or sandy silt; therefore the loose sandy fill materials are anticipated to be more susceptible to settlement than the medium dense native sand and sandy silt materials. The potential for seismically induced settlement of the native sand and silty sand materials in the upper 10 to 20 feet appears to be minor.

**Mitigation.** The potential for seismically induced settlement in the loose artificial fill materials can be mitigated by removing the artificial fill materials and replacing those materials as a controlled, compacted fill. The slight potential for seismically induced settlement in the native sand and sandy silt materials may be accommodated in the foundation design of the proposed structures or may be partially mitigated with the overexcavation and recompaction of surficial soils in building areas.

**Tsunamis and Seiches**

**General.** Large earthquakes can induce tsunamis, which are sea waves characterized by significant runup reaches extending beyond coastal beach areas. The most significant historical tsunami in this area resulted from the 1812 Santa Barbara Channel earthquake, in which the wave runup extended to Mission San Buenaventura (about El. 30 feet).

Seiches are waves generated in a closed body of water from ground excitations such as earthquake shaking, tectonic tilting, fault rupture of the basin floor, landsliding of the basin slopes, volcanic pressure waves, or from atmospheric disturbances. As the waves approach the basin boundaries, they reflect. When the slopes of the basin are near vertical, the reflected waves have the same frequency as the incident waves with no phase shifts. If the excitation continues, the interference sets up standing waves, which tend to grow in amplitude. The amplitude increase can result in a wave runup hazard if there is insufficient freeboard height.

**Evaluation.** According to the Ventura County Seismic Safety and Safety Element (1974), a tsunami runup elevation for most of Ventura County is about 35 feet MSL. Additionally, according to Houston (1979), the site lies in "Zone 3," with expected tsunami runup elevation in the range of 15 to 30 feet (with a 90-percent probability of not being exceeded in 50 years). The RiverPark B site is located adjacent to several man-made ponds (i.e., mining pits) up to about 90 feet deep in some areas.

The project site is generally above elevation +75 feet MSL datum and is located several miles from the Pacific Ocean. Therefore, there is no historical basis for tsunami hazards to impact the site.

With respect to seiche hazard, the basin slopes are anticipated to have a minimum freeboard of about 2½ feet under the fullest pit conditions. Therefore, ground excitations or atmospheric disturbances resulting in maximum wave heights less than the minimum anticipated

freeboard height should not pose a hazard. Atmospheric pressure changes resulting in wind surges are not likely to produce wave heights greater than about ½ foot because of the relatively small size of the pits. Current volcanic activity is absent in the Oxnard plain area, so that potential source of seiche activity is unlikely. Landslide potential of the pit slopes will be reduced to less than significant by increasing the stability of the pit slopes through implementation of the proposed reclamation plan.

Oscillations from ground shaking, tectonic tilt, and fault rupture may produce seiche waves that could exceed the available pit slope freeboard. Research on the effects of ground shaking, tectonic tilt, and fault rupture on seiche wave heights is rare. Numerical models developed by Ichinose et al. (2000) for Lake Tahoe predict that fault rupture occurring within the limits of that lake has the potential to produce more significant seiches than rupture occurring outside the lake. That study estimates maximum seiche wave heights on the order of ½ meter as a result of tectonic tilting caused by fault rupture occurring outside the Lake Tahoe basin. The same study suggests maximum seiche wave heights from fault rupture occurring within the Lake Tahoe basin at about 6 to 10 meters. Additionally, analytical results from Jackson Lake, Wyoming, estimate that seiches with maximum amplitudes of up to about 15 feet may result from fault rupture occurring beneath the that lake (Dewey and Dise, 1987). The nearest known active fault to the RiverPark site, the Oak Ridge fault, is located about 1,500 feet to the northwest. Therefore, the potential for seiche waves generated from fault rupture within the RiverPark basins is less than insignificant. However, it is conceivable that tectonic tilting resulting from activity along the nearby Oak Ridge fault may result in wave heights on the order of several feet.

Seiche waves resulting from oscillations generated from earthquake ground shaking have been observed hundreds of miles from the earthquake source (Richter, 1958). The March 27, 1964, Alaskan earthquake caused seiches in bays, harbors, bayous, rivers, canals and lakes in the Gulf Coast region of Texas and Louisiana; however, the largest of those seiches was only about 2 meters in crest-to-trough height (Korgen, 1995). In most cases of those distant events, the vertical amplitude of earthquake-shaking-induced seiche waves was no more than a few feet (Sherard, 1967).

When wave oscillations are in phase with ground motions from near-field events (i.e., nearby earthquake activity), significant wave heights may result. However, for water waves to be in phase with near-field ground motions, the body of water should be small. The size body of water most likely affected by near-field oscillations is in-ground swimming pools. Anecdotal observations of significant sloshing of in-ground swimming pools during the Northridge and other recent earthquakes are common. Conversely, larger bodies of water, such as the mining pits, are less likely to be in phase with near-field ground motions because their periods are typically much longer.

There is an anecdotal newspaper article about a possible 30-foot-high seiche in the Los Angeles reservoir during the January 17, 1994, Northridge earthquake. According to a January 18, 1994, Los Angeles Times article, a 30-foot wave had overtopped the Los Angeles dam during the earthquake. In an effort to confirm that reported seiche, research teams attempted to find evidence of the wave, but after considerable effort they were only able to find weak evidence that water-level sloshing may have reached a maximum level of about 15 feet (Ruscher, 1997). As a result of that newspaper report, A National Science Foundation-funded study was performed by a University of Southern California graduate student, Christophe Ruscher, under the direction of Professor Costas Synolakis. That study, which consisted of the development of scaled physical models of the Los Angeles reservoir, was not able to substantiate the development of any more than just a few feet of reservoir sloshing due to earthquake induced oscillations, thereby casting doubt on the validity of the height of the newspaper-reported seiche.

The Los Angeles reservoir geometry is somewhat similar to the contiguous Brigham, Vickers, and Small Woolsey pit dimension and depth. Additionally, the ground movement from the Northridge fault is similar to that anticipated from the nearby Oak Ridge fault. If seiche waves in the mining pits were comparable in height to those estimated in the Los Angeles reservoir study, they would barely overtop the pit slope crests when the pits are at their fullest. Most of the year, freeboard in the mining pits is anticipated to range from 10 to 30 feet or more, during which time seiche runup would not overtop the pit slopes.

The minor overtopping of the slope crests by seiche waves induced from ground shaking or tectonic tilting would not be expected to travel very far beyond the crest. Additionally, landscape berms, trees, and shrubs would tend to impede the reach of the wave. Occupied structures for the RiverPark B development are planned at least 75 feet from the proposed slope crests and existing occupied structures on adjacent properties will have a setback of at least 30 feet from proposed slope crests after implementation of the reclamation plan. Therefore, seiche potential is not considered to be significant in the mining pit areas.

**Mitigation.** The potential for tsunami hazard impact on the RiverPark site does not exist. Additionally, the potential for seiche hazard impacts on proposed and existing occupied structures near the pit slopes in the RiverPark B area is considered less than significant, because seiche wave heights are not likely to exceed the available freeboard by more than a few feet. Further, occupied structures are (or will be) set back a minimum of 30 feet from the pit slope crests, and freeboard overtopping on the order of even several feet is not likely to travel 10 to 20 feet beyond the slope crest. Therefore, no mitigative measures are necessary for seiche hazard.

## GEOTECHNICAL AND OTHER HAZARDS

### Hydroconsolidation

**General.** Hydroconsolidation is a phenomena whereby natural soil deposits or fill materials collapse (settle) when wetted. Natural deposits susceptible to hydroconsolidation are typically aeolian, alluvial, or colluvial materials, with high apparent strength when dry. That dry strength may be attributed to the clay and silt constituency of the soil, and the presence of salts. Additionally, capillary tension may act to "bond" soil grains. Once those soils are wetted, the constituency including soluble salts or "bonding" agents is weakened or dissolved, capillary tensions are reduced, and collapse occurs.

**Evaluation.** The loose on-site artificial fills may be susceptible to collapse settlement. Because the native sands and sandy silts generally are medium dense, the collapse potential in those materials is anticipated to be low. Additionally, soils that have been saturated should have already collapsed to some extent at the time of saturation. Therefore, native materials below the historical high groundwater level for the site should not have a significant collapse potential unless they are subjected to greater overburden stresses than those experienced in the past. The collapse potential of native soil materials at the project should be evaluated further in site-specific studies.

**Mitigation.** The collapse potential of loose artificial fill materials can be mitigated by their removal and replacement as a controlled, compacted fill. The collapse potential of native materials is not anticipated to be significant, and mitigative measures are not likely to be necessary.

### Subsidence

**General.** Subsidence is the sinking of the ground surface caused by the compression of earth materials resulting from manmade activities such as groundwater or oil and gas withdrawal, or from peat oxidation. The resulting compression occurs within the affected soil typically only once and cannot be repeated during fluctuations (i.e., rise and fall) of the groundwater level.

**Evaluation.** Subsidence from peat oxidation is not likely because of the absence of peat deposits in the logs for borings excavated on and near the project. Similarly, oil and gas withdrawal is not a likely cause of subsidence at the RiverPark project because there are no known active wells in that area (Padre Associates, 1998; Buena Engineers, 1984).

Groundwater withdrawal may have caused some of the regional subsidence observed in the Oxnard Plain, and in the project area, over the last several decades. The Oxnard Plain has been monitored by the U.S. Coast and Geodetic Survey since the 1930s. Records to 1968 show numerous benchmarks that have settled a foot over a 15 to 20 year period (i.e., between about 1950 and 1968). The Draft Safety Element Technical Appendix 7 (City of San Buenaventura,

1989) estimates subsidence in the project vicinity (near U.S. Highway 101 and the Santa Clara River) at about 0.05 feet/year. However, groundwater levels would have to continue to decline for subsidence to continue at that rate (i.e., 0.05 feet/year). Because groundwater levels are not likely to retreat below historic low levels (Fugro, 1997), more recent subsidence rates (i.e., since 1968) from groundwater withdrawal should have retreated if not ceased.

**Mitigation.** Because groundwater levels are not likely to retreat below historical low groundwater levels realized over the past several decades, additional subsidence in the project area should be minor. Therefore, no mitigation measures appear warranted.

### Expansive Soil

**General.** Expansive soil is characterized by a clay composition whereby the surface area of dry clay particles increases dramatically upon wetting. Montmorillonitic clays are most susceptible to expansion, resulting in heaving soils. Foundations for structures constructed on expansive soils require special design considerations (UBC, 1997).

**Evaluation.** Surficial materials generally consist of granular material (silty sand, well-graded sand, sandy silt, and some clayey silt). Those granular materials are not anticipated to be expansive. However, clayey silt soils may demonstrate a slight to moderate expansion potential.

**Mitigation.** The impacts from soil with a low to moderate expansion potential can be reduced by deepening footings to act as a barrier for moisture migration under interior floor slabs. Additionally, premoistening of low to moderately expansive foundation subgrade can reduce the potential and the effects of shrink/swell cycles beneath the slab. Thickened slabs and additional reinforcement also can reduce impacts from expansive soil.

### Artificial Fill

**General.** Uncontrolled artificial fills generally are considered to be unsuitable for support of structures and other improvements.

**Evaluation.** Artificial fill materials were encountered in the stockpile and the plant areas of the Hanson Aggregate property to depths ranging from a few feet to at least 85 feet. Those materials were found to be quite variable in thickness, density, and composition (Fugro, 1999). Artificial fill materials between about 2 and 5 feet thick have been encountered in agricultural areas surrounding the project and are anticipated in the RiverPark A site, which also is currently used for agriculture. Artificial fill also may exist in other areas of the project. The potential for artificial fill should be explored further with a site-specific study.

**Mitigation.** Overexcavation and recompaction appears to be the most reliable means of remediating existing artificial fill materials on the project.

**Basal Inclinations of Fill Placed over Native Slopes**

**General.** Differential thicknesses of fill beneath structures can result in unacceptable levels of differential settlement.

**Evaluation.** The potential for differential settlement is magnified in areas where fill is placed over natural slopes because fill materials are likely to settle more than the dense native slope materials. Therefore, if a great variation in fill thickness exists over a relatively short distance, as would be the case for steep original excavation gradients that may exist in the stockpile area, the potential for differential settlement beneath a future structure straddling those fill and native slope materials would increase. This condition is likely in the stockpile area where excavation depths up to about 85 feet, or more, have been estimated (Fugro, 1999). For example, a 60-foot-high, 2h:1v slope excavated in the stockpile area would have a differential fill thickness of 60 feet over a horizontal distance of about 120 feet. Additionally, the differential settlement would be even more pronounced if the slope was actually excavated at 1h:1v (i.e., potentially a 60-foot fill differential over a distance of 60 feet). A structure built over that portion of the fill that varies in thickness from 0 to 60 feet (i.e., that portion that coincides with the original natural slope excavation location) could experience significantly greater differential settlement than a structure constructed on a uniform, 60-foot-thick fill.

**Mitigation.** The differential settlement across a potential building area that straddles differential fill thicknesses can be reduced by constructing fills with low-angle base gradients. For example, in the stockpile area, the fill thickness variation was recommended not to exceed 20 percent (Fugro, 1999). Alternately, greenbelt areas that could endure significant differential settlements could be planned in areas where steep transitional fills occur.

**Levee Slopes**

**General.** Depending on the limits of existing artificial fills and the proposed development, excavation slopes resulting from future grading, including those generated to remove existing artificial fills in the stockpile area, may encroach on the levee. Additionally, existing pit slopes, although not a part of this study, may encroach or exceed the setback and gradient limits established by the Ventura County Flood Control District or the Army Corps of Engineers.

**Evaluation.** Levee setback requirements, if any, for temporary excavations associated with the removal and replacement of existing artificial fills in the stockpile area and other areas, as necessary, should be defined by the Ventura Flood Control District and/or the Army Corps of Engineers. Similar requirements should also be verified for pit areas adjacent to the levee when evaluating pit slope stability and/or reclamation.

**Mitigation.** Contingency plans should be developed in the event that the artificial fill removal in the stockpile area encroaches the levee. The County may be amenable to temporary

removal of the levee. Alternate options include ground improvement of artificial fills in area adjacent to the levee.

### Flooding

**General.** The site is located adjacent to the Santa Clara River, a major watercourse with dams and reservoirs located upstream. The potential for flooding from natural rainfall or failure of upstream dams should be evaluated by others.

The potential for flooding at the project should be evaluated further by others.

## LIMITATIONS

This geotechnical impacts summary report has been prepared for Keller Equity Group, Inc., solely for the preliminary planning of the proposed RiverPark development. The applicability of this report is specifically limited to use in an environmental impact report (EIR). However, our study has specifically excluded an assessment of the stability of the pit slopes on the Hanson property and any areas adjacent to the top of those slopes that would be affected by their stability.

In performing our professional services, we have used that degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical engineers currently practicing in this or similar localities. No other warranty, express or implied, is made as to the professional advice included in this report.

Additional site-specific, design-level studies that include subsurface exploration are needed for the proposed development, as the scope for the work performed for the residential, retail, research and various support facilities was developed as a preliminary, EIR-level study.

An investigation and discussion of potential subsurface contamination is beyond the scope of this geotechnical study, as are environmental assessments for the presence or absence of hazardous/toxic materials in the soil, surface water, ground water, or atmosphere. Any statements or absence of statements in this report or data presented herein regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous/toxic assessment.

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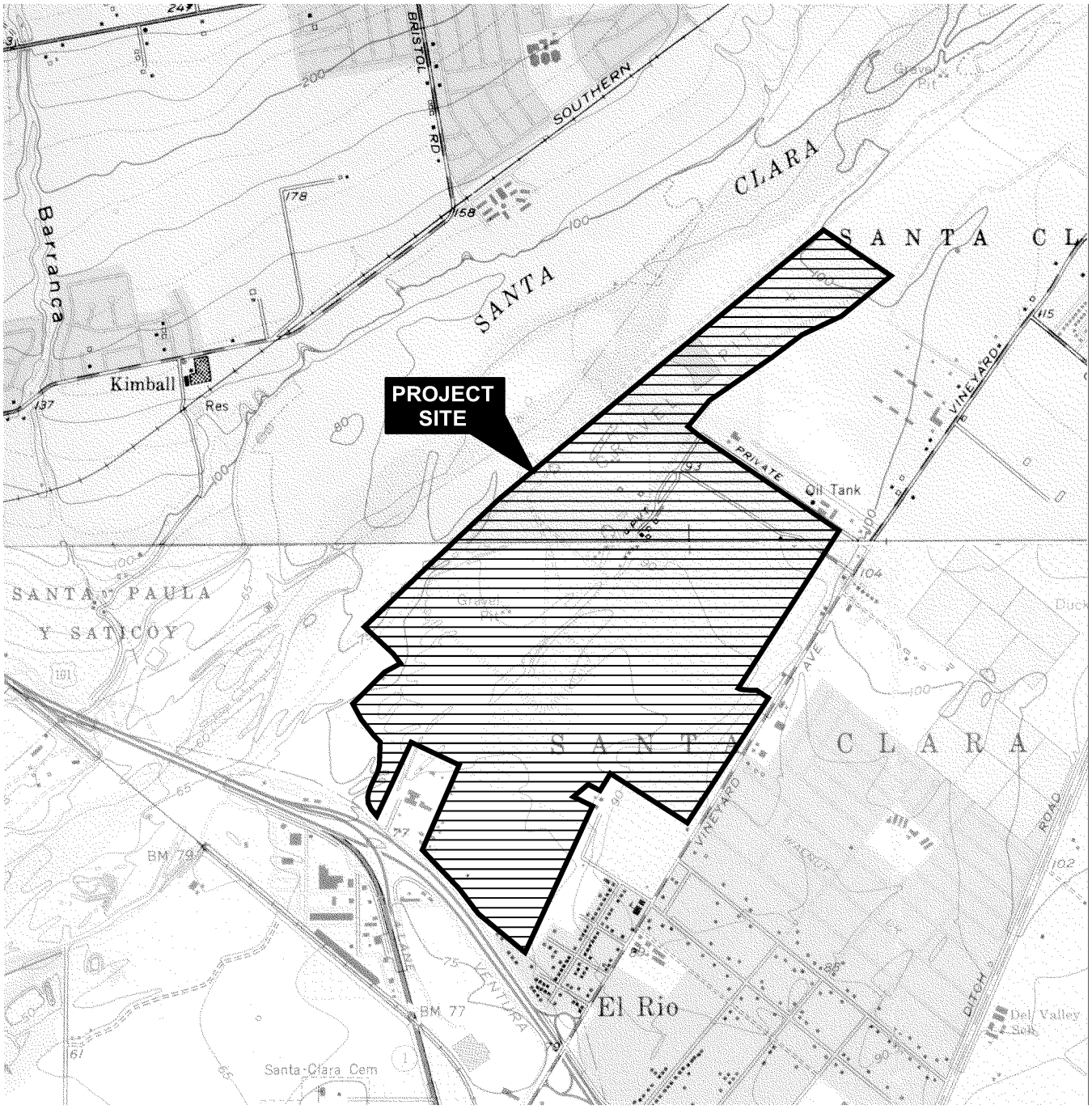
# AERIAL PHOTOGRAPHS REVIEWED

| Source | Flight No. | Date | Frame Nos. | Stereo |
|---|---|---|---|---|
| USGS | GS-EM | 8/20/47 | 74, 75 | Yes |
| U.S. Dept. of Agriculture (USDA) | AXI | 10/7/53 | 92,93 | Yes |
| USDA | AXI | 10/2/59 | 133, 134 | Yes |
| Mark Hurd | HA-LS | 6/30/61 | 37, 38, 39 | Yes |
| Mark Hurd | HA-OH | 3/24/62 | 51, 52, 53 | Yes |
| Mark Hurd | HA-RR | 1/7/63 | 110, 111 | Yes |
| Mark Hurd | HA-SH | 3/20/63 | 108, 109, 110 | Yes |
| Mark Hurd | HA-TG | 6/24/63 | 10, 11, 12 | Yes |
| Mark Hurd | HA-WE | 2/14/64 | 23.24, 37, 38 | Yes |
| USDA | AXI | 9/20/65 | 84, 85 | Yes |
| Mark Hurd | HB-IA | 7/5/66 | 54, 55 | Yes |
| USGS | GS-VBUK | 8/12/67 | 86, 87, 88 | Yes |
| Mark Hurd | HB-MA | 7/22/68 | 3, 4 | Yes |
| Pacific Western | VEN | 8/23/73 | 83, 84 | Yes |
| Pacific Western | 4918 | 3/17/75 | 1 | No |
| Teledyne Geotronics | 7500C | 7/29/75 | 5,6 | Yes |
| Teledyne Geotronics | 7700 | 3/14/77 | 14, 15 | Yes |
| Pacific Western | VEN-2 | 5/16/78 | 34, 60, 61 | Yes |
| Pacific Western | 9034 | 7/7/79 | 1 | No |
| Pacific Western | VEN-3 | 6/15/81 | 70, 71, 114, 115 | Yes |
| Pacific Western | VEN-4 | 1/11/84 | 114, 115 | Yes |
| Pacific Western | VEN-5 | 12/10/86 | 110, 111 | Yes |
| Pacific Western | VEN-5 | 1/12/87 | 122, 123, 124 | Yes |
| Pacific Western | 28847-3 | 1/20/88 | 35, 49 | No |
| Pacific Western | VEN-6 | 10/10/88 | 82, 83 | Yes |
| Pacific Western | VEN-7 | 5/23/89 | 112, 113 | Yes |
| Pacific Western | VEN-8 | 11/8/90 | 113 | No |
| Pacific Western | VEN-9 | 9/19/92 | 83, 84, 113, 114 | Yes |
| Pacific Western | 51706 | 12/29/93 | 1 | No |
| Pacific Western | 52043 | 2/24/93 | 3, 4 | Yes |
| Pacific Western | VEN-12 | 1/8/96 | 83 | No |

# PLATES




**BASE MAP SOURCE:** USGS 7.5' Saticoy and Oxnard, California quadrangle maps (both photorevised 1967).

NORTH

0 1000 2000

FEET

## VICINITY MAP

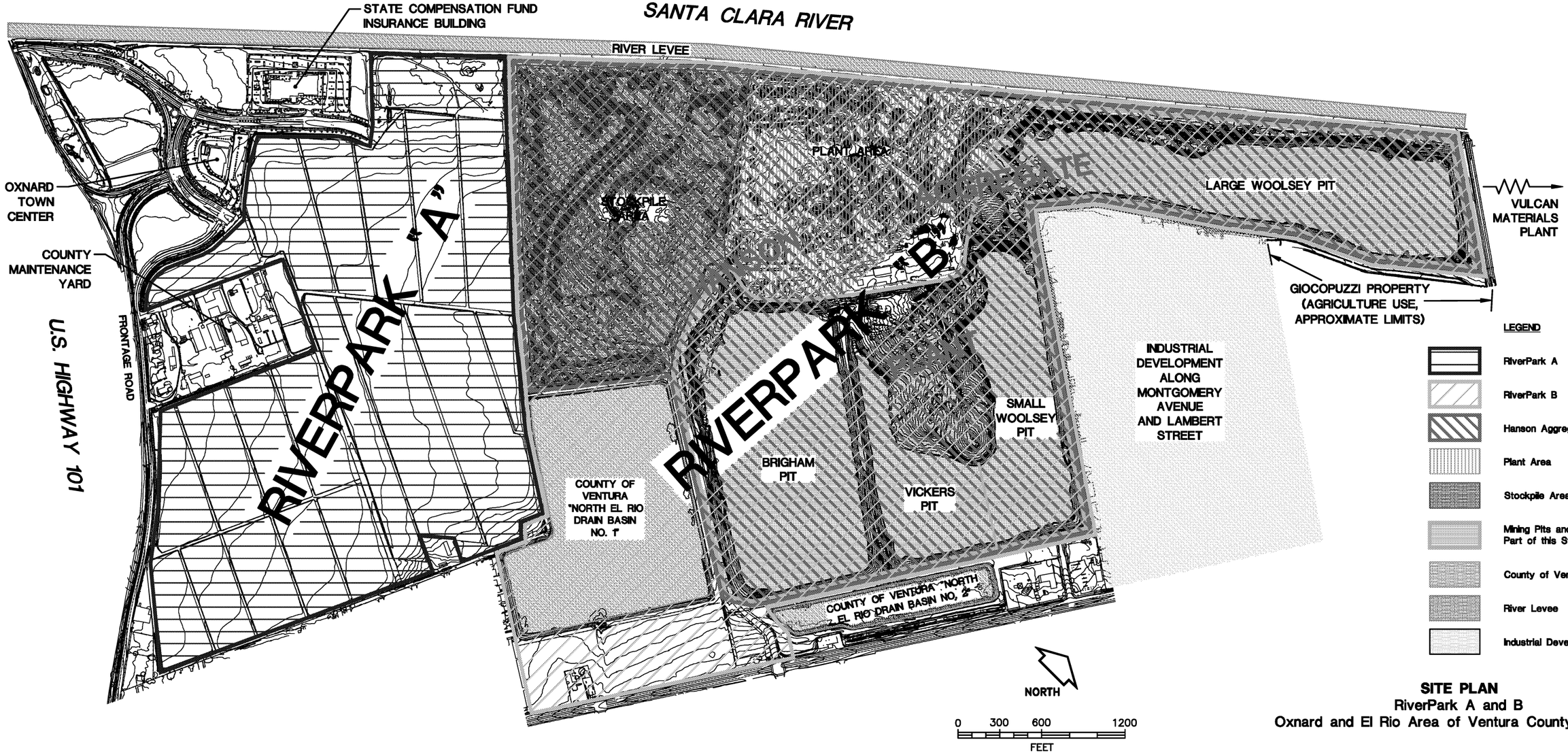
RiverPark A and B

Oxnard and El Rio Area of Ventura County, California

PLATE 1

99420023vic.dsf(1-3)

May 2000
Project No. 99-42-0023

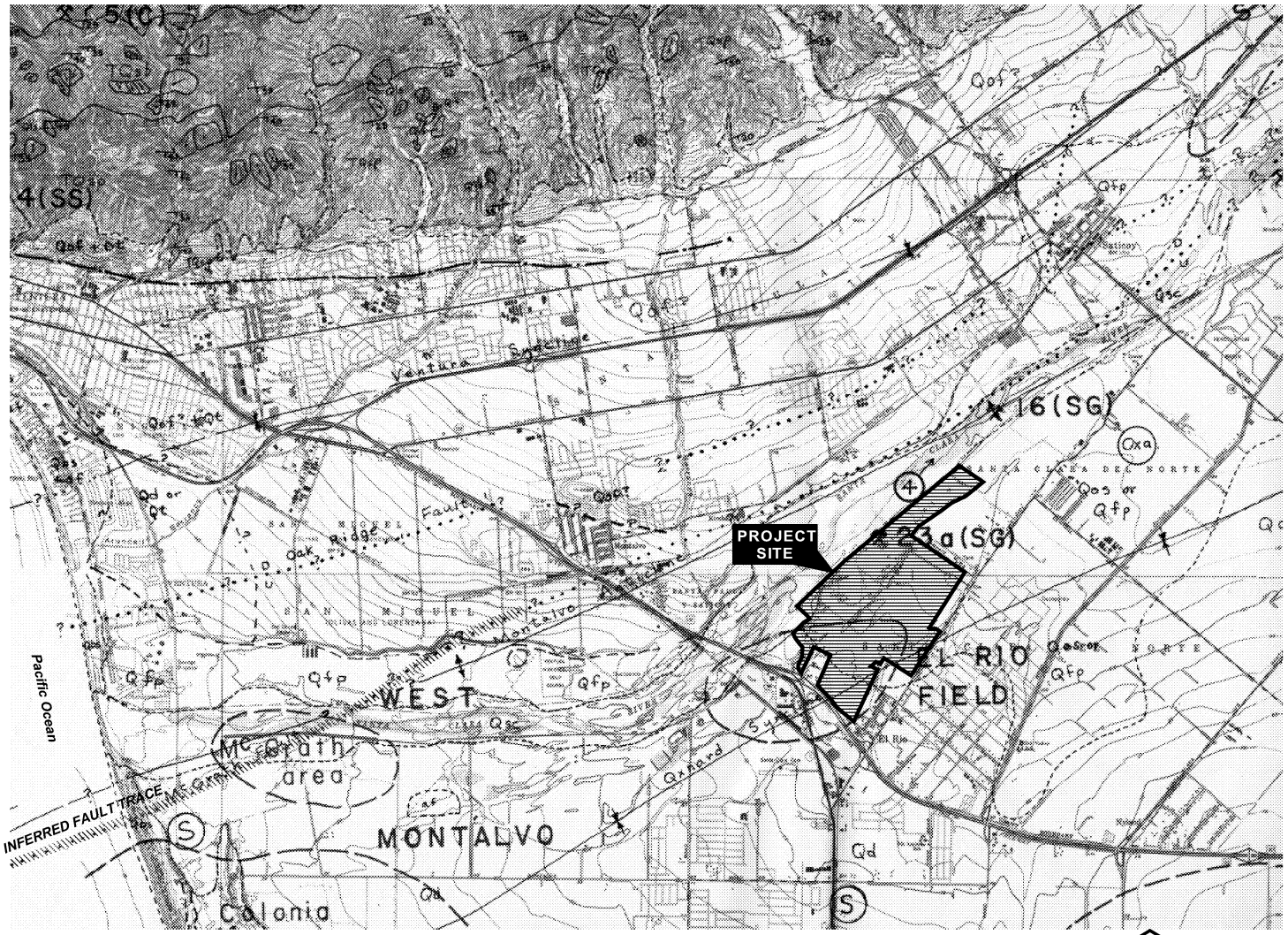



**SITE PLAN**
RiverPark A and B
Oxnard and El Rio Area of Ventura County, California

PLATE 2

9942\0023\0023plan.dwg(0.2 - 14),pa,mm(37063,dwg,0023plan.pcp

May 2000
Project No. 99-42-0023




**BASE MAP SOURCE:** California Division of Mines and Geology (CDMG), Geology and Mineral Resources Study of Southern Ventura County, California, Preliminary Report 14, (Weber et al., 1973).

NORTH

0 4000 8000

FEET

**LEGEND**

| | |
|---|---|
| af | Artificial Fill |
| Qbs | Beach and Dune Sand Deposits |
| Qsc | Stream Channel Deposits |
| Qfp | Flood Plain Deposits |
| Qd | Deltaic Deposits |
| Qt | Marine and Nonmarine Terrace Deposits |
| Qof | Older Alluvial Fan Deposits |
| Qos | Older Stream Channel Deposits |
| Qls | Landslide Deposits |
| TQsp | San Pedro Formation |
| TQsb | Santa Barbara Formation |

- Geologic contact, dashed where approximate
- Anticline, showing plunge, dotted where concealed
- Syncline, showing plunge, dotted where concealed
- Fault, dotted where concealed
- Suggested fault trace as identified on aerial photos, but not verified
- 25 — Strike and dip of bedding
- (Oxa) — Oxnard Aquifer is exposed within area shown as Qfp
- (S) — Area of known historic subsidence of land
- Petroleum, natural gas, and natural gas liquid

**GEOLOGIC MAP**
RiverPark A and B
Oxnard and El Rio Area of Ventura County, California

PLATE 3

9942\0023geo.dsf(1-3)

**Geotechnical Impacts Study for Pit Slopes**
**at the Hanson Aggregates Plant**
**(Fugro West, Inc., July 2001)**

## INTRODUCTION

This section presents a geotechnical impacts study for the pit slopes at the Hanson Aggregates plant in the El Rio area of Ventura County. The general location of the Hanson Aggregates plant is shown on Plate 1 - Vicinity Map. There are four pits on the Hanson Aggregates property: the Brigham, Vickers, Small Woolsey, and Large Woolsey. The proposed RiverPark B residential development will be constructed adjacent to the pit slopes, as shown on Plate 2 - Site Plan.

The purpose of this EIR-level geotechnical study is to identify potentially adverse geologic and geotechnical constraints along the existing and proposed pit slopes that could impact the proposed RiverPark B residential development and adjacent properties, and to describe proposed measures to mitigate those impacts to less than significant threshold levels. The geologic and geotechnical concerns evaluated in this study consist of:

- Assessment of existing and proposed mining pit slope topography, including slope heights and gradients.
- Description of generalized soil and groundwater conditions, and artificial fill along slope faces.
- Assessment of geologic setting and geologic hazards, such as static and seismic slope stability, liquefaction, seismic shaking, and seismically induced lateral movements.
- Assessment of effects of storm water infiltration into the subsurface at proposed dry swale locations adjacent to the pit slopes.

From the evaluation of the geologic and geotechnical concerns, significant impacts have been identified, and mitigative measures to reduce those impacts to less than significant levels, as defined by the County of Ventura, have been developed and are incorporated into the proposed Slope Reclamation Plan. Because of the complexities of the pit slope geometry and the limited soil property data evaluated for this study, additional geotechnical studies will be necessary to refine conclusions and recommendations presented herein. Recommended elements of the design-level study are presented at the end of this section.

## EXISTING CONDITIONS

As shown on Plate 2, the mining pits at the Hanson Aggregates plant include the Brigham, Vickers, Small Woolsey, and Large Woolsey pits. The Large Woolsey pit is adjacent to the northeastern end of the plant area. The Santa Clara River levee runs parallel to the northwestern side of the Large Woolsey pit. Industrial development and agricultural land borders the southeastern side of the Large Woolsey pit. The Small Woolsey pit is located east of

the plant area. Industrial property along Montgomery Avenue adjoins the northeastern side of the Small Woolsey pit, and private industrial property also adjoins the southeastern end (i.e., along Carnegie Street).

A peninsula consisting of fill materials discarded from the aggregate manufacturing process separates the Vickers pit from the southwestern side of the Small Woolsey pit. The Vickers pit is bounded on the northwest by the plant area, on the southeast by the County of Ventura flood control detention basin (North El Rio Drain Basin No. 1), and the southwest by the Brigham pit. A land bridge that was formerly the plant entrance road separates the Brigham and Vickers pit. The Brigham pit is bounded on the northwest by the plant area, on the west by the "stockpile" area, on the southwest by the current entrance road, and on the southeast by the County of Ventura flood control detention basin (North El Rio Drain Basin No. 1).

## PIT AREA TOPOGRAPHY

The historical excavated configuration of the mining pit slopes at the Hanson Aggregates plant has been estimated from a review of about 70 stereo pairs of aerial photographs and several 200-scale topographic maps of the pit areas (1977, 1979, 1986, 1988, 1989, 1990, 1992, 1997, and 1999). Some of the topographic maps reviewed were generated from aerial photographs specifically for this study (i.e., 1977, 1986, 1989, and 1990). The pits were actively mined between the mid-1970s and the late 1990s. During most of that period, the pits were partially filled with water, reflecting the local groundwater level at that time. The groundwater concealed the submerged slope topography. Excavation of materials for aggregate production continued during periods of pit inundation with a clamshell-type excavator. Some slope areas received artificial fill from localized slope failures induced from runoff over the pit slope faces. Artificial fill also resulted from the restoration of those failures and from the placement of materials discarded during aggregate production. Hence, because of the likelihood that the existing topographic maps and aerial photographs do not capture all episodes of excavation and subsequent filling, no single photograph or topographic map accurately reflects the deepest excavations or steepest slope gradients excavated into native, undisturbed earth materials.

To approximate the historical excavated slope configurations, the topography shown for a particular location on each map was compared with the topography at that location on the other maps. That comparison provided elevation data to help estimate the deepest historical excavation on the pit bottoms or slopes. For example, a section of a slope may have been cut steeper than 2h:1v decades ago, but recently received a "spill fill" that would now suggest that the slope is flatter.

An intermittent history of the mining operations in the four pits has been constructed from a chronological review (and comparison) of the aerial photographs and topographic maps and is discussed in Appendix A. A general summary of that review is presented below.

### Range of Pit Slope Crest and Pit Bottom Elevations

On the basis of the topographic maps reviewed for this study, the top of pit slope elevations range from about elevation (El.) 100 feet at the northeastern end of the Large Woolsey pit to about El. 85 feet at the western end of the Brigham pit. The elevations at the pit bottoms range from about El. -2 feet (MSL) at the northeastern end of the Large Woolsey pit and at the northwestern end of the Small Woolsey pit, to about El. -8 feet in the Brigham pit and El. -4 feet in the Vickers pit.

### Pit Slope Gradients

In general, the topographic maps reviewed indicate that the mining pits at the Hanson Aggregates plant are up to about 100 feet in depth, with excavated slope gradients typically between about 2h:1v (i.e., the original maximum gradient allowed according to condition No. 24 of CUP 1942) and 1h:1v. Oversteepened pit slope areas with gradients steeper than 1h:1v generally appear to be localized and do not appear to involve the entire slope height (refer to Appendix A for specific areas).

### Areas of Existing Artificial Fill

A review of the topographic maps indicates that up to approximately 65 feet of fill is present within about 200 feet of the present slope crest along the northwestern end of the Vickers pit, about 15 feet of fill is present along the southeastern slope of the Large Woolsey pit, and about 35 to 40 feet of artificial fill is present along the western corner of the Brigham pit. Additionally, a study by Fugro (1998) estimated up to about 35 feet of artificial fill along the northwestern two-thirds of the southwestern slope of the Brigham pit, extending to the southwestern property line.

## SLOPE MATERIALS

Slope materials consist of native undisturbed granular soil and, in some areas, artificial fills. In general, native slope materials consist of dense to very dense well-graded sand with varying amounts of gravel. Artificial fills consist of sands and silty sands that were discarded from the aggregate mining process.

### Native Slope Materials

Logs of borings excavated for previous studies (Earth Systems Consultants, 1997a,b; Fugro West, Inc., 1999; and The Byer Group, 2000) indicate that native slope materials consist of dense to very dense fine to coarse sand with varying amounts of gravel with intermittent gravel layers in a sandy matrix on the order of several feet thick.

Thin clay lenses (on the order of 1- to 2-inches thick) were encountered in a few boring locations; however, the elevation of the clay layers varied significantly between borings, when encountered, or were not noted in adjacent borings.

**Artificial Fill Materials**

Because of the active mining history in the pit areas over the past four decades, several areas of fill placement along the pit slope areas are known or, as discussed previously, have been revealed through the review of aerial photographs and historic topographic maps.

In addition to the areas of artificial fill identified previously and in Appendix A, Earth Systems Consultants (ESC) (1997a,b) identified several localized slope failures from uncontrolled runoff or drain pipe failures along the northeastern and eastern slopes of the Small Woolsey pit and the southeastern slope of the Large Woolsey pit. One of those slope failures occurred in the winter of 1994/95 at the eastern corner of the Small Woolsey pit, where concentrated runoff washed out several tens of feet of slope, the scarp of which migrated eastward onto the neighboring industrial property.

Additionally, according to ESC (1997a), one "washout" at the northern end of the southeastern slope of the Large Woolsey pit involved at least the upper 30 feet of slope materials. Those failed areas were restored to their prior configuration by the placement of artificial fill consisting of "spill fills" below the water level or in inaccessible slope areas, and conventional fill placement with grading equipment and some level of compactive effort as the filling process continued above the water level. However, there are no known records of the observation and testing of those fill materials by a geotechnical engineer during their placement. According to a study performed subsequent to fill placement in that slope area (ESC, 1997b), the artificial fill materials used to restore the slope at the eastern corner of the Small Woolsey pit consisted of silty fine sand with some fine gravel.

The approximate locations of the slope failures (and subsequent fills placed to restore the pre-failure slope gradients) along the southeastern and northeastern slopes of the Small Woolsey pit and the southeastern slope of the Large Woolsey pit have been mapped by ESC (1997a,b) and are shown on Plate 3 – Slope Reclamation Plan.

## PROPOSED PROJECT

As proposed, the southeastern edge of the RiverPark B residential development generally coincides with the existing Brigham and Vickers pit slope crest, but encroaches the western end of the Small Woolsey pit by up to about 100 feet beyond that slope crest. As shown on Plate 2, the proposed RiverPark development incorporates a perimeter road adjacent to the edge of the residential lots along the Brigham, Vickers, and Small Woolsey pits and a dry swale that further separates the residential lot areas from the northwestern end of the Brigham and Vickers pits. A

dry swale also is planned along the northeastern end of the southeastern side of the Large Woolsey pit.

The proposed perimeter road adjacent to the residential lots and near the Brigham, Vickers, and Small Woolsey pit slopes is on the order of about 25 feet wide, and the outlying dry swale area, where planned, is on the order of about 50 to 75 feet wide. The perimeter road and dry swale provide a minimum setback of about 75 feet between the closest edge of the residential property and the proposed top of slope and generally extend about 75 to 150 feet beyond the existing slope crest. Encroachment into the pits will require the construction of a fill over the steepest historical excavated slopes along the northwestern side of the Brigham, Vickers, and Small Woolsey pits.

The RiverPark B development also contains an elementary school proposed along the southwestern edge of the Brigham pit. Also, lined detention basins are proposed at the location of the existing El Rio Drainage Basin No. 1 (along Vineyard Avenue), between the northeastern end of the plant area and the western end of the Large Woolsey pit, and west of the western corner of the Brigham pit.

Areas outside the RiverPark development but adjacent to the top of pit slopes, consist of the following public or private properties:

- An existing industrial development along the northeastern side of the Small Woolsey pit and the southwestern half of the southeastern side of the Large Woolsey pit.
- A levee between the southeastern bank of the Santa Clara River and the northwestern slope of the Large Woolsey pit, and the drain adjacent to the northeastern end of the Large Woolsey pit, both of which are maintained by the County of Ventura Flood Control Department.
- A proposed juvenile detention facility to be constructed by the County of Ventura on the property adjacent to the northeastern half of the southeastern side of the Large Woolsey pit.

**PITWARD FILLS**

Pit slope areas to receive fills to extend the RiverPark development envelope pitward are shown on the Slope Reclamation Plan. Additionally, the general methodology for the construction of pitward fills adjacent to the RiverPark development areas are summarized as follows:

## NORTHWESTERN SLOPE OF BRIGHAM PIT

The construction of pitward fills to accommodate the proposed development envelope or detention basin as shown on Plate 2 will require the placement of a buttress-type fill over the existing native slope. The base of the fill could be constructed on a native bench that is suggested by the 1977, 1988, 1989, and 1992 topographic maps to lie between elevations of about 40 and 50 feet along the northwestern end of the Brigham pit.

## SOUTHWESTERN END AND SOUTHEASTERN SLOPE OF LARGE WOOLSEY PIT

A fill similar to that described above for the Brigham pit is proposed to extend the northern end of the RiverPark B development and the proposed detention basin into the southwestern end of the Large Woolsey pit and to provide adequate area to accommodate the proposed bioswale along the southwestern half of the southeastern slope of the Large Woolsey pit. The 1977, 1988, 1989, and 1992 topographic maps indicate that native materials are likely to be encountered at elevations between about 35 and 45 feet at that end of the Large Woolsey pit, upon which a fill may be constructed.

## NORTHWESTERN END OF VICKERS PIT

According to the 1977 topographic map, the northwestern end of the Vickers pit was excavated down to about elevation 19 feet within about 150 to 200 feet of the top of the existing slope. An intermediate, approximately 75-foot-wide bench was excavated at about El. 50 feet, below an approximately 25-foot-high 1-1/2h:1v slope. To extend the edge of the development about 100 feet pitward, a stable fill would need to be constructed over the existing fill peninsula.

## WESTERN END OF SMALL WOOLSEY PIT

The 1992 topographic map indicates that the western end of the Small Woolsey pit was excavated to about El. 10 feet within about 100 feet of the existing top of slope. The pitward fill beyond the existing slope would involve the placement of hydraulic fill below and conventional fill above the water level.

# SIGNIFICANCE THRESHOLDS

The proposed pit slope configurations, whether at existing or proposed gradients and composition, should meet or exceed minimum stability criteria to be considered as posing a "less than significant" impact. Those stability criteria, established by the County of Ventura (1992), include a factor of safety of at least 1.5 for static stability and a factor of safety of at least 1.1 for pseudostatic stability (using a horizontal seismic coefficient of 0.15g). Slope conditions that constitute an unmitigable landslide hazard or that do not meet those minimum factors of safety would be classified as "significant" impacts.

The purpose of this study is to evaluate the potential for slope instability and to provide recommendations so that threshold criteria for significant impacts are not exceeded. According to the County of Ventura, a landslide hazard constitutes a "…natural or man-induced slope instability that may adversely influence life or property." The landslide hazard, as defined by the county, consists of "…all gravity-induced downslope movements, including the separate phenomena of rockfall, soil creep, soil failures, dry raveling, rotational and translational slides, flows, slumps and complex combination of the above phenomena. The hazard applies to both natural and constructed slopes. Contributing factors include erosion, earthquake ground shaking, brush fires, and groundwater."

"Downslope movements" and "soil failures" include seismically induced lateral movements. The threshold for lateral movements for occupied ("inhabited") structures has been recommended at 5 centimeters (cm), or about 2 inches, by the Southern California Earthquake Center (SCEC, 2000). The California Division of Mines and Geology (CDMG, 1997) defines an occupied structure as one that is occupied at least 2,000 person-hours per year.

## IMPACTS

Areas adjacent to the existing and proposed pit slopes may be impacted by 1) gross instability of the pit slopes under static or seismic conditions, and/or 2) seismically induced lateral movements. Potentially impacted slope areas would consist of those areas where artificial fills are present along the slope face (Plate 3) or where the excavated pit slope gradient is steeper than about 2h:1v. For earthquake-induced lateral movements, potentially impacted areas may include RiverPark development areas and neighboring public and private properties adjacent to the pit slope crests.

## POTENTIAL INSTABILITY OF ARTIFICIAL FILLS

The significance of artificial fill materials in slope areas is that those materials are likely to be less stable than the indigenous native sands and gravel, particularly during seismic shaking. In general, the artificial fill materials discarded from the aggregate manufacturing process and placed in the pit areas were typically finer-grained than native granular materials. Those materials may have been end-dumped or may have been placed hydraulically (i.e., under water) into pit areas to be reclaimed. Neither method of placement reliably results in a dense state; therefore, those materials are considered to be potentially much weaker than the underlying native, undisturbed alluvial materials.

Additionally, artificial fills placed without keying and benching into native materials and without compactive effort are vulnerable to settlement and lateral movements under static conditions (e.g., creep), as well as seismic conditions. Settlement potential has been demonstrated for the fill slope located along the existing entrance road to the Hanson Aggregates plant (i.e., the fill extends from the southwestern slope of the Brigham pit to the southwestern

property line). Settlement of the fill in that area has adversely impacted the entrance road pavement, which has suffered repeated episodes of cracking with vertical offset visible across the cracks (Fugro, 1998).

Moreover, submerged fill materials likely would be susceptible to liquefaction and lateral movements during an earthquake. Such fill materials could fail, or flow, into the pit during an earthquake, thereby exposing an original cut slope surface of the denser native materials. In addition to the proposed development areas, there are slope stability concerns for existing pit slopes adjacent to private and public properties. For example, the 1977, 1988, 1989, and 1992 topographic maps suggest that the lower 30 feet or so of the northwestern half of the southeastern slope of the Small Woolsey pit was excavated at about 1/2h:1v. A slope toe that steep is not likely to be stable under static and seismic conditions. Other oversteepened areas have been identified from the review of the aerial photographs and the 1977, 1988, 1989, 1992, and 1999 topographic maps, and are summarized in Appendix A.

## SLOPE STABILITY EVALUATION

The evaluation of the pit slopes consisted of performing slope stability computations using the program XSTABL (Sharma, 2000) and estimating laterals movements using procedures developed by the Southern California Earthquake Center (SCEC) (2000). The slopes were modeled to approximate a configuration compatible with the reclamation and development plans and the topographic data compiled for this study. The stability evaluations consider the potential for seepage forces from the proposed dry swales and the likelihood of achieving the modeled slope configurations, based on the topographic maps reviewed and uncertainties in estimating the deepest historical slope excavations. Slope material properties were developed from a review of limited data from previous studies (Earth Systems, 1997; Fugro, 1999, 2000; and The Byer Group, 2000) and published literature on gravelly sands.

### Slope Characterization

Generalized slope geometry and soil material properties were developed for the slope stability evaluations. A horizontal seismic coefficient of 0.15g was used for the pseudostatic condition.

**Slope Geometry.** A generalized slope configuration consisting of an 85-foot high, 1.9h:1v slope and comprised of native sand and gravelly sand materials was used for slope stability evaluations.

That configuration was selected to represent the more conservative scenario compatible with the excavated slope data from the topographic maps. As existing artificial fills have been assumed to be unstable, the generalized slope configuration was developed to be consistent with the required removal of those materials through laying back existing slopes that are steeper than 1.9h:1v.

**Material Properties.** On the basis of the subsurface and laboratory data available to date, native sand and gravelly sand materials generally were characterized as follows:

- Unit weight: 120 pounds per cubic foot (pcf)
- Friction angle: 35 degrees
- Cohesion (apparent): 150 pounds per square foot (psf)

A review of the limited field and laboratory test data from previous studies (Earth Systems, 1997; Fugro, 2000) suggests that using a friction angle of 35 degrees is conservative. Higher interpreted friction angles for the native sand and gravelly sand materials likely would result from more comprehensive slope material characterization and shear strength testing.

The apparent cohesion was estimated using Rankine earth pressure theory and the unit weight and friction values (summarized above) applied to 20- to 25-foot-high vertical excavations typically observed during pit mining above the water level. The apparent cohesion can be attributed to the interlocking of coarse sand and gravel particles.

Additionally, blow count data from previous studies suggest that native undisturbed slope materials are not, in general, liquefiable. Therefore, the evaluation of seismic conditions would not need to accommodate reduced shear strength for slope stability evaluations.

**Reducing Uncertainties Regarding Slope Composition**

The slope evaluations summarized below assume that the existing slopes could be laid back at 2- to 2-1/2h:1v to completely expose native materials. However, there is some level of uncertainty in the existing cut (native) slope gradients because groundwater levels have concealed the lower half of the slopes over the past decade, thereby limiting the reliability of the topographic record of the pit slopes. To reduce that uncertainty, the existing overall gradient along a specific pit slope area was approximated by estimating the gradient of that portion of the slope shown above the groundwater level in the 1999 topographic map. The location of the slope toe was then estimated by extrapolating the upper slope gradient down to the local low at the bottom of that area of the pit.

The local low was estimated as the deepest excavation level shown on the available topographic maps (1977, 1979, 1986, 1988, 1989, 1990, 1992, 1997, and 1999) in the vicinity of the area being evaluated. The extrapolated toe location was compared with the corresponding toe location shown on the earlier maps to verify that the extrapolated toe did not project further into the pit bottom than shown previously (which would suggest that the extrapolated toe represents a fill).

Although an extrapolated toe located closest to the top of the pit slope does not guarantee a cut slope condition, the possibility of fill slope conditions are significantly reduced because

laying that resulting 1-1/2h:1v slope back at about 2- to 2-1/2h:1v from this conservatively-estimated slope toe location would likely result in the removal of surficial or shallow relict fills.

**Seepage Forces**

**General Conditions.** Slope stability evaluations for the pit slopes were performed assuming dry conditions; that is, no groundwater and no seepage forces were assumed. The dry slope conditions result in a lower factor of safety than if the pits were full or partially full of water with a level phreatic surface inside and outside the slope. For the northwestern slope of the Large Woolsey pit, which is adjacent to the Santa Clara River Levee, seepage conditions were developed for slope stability analyses.

**Dry Swales and Detention Basins.** Dry swales are planned adjacent to the southeastern slopes of the Brigham and Vickers pits, the western end of the Large Woolsey pit, and between the western corner of the Brigham pit and the northern corner of the Small Woolsey pit. The dry swales will be on the order of about 3 feet deep (relative to proposed grade of about El. 85 feet), and will be founded in and underlain by granular materials of similar composition as the pit slopes. The dry swales will receive storm water temporarily during wet weather cycles. The dry swale design will include a perforated PVC pipe that is enveloped in gravel to collect and convey the swale infiltrate to the detention basins or to a solid pipe collection system. The detention basins will be lined with an impermeable geomembrane.

To evaluate the potential for seepage forces developing in the pit slopes because of water infiltration from the dry swales or from a leak in the lined detention basins, two scenarios were considered when: 1) the water level in the nearby pit is low and 2) the water level in the pit is high. For the condition where the water level in the pit is low, infiltration from the swale or a leak in the lined detention basin probably would move almost vertically. Groundwater mounding would be deep beneath the basin and well away from the slope face. Hence, for this case, significant seepage toward the slope face seems unlikely.

For the high groundwater condition, the difference in the phreatic surface would be small because of the generally high permeability of the native subsurface materials. Under high groundwater conditions, the factor of safety of the pit slopes would be higher than if the pits were empty (or if groundwater level was low) because of the lateral pressure exerted by the water against the slope face (i.e., increased resisting force) and the reduction in driving forces from buoyant weights (instead of total weights). Given the geometrical relationship of the dry swales and detention basins, the lined condition of the detention basins, the french drain component of the dry swale system, and the transient nature of storm water infiltration into the granular subsurface materials, steady seepage conditions toward the pit slope faces seem unlikely to develop. Therefore, seepage from the dry swales and the lined detention basins is not anticipated to significantly affect the slope stability of the adjacent pit slopes.

**Santa Clara River Levee.** Slope stability for the northwestern slope of the Large Woolsey pit along the Santa Clara River Levee was evaluated for dry conditions and a worst-case scenario for steady seepage. The main source of seepage forces and the development of a phreatic surface directed towards the pit slope face possibly may be the Santa Clara River, particularly at flood level (e.g., 100-year storm) when the river level is near the levee crest elevation. However, the inside crest of the levee is about 150 feet from the pit slope crest, and there will be a tendency for infiltration from the river to move downward, as well as horizontally.

If groundwater levels are low, infiltration from the river probably will move almost vertically down. Any groundwater mounding would be deep beneath the pit slope crest and well away from the slope face. Hence, for this case, significant seepage towards the slope face seems unlikely. If groundwater levels are high, infiltration from the river would probably result in groundwater mounding locally beneath the river or levee. There may be some difference in the groundwater levels between the pond and the slope face, but that difference will be small because of the large permeability of subsurface materials and the transient nature of recharge from the river.

Given the geometrical relationship of the levee, Santa Clara River and the nearby pit slope and the transient nature of water infiltration from the Santa Clara River into subsurface materials, steady seepage conditions towards the existing slope face seem unlikely to develop. Based on this reasoning, seepage from the full river condition is not anticipated to significantly affect the slope stability of the nearby pit slopes.

However, for analytical purposes, potential worst-case steady seepage conditions were estimated by developing a phreatic surface using flownet construction. The phreatic surface was based on a water level in the Santa Clara River at El. 108 ft, continuous water flow from the river, the water level in the pit bottom of El. –2 ft, and an impermeable barrier along the pit bottom and beneath the pit slopes and levee. In particular, the assumption of an impermeable boundary extending from the pit bottom underneath the pit slope is very conservative.

One way to assess the improbability of the development of the worst-case steady seepage condition is as follows. The annual probability of a 100-year flood is roughly 1/100 (0.01). The annual probability of groundwater levels being near sea level is about 1 in 10 years (0.1). That is, groundwater levels have historically dropped to sea level about once every 10 years. The annual probability that a 100-year flood happens at the same time as the groundwater level is near sea level is then roughly 0.01 x 0.1 equals 0.001, or about once every 1,000 years. That translates to about a 10 percent probability of exceedance in 100 years. For comparative purposes, peak ground accelerations are usually selected as those with an exceedance probability of 10 percent in 50 years (i.e., an annual probability of about 1 in 475 years, or 0.002188). This evaluation neglects the improbability that an impermeable boundary will exist near sea level, an assumption needed to develop the phreatic surface for the worst-case steady seepage condition.

## RESULTS

The results of the evaluation of gross slope stability and lateral movements indicates that some remediation of the pit slopes is necessary to satisfy minimum factor of safety requirements established by the County of Ventura and to reduce lateral movements to an acceptable range for occupied structures in proposed development areas and on adjacent properties.

### XSTABL Analyses

**General.** On the basis of the slope evaluations performed for this study using the software XSTABL (Sharma, 2000), pit slope gradients on the order of about 2h:1v consisting of native, undisturbed dense granular alluvial materials are likely to demonstrate a factor of safety in excess of the minimum requirements of 1.5 for static conditions and 1.1 for pseudostatic conditions set by the County of Ventura (1992). For the pseudostatic condition, a horizontal site acceleration of 0.15g was used in the evaluation.

There appear to be many slope areas where either 1) the gradient appears to approximate 2h:1v, or 2) the existing slopes have adequate room available behind the slope crest to lay the slope back at that gradient (or flatter, as necessary) so that native, undisturbed materials are exposed along the entire recontoured slope face. Areas where the pit slope may be laid back between 2- and 2-1/2h:1v are shown in blue on the Slope Reclamation Plan. The blue-colored envelope approximates the range of possible top-of-slope locations likely to satisfy both the minimum factor of safety requirements and the need for the new slope face to expose native undisturbed materials, not artificial fill.

**Northwestern Slope of Large Woolsey Pit/Santa Clara River Levee.** For dry slope conditions, the estimated factor of safety is about 1.75, well in excess of the typical value of 1.5 used to denote adequate safety.

For the worst-case steady seepage conditions the estimated factor of safety drops to about 1.1. However, as noted above, the worst-case, steady seepage condition is very unlikely to develop.

Forcing the circular failure surfaces to exit near the river-side levee crest results in an estimated factor of safety of about 1.6. Introducing a horizontal acceleration coefficient of 0.15 g, results in a factor of safety of 1.01 for the pseudostatic case.

Setting the water level in the pit at El. 70 feet and allowing for seepage from the river at El. 108 feet results in an estimated factor of safety of about 1.7, which is not much different than the dry slope condition. This case demonstrates that, even allowing for some seepage from a postulated high river flow, water in the pit augments the factor of safety.

**Lateral Movements**

Strong ground motion from an earthquake may result in lateral movements that are not necessarily defined as slope failure, but can result in damage to structures. Lateral movements near the slope crest for the two generalized slope configurations were estimated using the "Guidelines for Analyzing and Mitigating Landslide Hazards In California," a draft publication for the California Division of Mines and Geology by the Southern California Earthquake Center (SCEC, 2000). The SCEC procedures are based on the Newmark sliding block analogy, as modified by Bray and Rathje (1998).

For the slope configuration evaluated, yield accelerations were computed for trial failure surfaces extending between the slope toe and increasing distances behind the slope crest. The yield acceleration is the value of the horizontal acceleration that results in a factor of safety of 1 for the potential failure surface. Input to the displacement evaluation for the modeled slope configuration included the following:

- Shear wave velocity: 1,500 feet per second
- Distance to causative fault: less than 2 miles
- Earthquake Magnitude: 6.75
- Peak Ground Acceleration: 0.66 g

Results of the lateral displacement evaluation suggest lateral movements on the order of about ½ foot near the slope crest, decreasing to a few inches (on the order of about 4 inches) about 50 feet behind the slope crest and on the order of about an inch or so at about 80 to 90 feet behind the crest.

SCEC (2000) recommends that for "occupied" structures, lateral movements are maintained at less than 5 cm (or about 2 inches). Therefore, seismically induced lateral movements should constitute a "significant impact" along the existing and proposed slopes within about 80 to 90 feet of the slope crest.

**Impacts Summary**

In summary, significant impacts of the existing and proposed slopes consist of the following:

1) Slopes or slope areas where artificial fills are suspect because artificial fills placed under water, by dumping, or without appropriate benching and compaction are likely to be vulnerable to instability, settlement, and to liquefaction and lateral movements during seismic shaking.

2) Areas where native slopes are steeper than 2h:1v will not satisfy factor of safety criteria for static and seismic conditions and are steeper than the limits established in the County Grading Ordinance.

3) Seismically induced lateral movements within about 80 feet of the pit slope crests are estimated to be on the order of 2 inches or more. According to the SCEC (2000), occupied structures are not recommended in areas with estimated lateral movements of more than 2 inches.

The significant impacts are identified and summarized for the various slope areas of the pits on Table 1 - Summary of Pit Slope Mitigation Measures, presented at the end of this section.

## MITIGATION

The existing pit slopes can be mitigated to affect the minimum factor of safety requirements established by the County of Ventura for gross stability. Additionally, reducing lateral movements of occupied structures near pit slope crests is feasible by establishing structure setback criteria; and, where setbacks currently are not sufficient, reducing lateral movements by providing lateral reinforcement to the upper portion of the pit slopes.

As discussed previously, laying back existing slopes to 2- to 2-1/2h:1v increases the factor of safety under static and pseudostatic conditions to exceed 1.5 and 1.1, respectively, and reduces the potential for relict unstable fills in the slopes. However, there are some areas where laying back the entire slope to effect a more stable configuration is not viable because of the proximity of the slope crest to either the proposed development or adjacent private or public properties. For those areas, reinforcing the upper half of the slope by providing a lateral resisting force from, for example, drilled piers, tiebacks, or minipiles would decrease the lateral movements behind the slope crest.

Slope evaluations for an 85-foot-high, 2h:1v slope (with material properties described previously) suggest that lateral movements can be maintained less than about 2 inches beyond a minimum distance of 30 feet from the slope crest when a resultant resisting force of about 22 kips is applied 25 feet below the slope crest. Note that for friction angles greater than 35 degrees, the estimated lateral movements would decrease at that location (i.e., 30 feet beyond slope crest) or the resultant force would be less for a comparable level of lateral movement at that location.

Based on preliminary evaluations, the equivalent of about a 22 kip horizontal resisting force possibly may be provided by a series of 3-foot-diameter cast-in-place concrete piers constructed on about 8- to 10- foot centers to depths between about 35 and 50 feet below the ground surface.

Consequently, slopes with insufficient area available to lay the existing slope back to 2- to 2½h:1v, or to maintain a sufficient setback distance from the crest to adjacent property lines or occupied structures may be reinforced to increase the factor of safety of the slope and/or to reduce impacts from lateral movements.

Additionally, artificial fills should be removed and replaced with compacted fills that are keyed and benched into native, undisturbed slope materials.

## PROPOSED SLOPE CONFIGURATIONS

On the basis of the slope evaluations and the objectives of the Slope Reclamation Plan, potential slope envelopes have been developed for the pit slope areas to improve slope stability and to reduce lateral movements to suggested tolerable values in accordance with the County of Ventura and the SCEC (2000). The slope envelopes represent proposed slope configurations that satisfy the minimum County of Ventura factor of safety requirements for static and pseudostatic conditions and, where needed, reduce seismically induced lateral movements to levels recommended by the SCEC (2000) by increasing the setback of occupied structures on adjacent properties to the slope crest. As discussed previously, areas where minimum setback criteria to property lines or occupied structures cannot be met will require some level of reinforcement of the upper portion of the slope.

Seven slope configurations are depicted on Plate 3 to illustrate the location range for either the slope crest or, where the crest location is fixed, the slope toe. The general construction methodology for each of the six slope configurations also is shown in cross-sectional detail on Plate 3. In most areas, the slope configurations typically are achieved by 1) laying back the full height of the slope at a 2- to 2-1/2h:1v gradient (represented by the "blue" slope envelopes on Plate 3) or 2) the construction of a standard 2h:1v fill slope above a native bench typically encountered at about El. 45 feet (represented by the brown envelopes on Plate 3).

Additionally, extending the development area over the existing fill peninsula in the Vickers pit would require the excavation of the existing artificial fill material down to either native materials or about El. 45 feet. Fill materials below about El. 45 feet would be improved using Deep Dynamic Compaction (DDC) of the remaining fill materials (if applicable). DDC is a method of in situ ground improvement that employs a heavy tamper (typically on the order of 6 to 30 tons) that is repeatedly raised and dropped from varying heights to impact the ground. DDC can result in the densification of granular soils to a depth of about 30 feet below the impact surface.

The pitward fill would be constructed above the native bench or above the ground-improved surface at a gradient of about 2- to 2-1/2h:1v (the location of the toe of the reconstructed slope above the ground-improved surface is represented by the magenta envelope on Plate 3), using conventional grading methods, or at 1- to 1-1/2h:1v, using mechanical reinforcement (the overall slope above the ground-improved surface is represented by the

lavender envelope on Plate 3). Mechanical reinforcement of the constructed slope could be achieved by reinforcing the upper portion of the slope with mechanical components such as geogrid or metal strips, or mixing native slope materials with cement.

One area of pitward slope extension over the western corner of the Small Woolsey pit would require the hydraulic placement and subsequent compaction of those (submerged) materials using DDC or vibroflotation, followed by the construction of a 1- to 1-1/2h:1v, mechanically reinforced fill above the ground-improved surface (the overall slope above the ground-improved surface is represented by the dark blue envelope on Plate 3).

The general methodology of the construction of the slope configurations summarized above and in Table 1 are shown as schematics on the Plate 3 and are outlined as follows for each of the pit slope areas:

**Brigham Pit**

**Southwestern Slope.** The extensive artificial fills along the northwestern two-thirds of the southwestern slope of the Brigham pit should be removed down to a native bench that appears between elevations of about 40 and 50 feet on the 1977, 1988, 1989, and 1992 topographic maps. Placement of fill above the exposed native bench should be in accordance with conventional grading methods, including the keying and benching of fill materials into dense, undisturbed native materials. Undisturbed native slopes below that bench that are found to be steeper than a 2- to 2-1/2h:1v gradient should be laid back to inclinations of 2- to 2-1/2h:1v. (The top of the reconstructed fill slope is approximately shown as the brown envelope on the Slope Reclamation Plan.)

**Northwestern End.** The slope along the northwestern end of the Brigham pit may be reconstructed pitward by placing fill over a native bench suggested in the 1977, 1988, 1989, and 1992 topographic maps, at an elevation of about 40 to 50 feet. Placement of fill above the native bench should be in accordance with conventional grading methods, including the keying and benching of fill materials into dense, undisturbed native materials. Undisturbed native slopes below the conventionally constructed fill slope that are found to be steeper than a 2- to 2-1/2h:1v gradient should be laid back to inclinations of 2- to 2-1/2h:1v. (The toe of the pitward fill is approximately shown as the green envelope on the Slope Reclamation Plan.)

**Southeastern Slope and South Corner.** The southeastern slope of the Brigham pit should be laid back at about 2- to 2-1/2h:1v, as shown by the blue envelope. The proposed detention basin will be set back a horizontal distance of about 40 feet from the top of the southeastern slope of the Brigham pit. To accommodate that setback, the existing basin slope should be shifted to the southeast by constructing a fill over the existing basin slope face.

The southern corner (i.e., the southeastern end of the southwestern slope) also should be laid back to inclinations of 2- to 2-1/2h:1v and existing artificial fill in the upper portion of the

slope should be removed and replaced with compacted fill placed at 2- to 2-1/2h:1v. (The top of the combination slope is shown as the blue/brown envelope on the Slope Reclamation Plan.)

**Western Corner.** As recommended in the study for the former stockpile area (Fugro, 1999), the deep fill at the southeastern quarter of the stockpile area will require removals to below El. 10 feet, thereby necessitating local dewatering. The fill removal on the Brigham pit side of that deep removal should extend down to native materials, which, according to the 1977, 1988, 1989, and 1992 topographic maps, are likely between elevations of about 40 and 50 feet. The fill on the native bench should be placed according to conventional grading methods, including keying and benching of the fill into dense undisturbed native materials. (The toe of the pitward fill slope is approximately shown as the green envelope on the Slope Reclamation Plan.)

**Vickers Pit**

**Northwestern End.** The existing fill peninsula in the Vickers pit will be largely removed to generate fill materials for the overall project. For pitward slope construction, existing fill materials at the northwestern end of the Vickers pit should be removed down to a native bench suggested by the 1977, 1988, 1989, and 1992 topographic maps at about El. 45 to 50 feet within a distance of roughly 100 feet from the current slope crest in the plant area. The steep slope below the native bench should be laid back to about 2-1/2h:1v.

To extend the development area further pitward (i.e. greater than about 100 feet beyond the current slope crest), the removals should extend down to about El. 40 to 50 feet, or 10 feet above the groundwater level, whichever is deeper. That area should be densified using DDC to a horizontal distance pitward of about 2 to 3 times the thickness of the fill being densified, followed by laying back the pitward edge of the improved zone at about 2- to 2-1/2h:1v. The fill placed above the densified layer should be constructed at 2- to 2-1/2h:1v with conventional grading methods. (The toe of the pitward fill slope is approximately shown as the magenta envelope on the Slope Reclamation Plan.)

The fill placed above the densified layer of hydraulically placed fill along the northern third of the existing fill peninsula should be mechanically reinforced with geogrid, metal strips, or cement to limit the pitward extension of the overall slope toe (comprising DDC-densified materials), because beyond the slope envelope shown on the Slope Reclamation Plan, the submerged fill thickness likely exceeds the "reach" of the DDC treatment. (This slope area is approximated by the lavender envelope on the Slope Reclamation Plan.)

**Southeastern End.** The southeastern slope of the Vickers pit should be laid back to 2- to 2-1/2h:1v. (The resulting slope crest area is approximated by the blue envelope on the Plate 3.) The proposed detention basin will be set back a horizontal distance of about 40 feet from the top of the southeastern slope of the Vickers pit. To accommodate that setback, the existing basin slope should be shifted to the southeast by constructing a fill over the existing basin slope face.

**Small Woolsey Pit**

**Northern End.** The northern end of the Small Woolsey pit should be laid back at about 2- to 2-1/2h:1v. Artificial fill materials above an elevation of about 50 feet, where according to the 1977, 1988, 1989, and 1992 topographic maps, native materials are likely to be encountered, should be removed and replaced with compacted fill. This removal should continue northwestward and northward so that existing artificial fill is removed in the proposed detention basin area and along the northern end of the RiverPark development. (The slope crest area is approximated by the blue/brown envelope on the Slope Reclamation Plan.)

**Northwestern Corner.** The pitward extension of the development at the northwestern corner of the Small Woolsey pit consists of the underwater construction of a rock dike up to an elevation of a few feet above the groundwater level (El. 45 feet), followed by the placement of hydraulic (granular) fill against the rock dike. The submerged hydraulically placed fill should then be densified using vibroflotation, followed by the construction of a mechanically reinforced fill (e.g., with geogrid, metal strips, or cement) above the densified surface, using conventional grading methods. If the groundwater recedes below an elevation of about 45 feet, DDC may be used as an alternative method to densify the hydraulically placed fill. (This slope area is the dark blue envelope on the Slope Reclamation Plan.)

**Southeastern Slope.** Portions of the southeastern slope of the Small Woolsey pit are steeper than 2h:1v. For example, the lower 30 feet of the slope below the currently exposed bench at about El. 45 feet at the northwestern end of the pit (formerly an access road to the pit bottom), appears to be about 1/2h:1v according to the 1992 topographic map. Alternatives for increasing the stability and increasing the distance between the slope crest and the property line (and to reduce lateral movements at the property line) along the southeastern slope of the Small Woolsey Pit consist of the following:

- Laying the steep slope areas back to 2- to 2-1/2h:1v, and/or
- Reinforcing the upper portion of the slope with drilled piers to reduce lateral movements at the property line or adjacent occupied structures to less than 2 inches.

The artificial fills placed during the slope repair at the eastern corner (i.e., the southern end of the southeastern slope) of the Small Woolsey pit should be removed down to native materials. That slope area should be reconstructed at a gradient of 2- to 2-1/2h:1v using conventional grading methods. Reinforcing the upper portion of the reconstructed slope using, for example, drilled piers may be necessary to reduce lateral movements at the property line or adjacent occupied structures to less than 2 inches.

## Large Woolsey Pit

**Northern Detention Basin Over Southwestern End.** Artificial fill at the southwestern end of the Large Woolsey pit should be removed down to about El. 40, where according to the 1977, 1988, 1989, and 1992 topographic maps, native materials are likely to be exposed. The pit fill slope should be constructed at about 2- to 2-1/2h:1v. For granular soil conditions, the proposed detention basin should be set back at least 20 feet from the top of the northwestern slope of the Small Woolsey pit and the top of the proposed southwestern fill slope of the Large Woolsey pit. Fill materials should comprise onsite sand and gravelly sand so that seepage forces are not introduced near the pit slopes in the event of a leak in the basin liner. (The slope crest area is approximated by the brown envelope on the Slope Reclamation Plan.)

**Southeastern Slope.** The northeastern half of the southeastern slope of the Large Woolsey pit (i.e., where the toe extends to about El. 10 feet) should be laid back at about 2- to 2-1/2h:1v to expose undisturbed native materials. Additionally, the artificial fill placed during the slope repair at the northeastern end of the southeastern slope should be removed down to native, undisturbed slope materials. Some areas may require lateral reinforcement of the upper portion of the slope to keep lateral movements below significant threshold levels for adjacent occupied structures.

To increase the setback behind the slope crest to the property line (thereby decreasing lateral movements at the property line), the southwestern half of the southeastern slope (i.e., where the pit bottom is between about El. 35 and 40 feet), can be reconstructed about 20 to 30 feet pitward on the broad native bench exposed at about El. 45 feet. The slope may be constructed using conventional grading methods at a gradient of about 2- to 2-1/2h:1v. (The approximate slope crest envelope to effect the increased setback along the southwestern portion of the southeastern slope is shown in brown on Plate 3.)

**Northeastern Slope.** The northeastern slope should be laid back at 2- to 2-1/2h:1v. (The slope crest area for the 2- to 2-1/2h:1v configuration is approximated by the blue envelope on Plate 3.) In some areas of the northeastern slope, the 2- to 2-1/2h:1v inclination may encroach the County of Ventura drainage easement. If that encroachment is not acceptable, the upper portion of the slope may be reinforced with drilled piers to increase the factor of safety of a 2h:1v gradient to an acceptable level.

**Northwestern Slope.** The northwestern pit slope that parallels the Santa Clara River levee should be laid back at 2- to 2-1/2h:1v. The southwestern third of this slope should be trimmed back by lowering the existing gradient so that native materials are exposed and the resulting gradient is 2- to 2-1/2h:1v, or flatter. (The slope crest area is approximated by the blue envelope on the Slope Reclamation Plan.)

## MITIGATIVE MEASURES FOR LATERAL MOVEMENTS

Seismically induced lateral movements generally should decrease with increasing distance from the top of the slope. Occupied structures should be located at least 80 feet beyond the top of unreinforced slopes to limit seismically induced lateral movements to less than 2 inches (as recommended by the SCEC [2000]). Setback distances from slope crests to occupied structures (or property lines, where applicable) may be reduced to about 30 feet in areas where the upper slope is laterally reinforced with drilled piers or other means such as tiebacks or minipiles.

Dry swales, detention basins, greenbelt areas, and streets may be located within 80 feet of the slope crest provided those improvements can accommodate potentially several inches of movement.

Utility lines should be placed on opposite side (from slope crest) of streets planned within 50 to 100 feet of the pit slope crests to maximize the setback and should have flexible connections able to withstand movements of at least 2 inches.

## CAVEATS TO MITIGATION AND ALTERNATIVES

The proposed concepts for stabilizing existing pit slopes as shown on the Slope Reclamation Plan are based on the following assumptions:

- The water level in the pits will recede to below El. 45 feet to allow conventional (dry) grading methods.
- The exposed benches at about that elevation (i.e., El. 45 feet) comprise native, undisturbed materials.
- Native materials adjacent to all slope areas consist of granular soils.
- Artificial fills will be removed in the course of implementing the Slope Reclamation Plan.

The possibility of those assumptions not being satisfied and alternative mitigative measures for those conditions are described below and summarized on Table 1 presented at the end of this section.

### Groundwater Levels

In late October 2000, the groundwater level in the pits receded to below El. 42 feet in the Brigham pit, below El. 45 feet in the Vickers and Small Woolsey pits, and below El. 47 feet in the Large Woolsey pit (WM Holdings Inc., 2000). Several benches were well exposed at that time, and generally correspond in elevation and location to the benches suggested on the 1992

topographic map. Most of the benches that were exposed in October 2000 also were exposed in the fall of 1999 (although the water level in the pits was not surveyed as in October 2000). On the basis of recent water level observations and readings over the past two years, the water level in the pits could conceivably subside to similar levels in the next few years, allowing the reconstruction of the pit slopes with conventional grading methods above those exposed benches.

**Composition of Bench Materials**

Bench materials should consist of native, undisturbed granular materials. If artificial fill materials are exposed, the thickness of the fill should be determined and an appropriate method of mitigation of those materials should be selected. For example, if the fill materials lie above the water level, the bench keyway should be excavated until fill materials are removed to expose the underlying native, undisturbed soil. If the water level precludes complete removal of fill materials on the exposed bench, a ground improvement method such as DDC may be used to densify those submerged materials in-place so that a conventional fill slope can be constructed above the ground-improved soil.

**Granular Soil Conditions Adjacent to Pit Slopes**

The stability of the pit slopes assumes that there are no continuous clay layers in slope areas, particularly in slope areas adjacent to the proposed dry swales and lined detention basins. On the basis of a review of the logs of borings drilled adjacent to the pit slopes (Fugro West, Inc., 1999; The Byer Group, 2000; Earth Systems Consultants, 1997a,b), soil conditions generally consist of granular well-graded sands with varying amounts of gravel. Potential development of seepage forces in areas where fine-grained artificial fill materials may be encountered (such as in the stockpile area located northwest of the Brigham pit) may be mitigated during the course of fill removal by the replacement of fine-grained soils with granular soils near slope areas.

**Removal of Artificial Slope Materials**

Although the 1977, 1979, 1986, 1988, 1989, 1990, 1992, 1997, and 1999 topographic maps have been reviewed and compared with each other to help identify areas of artificial fill, unknown areas of artificial fill may be present. Artificial fills also may remain undetected during surficial reconnaissance mapping because of vegetative cover or the erosion of slope face materials by "wave action" from fluctuating water levels. However, because of the considerations given to reducing uncertainties in slope composition (described previously) most artificial fills should be removed in the course of laying back the slopes as proposed. However, in areas of deeper fills, those materials would be revealed during the laying back of the slopes (while slope surfaces are excavated) or, where applicable, during the reconstruction of the upper 35 to 45 feet of the slopes. Artificial fills encountered above the water level should be removed and recompacted with conventional grading methods. Artificial fill encountered below the water

level may be removed by laying the submerged portion of the slope back into native materials, or may be improved with ground improvement techniques such as DDC or vibroflotation.

## CONDITIONS FOR APPROVAL

Prior to preparation of site grading plans for the slope areas, site-specific geotechnical studies should be performed. Those studies should evaluate the uniformity of slope materials and verify that benches (where keyways are planned for reconstructed slopes) consist of native, undisturbed materials. Areas between proposed dry swales and the slope faces should be explored to verify the absence of continuous clay layers.

A summary of recommended additional studies for the various pit slope areas are listed under the "Conditions for Approval" heading of Table 1 presented at the end of this section. In addition to those conditions, the following elements should be included in the design-level study:

- An evaluation of the composition and strength of slope materials, consisting of incremental penetration resistance tests, the continuous characterization of overall slope materials, and laboratory tests appropriate for the material composition, grain-size, and sample quality. Continuous characterization of slope materials may be achieved by excavating a trench above the full, unsubmerged upper portion of the pit slope face.

- The extent of artificial fills should be explored further by reconnaissance mapping and trenching.

Once additional field data and material samples are collected and evaluated, higher strengths for slope materials may be justifiable. If higher strength values result, reevaluation of slope stability and lateral movements should reduce the lateral movements estimated herein and increase the factors of safety for gross stability under static and pseudostatic conditions.

Additionally, private properties located adjacent to slope crests should be inventoried for "occupied" structures, so that setback criteria can be satisfied and/or owners apprised of the risk of earthquake-induced lateral movements to their structures and improvements (whether occupied or not).

## REFERENCES

Bray J.D. and Rathje, E.M. (1998), "Earthquake-Induced Displacements of Solid-Waste Landfills," Journal of Geotechnical and Geoenvironmental Engineering, Vol. 124, No. 3, March.

California Division of Mines & Geology (CDMG) (1997), "Guidelines for Evaluating and Mitigating Seismic Hazards in California," Special Publication 117, Table 1.

Earth Systems Consultants, Inc. (1997a), "Slope Stability Analyses of South Slope of Easternmost Pit," ESC Job No. SS-21279-VI, June 11.

_____(1997b), "Slope Stability Analyses of Borrow Pit Slopes Along Montgomery and Lambert Streets," Job No. SS-21229-V1, Report No. 97-10-112, October 24.

Fugro West, Inc. (1998), "Preliminary Geotechnical Evaluation, Southern Pacific Milling Main Entrance Road, El Rio Area of Ventura County, California," FWI Project No. 97-71-0261, February 18 (revised February 28).

_____(1998), "Preliminary Slope Assessment of Woolsey Pit Slope Along Giacopuzzi Property, El Rio Area of Ventura County, California," Fugro Project No. 97-71-0262, December 22.

_____(1999), "Geotechnical Study, RiverPark B, at Former S.P. Milling Company Property, El Rio Area of Ventura County, California," FWI Job No. 99-42-0021, December.

_____(2000), "Geotechnical Study, El Rio Juvenile Justice Center Complex, Vineyard Avenue and Beedy Street, El Rio/Oxnard, California," FWI Job No. 99-42-0433, August 25 (updated February 2001).Sharma, S. (2000), "XSTABL, An Integrated Slope Stability Analysis Program for Personal Computers, Version 5," prepared for Interactive Software Designs, Inc., Moscow, Idaho.

Southern California Earthquake Center (SCEC) (2000), "DRAFT, Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Landslide Hazards in California," R. Hollingsworth and J. Stewart, Editors, University of Southern California, Los Angeles, California.

The J. Byer Group, Inc. (1998), "Preliminary Findings, Geotechnical Research, Oxnard Town Center and Southern Pacific Milling Company, Northeast of the 101 Freeway and Santa Clara River Intersection, City of Oxnard and Ventura County, California," Job No. JB 17923-B, November 19.

Uniform Building Code (UBC) (1997), International Conference of Building Officials, April.

# AERIAL PHOTOGRAPHS REVIEWED

| Source | Flight No. | Date | Frame Nos. | Stereo |
|---|---|---|---|---|
| USDA | AXI | 5/9/38 | 44, 45 | Yes |
| USGS | GS-EM | 8/20/47 | 74, 75 | Yes |
| U.S. Dept. of Agriculture (USDA) | AXI | 10/7/53 | 92,93 | Yes |
| USDA | AXI | 10/2/59 | 133, 134 | Yes |
| Mark Hurd | HA-LS | 6/30/61 | 37, 38, 39 | Yes |
| Mark Hurd | HA-OH | 3/24/62 | 51, 52, 53 | Yes |
| Mark Hurd | HA-RR | 1/7/63 | 110, 111 | Yes |
| Mark Hurd | HA-SH | 3/20/63 | 108, 109, 110 | Yes |
| Mark Hurd | HA-TG | 6/24/63 | 10, 11, 12 | Yes |
| Mark Hurd | HA-WE | 2/14/64 | 23, 24, 25, 37, 38 | Yes |
| USDA | AXI | 9/20/65 | 84, 85 | Yes |
| Mark Hurd | HB-IA | 7/5/66 | 54, 55 | Yes |
| USGS | GS-VBUK | 8/12/67 | 86, 87, 88 | Yes |
| Mark Hurd | HB-MA | 7/22/68 | 3, 4 | Yes |
| Western Pacific | M7124 | 6/14/71 | 2 | No |
| Western Pacific | VEN | 8/24/70 | 80 | No |
| Western Pacific | VEN | 9/15/70 | 140 | No |
| Western Pacific | VEN | 10/28/70 | 170 | No |
| Continental Aerial | 107-10 | 4/20/72 | 4, 5 | Yes |
| Pacific Western | VEN | 8/23/73 | 83, 84 | Yes |
| Pacific Western | 4918 | 3/17/75 | 1 | No |
| Teledyne Geotronics | 7500C | 7/29/75 | 5,6 | Yes |
| Teledyne Geotronics | 7700 | 3/14/77 | 14, 15 | Yes |
| Western Pacific | 7819 | 2/16/78 | 7, 8 | Yes |
| Pacific Western | VEN-2 | 5/16/78 | 34, 60, 61 | Yes |
| Pacific Western | 9034 | 7/7/79 | 1 | No |
| I.K. Curtis | VEN-59 | 12/11/78 | 65, 66 | Yes |
| Continental Aerial | 2-VEN | 4/3/79 | 2, 3 | Yes |
| Western Pacific | 79151 | 6/29/79 | 1 | No |
| Pacific Western | PW-9034 | 7/7/79 | 1 | No |
| Western Pacific | 79166 | 8/7/79 | 14, 15 | Yes |
| Continental Aerial | VEN-17 | 2/80 | 8, 10 | Yes |
| Western Pacific | 8158 | 3/24/81 | 7, 8 | Yes |
| Pacific Western | VEN-3 | 6/15/81 | 70, 71, 114, 115 | Yes |
| Pacific Western | PW-14063 | 8/13/82 | 1, 2 | Yes |
| Pacific Western | VEN-4 | 1/11/84 | 114, 115 | Yes |
| I.K. Curtis | V59 | 1/3/85 | 59, 60 | Yes |
| WAC | 85CA | 4/21/86 | 8, 9, 10 | Yes |
| Western Pacific | 86101 | 6/24/86 | 3, 4 | No |
| Pacific Western | VEN-5 | 12/10/86 | 110, 111 | Yes |
| Pacific Western | VEN-5 | 1/12/87 | 122, 123, 124 | Yes |
| I.K. Curtis | VEN | 4/22/87 | 432, 433 | Yes |
| NAC (Continental Aerial) | NAC-VEN | 1/11/88 | 3, 4 | Yes |
| Pacific Western | PW28847 | 1/12/88 | 53, 54, 68, 69, 70, 85 | Yes |
| Pacific Western | 28847-3 | 1/20/88 | 35, 48, | No |

| Source | Flight No. | Date | Frame Nos. | Stereo |
|---|---|---|---|---|
| I.K. Curtis | VEN | 3/25/88 | 311, 312 | Yes |
| Pacific Western | VEN-6 | 9/29/88 | 114, 115 | Yes |
| Pacific Western | VEN-6 | 10/10/88 | 82, 83 | Yes |
| I.K. Curtis | VEN | 3/14/89 | 1073, 1074 | Yes |
| Pacific Western | VEN-7 | 5/23/89 | 83, 84, 112, 113 | Yes |
| Western Pacific | 8972 | 6/28/89 | 4, 5 | Yes |
| Western Pacific | 8972 | 6/29/89 | 6 | No |
| I.K. Curtis | VEN | 4/12/90 | 644, 645 | Yes |
| Continental Aerial | C82 | 6/7/90 | 4, 5 | Yes |
| Pacific Western | VEN-8 | 11/8/90 | 111, 113 | No |
| I.K. Curtis | VEN | 1/22/92 | 188, 189 | Yes |
| Pacific Western | VEN-9 | 9/19/92 | 83, 84, 113, 114 | Yes |
| I.K. Curtis | VEN | 4/7/93 | 374, 375 | Yes |
| Continental Aerial | C89 | 5/13/93 | 171, 172, 173 | Yes |
| I.K. Curtis | VEN | 12/3/93 | 612, 613 | Yes |
| Pacific Western | 51706 | 12/29/93 | 1 | No |
| Pacific Western | 52043 | 2/24/94 | 3, 4 | Yes |
| Western Pacific | 9437 | 8/25/94 | 14 | No |
| I.K. Curtis | VEN | 1/31/95 | 52, 53 | Yes |
| Continental Aerial | C113 | 6/19/95 | 83, 84 | Yes |
| Pacific Western | VEN-12 | 1/8/96 | 83 | No |
| I.K. Curtis | VEN | 10/13/97 | 360, 361 | Yes |
| Western Pacific | 9765 | 12/16/97 | 2, 3 | Yes |
| I.K. Curtis | VEN | 11/21/98 | 486, 487 | Yes |
| Continental Aerial | C-130 | 12/7/98 | 166, 167 | Yes |
| I.K. Curtis | VEN | 3/22/00 | 577, 578 | Yes |

# TABLES AND PLATES

| PIT SLOPE | | EXISTING/PROPOSED CONDITIONS | IMPACTS | MITIGATION | | CONDITIONS FOR APPROVAL | ALTERNATIVES |
|---|---|---|---|---|---|---|---|
| BRIGHAM | Southwestern Slope | Existing artificial fill to ~ El. 40 to 50 feet | Existing artificial fills subject to settlement and lateral movements | Remove and recompact artificial fill. Key and bench fill into native, undisturbed slope materials | Brown | Verify native bench between El. 40 and 50 feet | Use DDC to compact submerged granular fill |
| | Southeastern end of Southwestern slope | Existing slopes at ~1½h:1v, along lower portion, artificial fill in upper portion of slope | Existing artificial fills subject to settlement and lateral movements, does not meet minimum factor of safety requirements | Lay back lower portion of slope at 2- to 2½:1v, remove fill in upper slope area and reconstruct upper slope at 2- to 2½h:1v | Blue/ Brown | Verify reconstructed upper slope founded on native materials | Use DDC to compact submerged fill |
| | Southeastern Slope | Existing slope at ~1½h:1v | Does not meet minimum factor of safety requirements. | Lay slope back at 2- to 2½h:1v | Blue | Verify native materials exposed along slope face | NA |
| | Northwestern End | Proposed pitward fill at 2- to 2½h:1v. | None | Remove and recompact artificial fill. Key and bench fill into native, undisturbed slope materials | Green | Verify native bench between El. 40 and 50 feet | Use DDC to compact submerged fill on bench |
| | Western Corner | Existing artificial fill to ~ El. 40 to 50 feet | Existing artificial fill subject to settlement and lateral movements. | Remove and recompact artificial fill. Key and bench fill into native, undisturbed slope materials | Green | Verify native bench between El. 40 and 50 feet | Use DDC to compact submerged fill on bench |
| VICKERS | Northwestern End | Existing artificial fill to ~ El. 20 feet. | Existing artificial fills subject to settlement and lateral movements | Remove fill to ~El. 50 feet, treat exposed surface with DDC, construct conventional fill at 2- to 2½h:1v above treated soil | Magenta | Verify depth of artificial fill in peninsula area and that fill peninsula materials below El. 50 feet are granular. Verify densification of improved hydraulic fill with field testing | Use alternative ground-improvement technique (such as vibroflotation) for fills thicker than 30 feet. |
| | North End of Northwestern Slope | Existing artificial fill to ~ El. 20 feet, adjacent pit bottom to ~ El. 10 feet beyond fill peninsula | Existing artificial fills subject to settlement and lateral movements | As above, except construct fill at 1- to 1½h:1v above treated soil | Lavender | As above | As above |
| | Southeastern Slope | Existing slopes at ~1½h:1v | Does not meet minimum factor of safety requirements | Lay slope back at 2- to 2½h:1v | Blue | Verify native materials exposed along slope face | NA |
| SMALL WOOLSEY | Northern End | Fill in upper portion of slope, sections of lower portion steeper than ~1½h:1v | Existing artificial fills subject to settlement and lateral movements; steep portions of slope do not meet minimum factor of safety requirements | Lay lower slope back at 2- to 2½h:1v, remove and recompact artificial fill in upper slope with conventional grading methods | Blue/ Brown | Verify reconstructed upper slope founded on native materials | Use DDC or vibroflotation to compact submerged fill |
| | Northwestern Corner | Existing pit slope steeper than ~1½h:1v, toe at ~El. 10 feet, pitward fill requires underwater placement of fill | Hydraulic fill subject to liquefaction, lateral movement | Place hydraulic fill against rock dike in pit bottom, densify hydraulic fill w/DDC or vibroflotation, construct mechanically-reinforced fill above improved soil | Dark Blue | Verify densification of hydraulic fill with field testing | NA |
| | Southeastern Slope | Sections of slope between ~1h:1v and ~1½h:1v | Does not meet minimum factor of safety requirements | Lay back slope at 2- to 2½h:1v | Blue | Verify distance from slope crest to occupied structures on adjacent properties is greater than 80 feet, native materials exposed, absence of continuous clay layers | Where less than 80-foot setback from area to structures provide lateral resistance with piers to reduce seismically induced lateral movement |
| | Eastern Corner | Artificial fill down to ~El. 55 feet or lower from slope repair | Existing artificial fills subject to settlement and lateral movements | Lay back lower portion of slope at 2- to 2½h:1v, remove and recompact fill using conventional grading, reconstruct fill slope at 2- to 2½h:1v | Blue/ Brown | Verify reconstructed upper slope founded on/into native materials | Where less than 80-foot setback from area to structures provide lateral resistance with piers to reduce seismically induced lateral movement |
| LARGE WOOLSEY | Southwestern End | Artificial fill down to ~El. 40 feet | Existing artificial fills subject to settlement and lateral movements | Remove and recompact artificial fill and reconstruct slope at 2- to 2½h:1v | Brown | Verify reconstructed upper slope founded on native materials | Use DDC to compact submerged granular fill |
| | Southwestern Half of Southeastern Slope | ~ 15 feet of artificial fill on upper slope, construct slope pitward to accommodate bioswale area | Existing artificial fills subject to settlement and lateral movements | Reconstruct pitward slope over native bench at ~El. 45 feet to increase setback to existing structures | Brown | Verify native bench ~ El. 45 feet | Use DDC to compact submerged granular fill |
| | Northeastern Half of Southeastern Slope | ~ 15 feet of artificial fill on upper slope, > 30 feet artificial fill in repair area, lower half of slope steeper than 1½h:1v | Existing artificial fills subject to settlement and lateral movements, slope does not meet minimum factor of safety requirements | Lay slope back at 2- to 2½h:1v, remove and recompact artificial fill in upper slope with conventional grading methods | Blue | Verify artificial fills in upper slope removed down to native, verify 80-foot setback to existing structures | Where less than 80-foot setback from area to structures provide lateral resistance with piers to reduce seismically induced lateral movement |
| | Northeastern Slope | Slope steeper than 1½h:1v | Does not meet minimum factor of safety requirements | Lay slope back at 2- to 2½h:1v | Blue | Verify native materials exposed along slope face | If cannot encroach onto County drain easement, provide lateral resistance with drilled piers along crest |
| | Northwestern Slope | Some areas of slope steeper than 1½h:1v | Does not meet minimum factor of safety requirements | Lay slope back at 2- to 2½h:1v, and trim slope to expose native materials where existing gradient is flatter than 2- to 2½h:1v | Blue | Verify native materials exposed along slope face | NA |

**SUMMARY OF PIT SLOPE MITIGATION MEASURES**
**RiverPark B**

**TABLE 1**

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| PIT SLOPE | | EXISTING/PROPOSED CONDITIONS | IMPACTS | MITIGATION | | CONDITIONS FOR APPROVAL | ALTERNATIVES |
|---|---|---|---|---|---|---|---|
| BRIGHAM | Southwestern Slope | Existing artificial fill to ~ El. 40 to 50 feet | Existing artificial fills subject to settlement and lateral movements | Remove and recompact artificial fill. Key and bench fill into native, undisturbed slope materials | Brown | Verify native bench between El. 40 and 50 feet | Use DDC to compact submerged granular fill |
| | Southeastern end of Southwestern slope | Existing slopes at ~1½h:1v, along lower portion, artificial fill in upper portion of slope | Existing artificial fills subject to settlement and lateral movements, does not meet minimum factor of safety requirements | Lay back lower portion of slope at 2- to 2½:1v, remove fill in upper slope area and reconstruct upper slope at 2- to 2½h:1v | Blue/ Brown | Verify reconstructed upper slope founded on native materials | Use DDC to compact submerged fill |
| | Southeastern Slope | Existing slope at ~1½h:1v | Does not meet minimum factor of safety requirements. | Lay slope back at 2- to 2½h:1v | Blue | Verify native materials exposed along slope face | NA |
| | Northwestern End | Proposed pitward fill at 2- to 2½h:1v. | None | Remove and recompact artificial fill. Key and bench fill into native, undisturbed slope materials | Green | Verify native bench between El. 40 and 50 feet | Use DDC to compact submerged fill on bench |
| | Western Corner | Existing artificial fill to ~ El. 40 to 50 feet | Existing artificial fill subject to settlement and lateral movements. | Remove and recompact artificial fill. Key and bench fill into native, undisturbed slope materials | Green | Verify native bench between El. 40 and 50 feet | Use DDC to compact submerged fill on bench |
| VICKERS | Northwestern End | Existing artificial fill to ~ El. 20 feet. | Existing artificial fills subject to settlement and lateral movements | Remove fill to ~El. 50 feet, treat exposed surface with DDC, construct conventional fill at 2- to 2½h:1v above treated soil | Magenta | Verify depth of artificial fill in peninsula area and that fill peninsula materials below El. 50 feet are granular. Verify densification of improved hydraulic fill with field testing | Use alternative ground-improvement technique (such as vibroflotation) for fills thicker than 30 feet. |
| | North End of Northwestern Slope | Existing artificial fill to ~ El. 20 feet, adjacent pit bottom to ~ El. 10 feet beyond fill peninsula | Existing artificial fills subject to settlement and lateral movements | As above, except construct fill at 1- to 1½h:1v above treated soil | Lavender | As above | As above |
| | Southeastern Slope | Existing slopes at ~1½h:1v | Does not meet minimum factor of safety requirements | Lay slope back at 2- to 2½h:1v | Blue | Verify native materials exposed along slope face | NA |
| SMALL WOOLSEY | Northern End | Fill in upper portion of slope, sections of lower portion steeper than ~1½h:1v | Existing artificial fills subject to settlement and lateral movements; steep portions of slope do not meet minimum factor of safety requirements | Lay lower slope back at 2- to 2½h:1v, remove and recompact artificial fill in upper slope with conventional grading methods | Blue/ Brown | Verify reconstructed upper slope founded on native materials | Use DDC or vibroflotation to compact submerged fill |
| | Northwestern Corner | Existing pit slope steeper than ~1½h:1v, toe at ~El. 10 feet, pitward fill requires underwater placement of fill | Hydraulic fill subject to liquefaction, lateral movement | Place hydraulic fill against rock dike in pit bottom, densify hydraulic fill w/DDC or vibroflotation, construct mechanically-reinforced fill above improved soil | Dark Blue | Verify densification of hydraulic fill with field testing | NA |
| | Southeastern Slope | Sections of slope between ~1h:1v and ~1½h:1v | Does not meet minimum factor of safety requirements | Lay back slope at 2- to 2½h:1v | Blue | Verify distance from slope crest to occupied structures on adjacent properties is greater than 80 feet, native materials exposed, absence of continuous clay layers | Where less than 80-foot setback from area to structures provide lateral resistance with piers to reduce seismically induced lateral movement |
| | Eastern Corner | Artificial fill down to ~El. 55 feet or lower from slope repair | Existing artificial fills subject to settlement and lateral movements | Lay back lower portion of slope at 2- to 2½h:1v, remove and recompact fill using conventional grading, reconstruct fill slope at 2- to 2½h:1v | Blue/ Brown | Verify reconstructed upper slope founded on/into native materials | Where less than 80-foot setback from area to structures provide lateral resistance with piers to reduce seismically induced lateral movement |
| LARGE WOOLSEY | Southwestern End | Artificial fill down to ~El. 40 feet | Existing artificial fills subject to settlement and lateral movements | Remove and recompact artificial fill and reconstruct slope at 2- to 2½h:1v | Brown | Verify reconstructed upper slope founded on native materials | Use DDC to compact submerged granular fill |
| | Southwestern Half of Southeastern Slope | ~ 15 feet of artificial fill on upper slope, construct slope pitward to accommodate bioswale area | Existing artificial fills subject to settlement and lateral movements | Reconstruct pitward slope over native bench at ~El. 45 feet to increase setback to existing structures | Brown | Verify native bench ~ El. 45 feet | Use DDC to compact submerged granular fill |
| | Northeastern Half of Southeastern Slope | ~ 15 feet of artificial fill on upper slope, > 30 feet artificial fill in repair area, lower half of slope steeper than 1½h:1v | Existing artificial fills subject to settlement and lateral movements, slope does not meet minimum factor of safety requirements | Lay slope back at 2- to 2½h:1v, remove and recompact artificial fill in upper slope with conventional grading methods | Blue | Verify artificial fills in upper slope removed down to native, verify 80-foot setback to existing structures | Where less than 80-foot setback from area to structures provide lateral resistance with piers to reduce seismically induced lateral movement |
| | Northeastern Slope | Slope steeper than 1½h:1v | Does not meet minimum factor of safety requirements | Lay slope back at 2- to 2½h:1v | Blue | Verify native materials exposed along slope face | If cannot encroach onto County drain easement, provide lateral resistance with drilled piers along crest |
| | Northwestern Slope | Some areas of slope steeper than 1½h:1v | Does not meet minimum factor of safety requirements | Lay slope back at 2- to 2½h:1v, and trim slope to expose native materials where existing gradient is flatter than 2- to 2½h:1v | Blue | Verify native materials exposed along slope face | NA |

**SUMMARY OF PIT SLOPE MITIGATION MEASURES**
**RiverPark B**

**TABLE 1**

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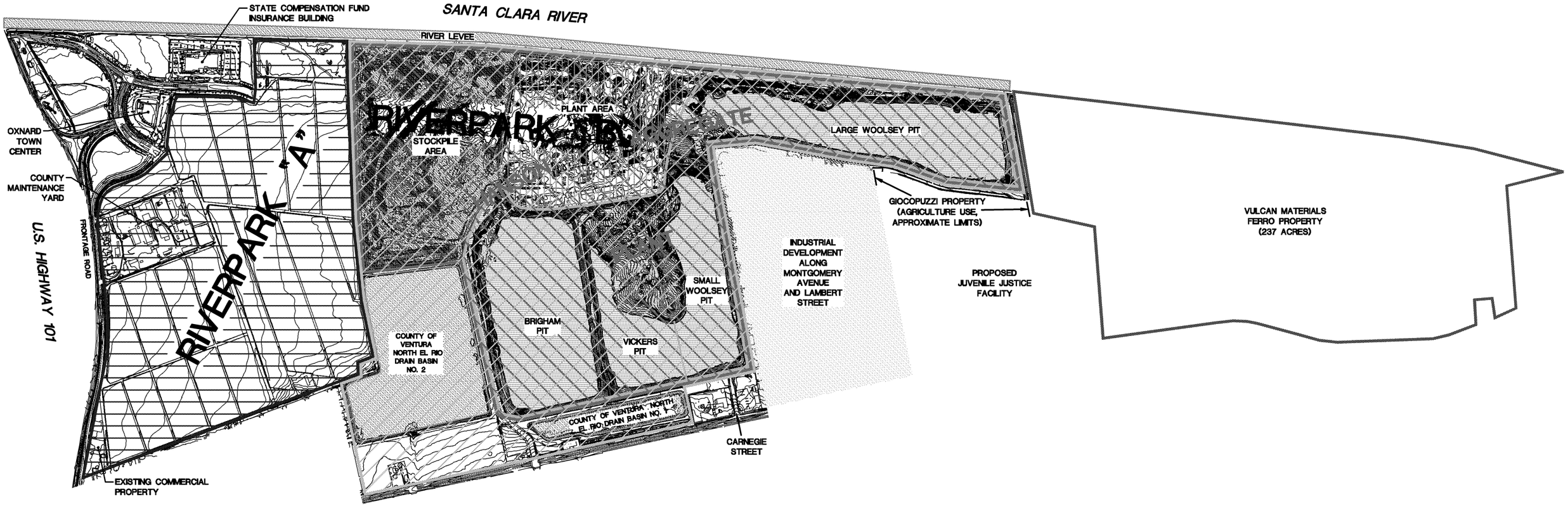
March 2001
Project No. 99-42-0026




LEGEND

- RiverPark A
- RiverPark B
- Hanson Aggregate Plant
- Plant Area
- Stockpile Area
- Mining Pits and Slopes
- County of Ventura Retention Basin
- River Levee
- Industrial Development
- Vulcan Materials Ferro Property (237 Acres)

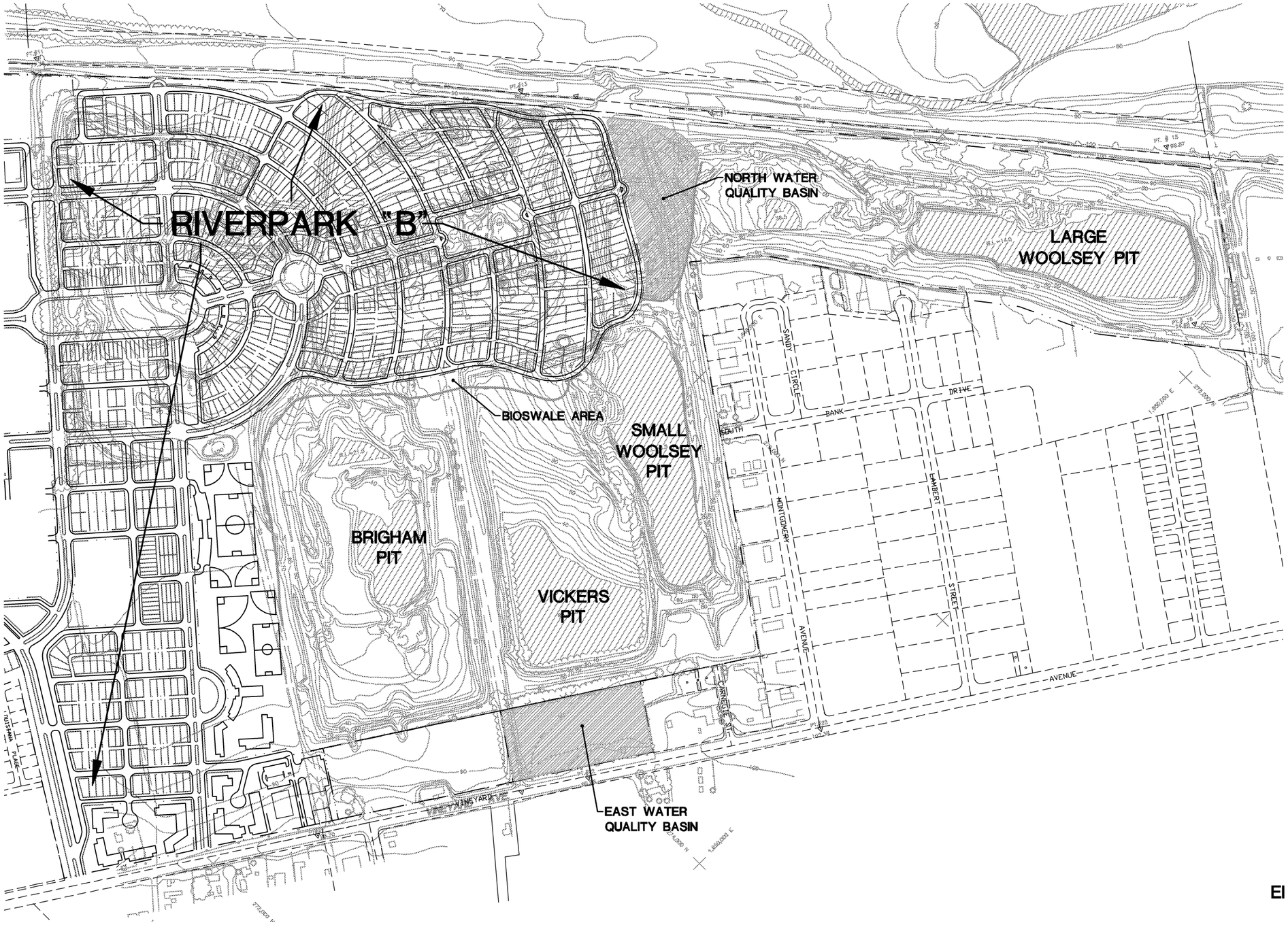
NORTH

0 1000 2000
FEET

**VICINITY MAP**
RiverPark B
El Rio Area of Ventura County, California

PLATE 1

9942\0026plan.dwg(0,2-15),ps,xref0023\37083.dwg,0026plan.pcp




**SITE MAP**
RiverPark B
El Rio Area of Ventura County, California

**PLATE 2**

9942\0026map.dwg(0,22-27),ps,0026map.pcp

oversize pocket: plate 3

**KEY**

- Area to be Cut
- Reinforced Fill
- In Situ Ground-Improved Material
- Hydraulically-Placed Fill

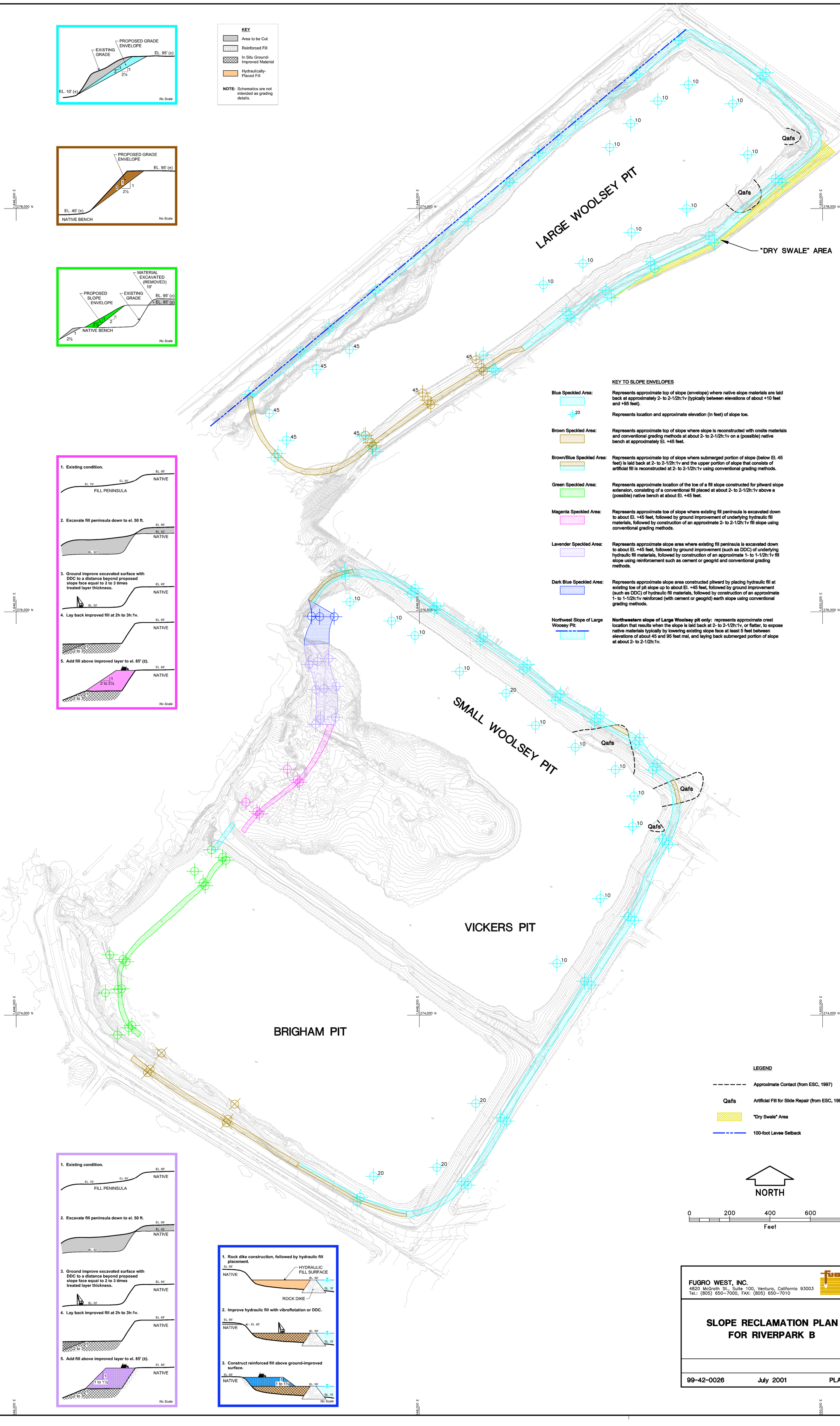
**NOTE:** Schematics are not intended as grading details.










**KEY TO SLOPE ENVELOPES**

**Blue Speckled Area:** Represents approximate top of slope (envelope) where native slope materials are laid back at approximately 2- to 2-1/2h:1v (typically between elevations of about +10 feet and +95 feet).

20 — Represents location and approximate elevation (in feet) of slope toe.

**Brown Speckled Area:** Represents approximate top of slope where slope is reconstructed with onsite materials and conventional grading methods at about 2- to 2-1/2h:1v on a (possible) native bench at approximately El. +45 feet.

**Brown/Blue Speckled Area:** Represents approximate top of slope where submerged portion of slope (below El. 45 feet) is laid back at 2- to 2-1/2h:1v and the upper portion of slope that consists of artificial fill is reconstructed at 2- to 2-1/2h:1v using conventional grading methods.

**Green Speckled Area:** Represents approximate location of the toe of a fill slope constructed for pitward slope extension, consisting of a conventional fill placed at about 2- to 2-1/2h:1v above a (possible) native bench at about El. +45 feet.

**Magenta Speckled Area:** Represents approximate toe of slope where existing fill peninsula is excavated down to about El. +45 feet, followed by ground improvement of underlying hydraulic fill materials, followed by construction of an approximate 2- to 2-1/2h:1v fill slope using conventional grading methods.

**Lavender Speckled Area:** Represents approximate slope area where existing fill peninsula is excavated down to about El. +45 feet, followed by ground improvement (such as DDC) of underlying hydraulic fill materials, followed by construction of an approximate 1- to 1-1/2h:1v fill slope using reinforcement such as cement or geogrid and conventional grading methods.

**Dark Blue Speckled Area:** Represents approximate slope area constructed pitward by placing hydraulic fill at existing toe of pit slope up to about El. +45 feet, followed by ground improvement (such as DDC) of hydraulic fill materials, followed by construction of an approximate 1- to 1-1/2h:1v reinforced (with cement or geogrid) earth slope using conventional grading methods.

**Northwest Slope of Large Woosey Pit:** **Northwestern slope of Large Woolsey pit only:** represents approximate crest location that results when the slope is laid back at 2- to 2-1/2h:1v, or flatter, to expose native materials typically by lowering existing slope face at least 5 feet between elevations of about 45 and 95 feet msl, and laying back submerged portion of slope at about 2- to 2-1/2h:1v.







**LEGEND**

- Approximate Contact (from ESC, 1997)
- Qafs — Artificial Fill for Slide Repair (from ESC, 1997)
- "Dry Swale" Area
- 100-foot Levee Setback

NORTH

0 200 400 600 800

Feet


**FUGRO WEST, INC.**
4820 McGrath St., Suite 100, Ventura, California 93003
Tel.: (805) 650-7000, FAX: (805) 650-7010


# SLOPE RECLAMATION PLAN FOR RIVERPARK B

99-42-0026 | July 2001 | PLATE 3


6942\0026\eps.dwg[0-5,10-17,19,20,26,27,29,30,35,39,41,42,44].pc,0026eps.pcp

# APPENDIX A
# PIT MINING HISTORY

The following summaries of pit mining at the Hanson Aggregate plant have been based on a review of about 70 sets of aerial photographs and 200-scale topographic maps of the pit areas from 1977, 1979, 1988, 1989, 1992, 1997, and 1999. The 1977 and 1989 topographic maps were generated from aerial photographs specifically for this study. The fragmented nature of the histories, based on intermittent "snapshots" of the subject site, provides only, at best, an approximation and does not provide a complete or fully accurate record of past mining activities or slope configurations.

## LARGE WOOLSEY PIT

The Large Woolsey pit appears to have been the first of the four subject pits mined, starting in approximately late 1959, at the northeastern end of the existing pit. Excavation continued to expand at the northeastern end of the pit in 1961 and removals also started at the southwestern end. In early 1962, the southwestern excavation was being backfilled. By early 1963, the excavation in the Large Woolsey pit was expanded to most of the pit, but the excavation did not appear very deep. By 1965, the pit was deepened at the northeastern end, in several narrow locations, and in 1966, the southwestern end was deepened. The northeastern end of the Large Woolsey pit again was deepened in mid-1968. Excavating up to about mid-1968 appears to have been performed under dry conditions.

Several deep holes were observed in aerial photographs from the 1970s. Water was present in the deep excavation at the northeastern end. The western third of the southeastern slope adjacent to the industrial development appears to have been undercut by March 1976. Through early 1978, the northeastern end appears enlarged. By May 1978, water in the pits concealed most of the slope areas. By August 1982, the water level subsided and extensive excavation is evident above the water level.

Several periods of elevated water level suggest little mining activity (unless underwater excavation with a clamshell-type excavator was used). Periods when the pits were dry (or nearly so) typically coincided with a notable increase in excavation on the pit bottom.

In addition to the aerial photographs, the topographic maps from 1977, 1988, 1989, 1992, and 1999 lend insight into the excavation depths, slope locations, and slope gradients. On the basis of those maps, the southwestern half of the Large Woolsey pit appears to have been excavated to between about El. 50 feet and El. 23 feet and the northeastern half appears to have been excavated to between about El. 20 feet and El. -2 feet. Additionally, the 1989 topographic map suggests that portions of the upper half of the southeastern slope had up to about 15 feet of fill compared with the slope gradients in the same areas shown on the 1977 topographic map.

According to observations by Earth Systems (1997b) and a geologic map by The Byer Group (2000), the southeastern slope of the Large Woolsey pit has experienced shallow failures, at least some of which were precipitated by concentrated runoff over the slope face from storm drains and pipe breakages. In the immediate vicinity of the shallow failures, pre-failure slope gradients were restored by a combination of "spill fills" along the inaccessible or inundated portions of the slope and conventional grading equipment above those areas. The depth and extent of those fills are not well documented but appear to have been approximated by geologic reconnaissance mapping.

## BRIGHAM PIT

In mid-1968, excavation started in the northwestern end of the Brigham pit. By November 1970, approximately two-thirds of the present plan footprint of the Brigham pit was excavated to a somewhat level bottom. By early 1975, excavations had resumed in the pit bottom, and by March 1977, the northwestern end was excavated as deep as about El. 40 feet, the southeastern end between El. 20 and El. 30 feet, and the southwestern end generally between about El. 40 and 50 feet. The southeastern excavation appears to have expanded farther southeast in 1978, until the pit was inundated between mid-1979 and mid-1986. In mid-1986, excavation along the southwestern side was visible with an interior ridge. By late 1988, the water level had subsided and grading in the bottom of the southeastern half of the pit resumed. By mid-1989, the northwestern third of the pit was excavated to elevations between about 20 and 50 feet, the north-central portion down to near sea level, and the southeastern end to about El. 20 feet. Slopes along the southeastern edge of the pit and along the eastern end of the southwestern slope were as steep as about 1h:1v. Slopes along the northwestern edge of the pit generally ranged from about 1-3/4h:1v to 2h:1v. By April 1992, the central pit area was excavated to about El. -8 feet and the slope along the southwestern side of the pit had received up to about 35 feet of fill, compared to 1989 elevations. That area was converted to the plant entrance drive within a few years of filling. Settlement and tension cracks have appeared along the entrance road since its construction, suggesting that the fill is not stable.

Between about early-1993 and 1994, the northern corner of the Brigham pit was removed.

## VICKERS PIT

Deep exploration excavations appeared at the northwestern and southeastern end of the Vickers Pit in mid-1970. By mid-1971, approximately one-half of the present plan footprint of the Vickers Pit was excavated. By late-August 1973 most of the present pit configuration was excavated. By early 1977, the northwestern end of the pit was deepened to about El. 20 feet within 200 feet of the top of slope. According to the 1977 topographic map, the northwestern slope appears to have been excavated in two 30-foot-high, 1-1/2h:1v segments, with an approximately 100-foot-wide bench (with about 5 feet of relief across the bench) mid-height of

the 65-foot-high slope. The southeastern two-thirds of the pit was excavated to about El. -2 feet, with slopes locally as steep as about 1-1/2h:1v. After additional enlarging and deepening of the pit in early 1978, groundwater filled the pit bottom for several years. In February of 1980, fill appears at the northwestern end of the Vickers pit and placement creates a fill peninsula that progressively expands southeastward. By early 1995, a land bridge between the Vickers and Small Woolsey pit (to the northeast) was removed (at least above the groundwater level in the pits).

**SMALL WOOLSEY PIT**

Excavation in the Small Woolsey pit had begun by mid-1970. By early 1972, most of the Small Woolsey pit was excavated, with the deepest excavation at the northwestern end. Deepening progressed southeastward in mid-1973. After a short period of inundation (through mid-1975), the pit bottom excavation ranged from about El. 20 feet near the center to about 40 feet at the northwestern end. Slopes appeared to have been excavated to gradients of about 1h:1v to 1-1/2h:1v, and by mid-1987, the northeastern pit slope shifted about 80 feet northeastward and appears to have been excavated at about 2h:1v. The northwestern end of the Small Woolsey pit was excavated down to about El. 30 feet, and the southeastern end was excavated down to about El. 25 feet. An access road was graded along the northwestern end of the northeastern slope between El. 30 and 60 feet. By 1992, the northwestern end of the Small Woolsey pit was excavated down to about El. -2 feet and the excavation migrated southwestward, removing a former land bridge between the northwestern end of the Vickers and Small Woolsey Pits. The upper 60 feet of the slope at the westernmost corner of the Small Woolsey Pit appears to be excavated at a gradient as steep as about 3/4h:1v. Additionally, below the outside edge of the pit access road (at the northwestern end of the northeastern side of the pit), the lower 30 to 40 feet of slope appears to have been cut at about 1/2h:1v .

By 1995, the southeastern end of the Small Woolsey pit was extended toward Vineyard Avenue. Shortly after, concentrated runoff from adjacent properties converging at the eastern corner of the Small Woolsey pit precipitated a washout of approximately the upper half of slope that extended onto the private (industrial) property to the east. We understand that the repair was performed with spill fills below accessible areas and conventional grading above. The slope repair was performed without observation and testing by the geotechnical engineer, and probably also without keying and benching into native undisturbed slope materials).

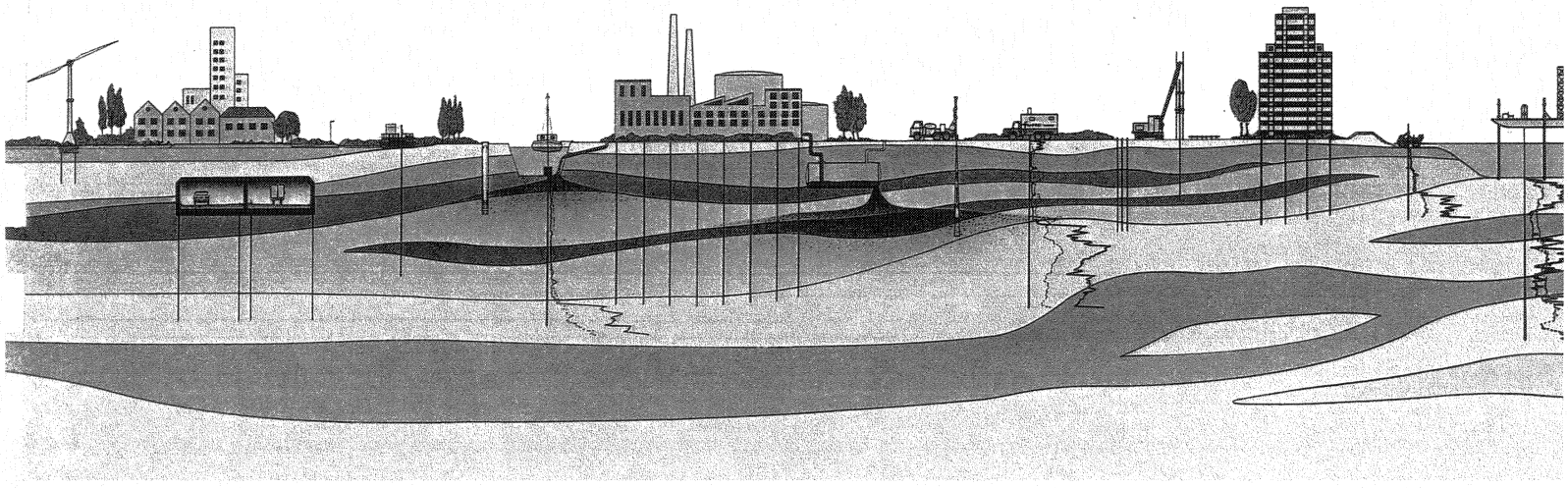
Geotechnical Study RiverPark B
at Former S.P. Milling Company Property
(Fugro West, Inc., October 1999)

FUGRO WEST, INC.

# GEOTECHNICAL STUDY
# RIVERPARK B
# AT FORMER S.P. MILLING COMPANY PROPERTY
# EL RIO AREA OF VENTURA COUNTY, CALIFORNIA

Prepared for:
KELLER EQUITY GROUP
Los Angeles, California

October 1999



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December 17, 1999
Project No. 99-42-0021

Keller Equity Group
304 S. Broadway, Suite 550
Los Angeles, California 90013

Attention: Mr. Paul Keller

Subject: Geotechnical Study for RiverPark B, at Former S.P. Milling Company Property, El Rio Area of Ventura County, California

Dear Mr. Keller:

Fugro is pleased to submit this geotechnical report for the RiverPark B development at the former S.P. Milling property in the El Rio area of Ventura County, California. This study is limited to the exploration and evaluation of the existing fill materials in the stockpile and plant areas of the property. Our scope of services for this study did not include an evaluation of slope stability of the adjacent pit slopes.

This study was completed in general accordance with Fugro's revised proposal, dated August 16, 1999, and addendum dated September 22, 1999, and was authorized with the execution of our Agreement for Professional Services by Mr. Paul Keller of Keller Equity Group, Inc., on August 26, 1999. The addendum to the agreement was authorized by Mr. Keller on October 4, 1999.

We appreciate the opportunity to provide our services to Keller Equity Group on this project. Please call if we can provide further information or clarify any findings or recommendations.

Sincerely,

FUGRO WEST, INC.

Carole Wockner
Project Engineer

Thomas F. Blake, G.E., C.E.G.
Geotechnical Services Manager

Copies submitted: (6)

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# CONTENTS

Page

INTRODUCTION ..... 1
General Statement ..... 1
Purpose ..... 1
Authorization ..... 1
Key Personnel ..... 2
Project Description ..... 2
WORK PERFORMED ..... 2
Review of Existing Reports and Data ..... 2
Aerial Photograph Review ..... 3
Subsurface Exploration ..... 3
Laboratory Testing ..... 4
Geotechnical Engineering and Report ..... 4
SITE CONDITIONS ..... 5
Topography ..... 5
Geologic Conditions ..... 5
Regional Geology ..... 5
Site Geology ..... 6
SITE HISTORY ..... 6
Interpretation of Aerial Photographs ..... 6
1947 ..... 7
1953 ..... 7
1959 ..... 7
1961 ..... 8
1962 ..... 8
1963 ..... 8
1964 ..... 8
1965 ..... 9
1966 ..... 9
1967 ..... 9
1968 ..... 10
1970 ..... 10
1973 ..... 10
1975 ..... 11
1977 ..... 11
1978 ..... 11

## CONTENTS -- CONTINUED

Page

1979 ..... 11
1981 ..... 12
1984 ..... 12
1986 ..... 12
1987 ..... 12
1988 ..... 12
1989 ..... 12
1990 ..... 13
1992 ..... 13
1993 ..... 13
1994 ..... 13
1996 ..... 13

FINDINGS ..... 14
Earth Materials ..... 14
Stockpile Area ..... 14
Plant Area ..... 14
Engineering Properties of Earth Materials ..... 15
Stockpile Area ..... 15
Plant Area ..... 15
Estimated Depth of Artificial Fill ..... 16
Fill Depth Estimated from CPT Logs ..... 16
Fill Depth Estimated from Boring Logs ..... 16
Fill Depth Estimated from Diesel Spray Rack Excavation ..... 17
Fill Depth Estimated from Parallax Measurements off Aerial Photos ..... 17
Evaluation of Fill Depths ..... 17
Stockpile Area ..... 17
Plant Area ..... 18
Groundwater Conditions ..... 19
Liquefaction ..... 20
General ..... 20
Stockpile Area ..... 20
Plant Area ..... 21

CONCLUSIONS ..... 21
Grading, Earthwork, and Excavation ..... 22
General ..... 22
Site Preparation ..... 22
Artificial Fill Removal ..... 22

## CONTENTS -- CONTINUED

Page

Stockpile Area ..... 22
Plant Area ..... 23
Excavation Considerations ..... 23
Equipment ..... 23
Dewatering ..... 23
Temporary Slopes ..... 24
Excavation Bottoms ..... 24
Special Subgrade Stabilization Measures ..... 24
Fill Selection and Compaction ..... 25
General ..... 25
Imported Fill ..... 25
Compaction Requirements ..... 25

LIMITATIONS ..... 26

REFERENCES ..... 27

## TABLES

Page

1 Groundwater Observations ..... 19

## PLATES

Plate

Vicinity Map ..... 1
Site Map ..... 2
Subsurface Exploration Map ..... 3
Subsurface Cross Section A-A' ..... 4
Subsurface Cross Section B-B' ..... 5
Subsurface Cross Section C-C' ..... 6
Subsurface Cross Section D-D' ..... 7
Subsurface Cross Section E-E' ..... 8
Key to Cross Sections, Borings ..... 9a
Key to Cross Sections, CPT Logs ..... 9b
Aerial Photograph of Site - 1947 ..... 10
Aerial Photograph of Site - 1953 ..... 11
Aerial Photograph of Site - 1959 ..... 12
Aerial Photograph of Site - 1961 ..... 13

## CONTENTS -- CONTINUED

## PLATES -- CONTINUED


| | Plate |
|---|---|
| Aerial Photograph of Site - 1962 | 14 |
| Aerial Photographs of Site - 1963 | 15 through 17 |
| Aerial Photograph of Site - 1964 | 18 |
| Aerial Photograph of Site - 1965 | 19 |
| Aerial Photograph of Site - 1966 | 20 |
| Topography of Site - 1967 | 21 |
| Aerial Photographs of Site - 1967 | 22 |
| Aerial Photograph of Site - 1968 | 23 |
| Topography of Site - 1970 | 24 |
| Aerial Photograph of Site - 1973 | 25 |
| Aerial Photographs of Site - 1975 | 26 and 27 |
| Aerial Photograph of Site - 1977 | 28 |
| Aerial Photograph of Site - 1978 | 29 |
| Aerial Photograph of Site - 1979 | 30 |
| Aerial Photograph of Site - 1981 | 31 |
| Aerial Photograph of Site - 1984 | 32 |
| Aerial Photograph of Site - 1986 | 33 |
| Aerial Photograph of Site - 1987 | 34 |
| Aerial Photographs of Site - 1988 | 35 and 36 |
| Aerial Photograph of Site - 1989 | 37 |
| Aerial Photograph of Site - 1990 | 38 |
| Aerial Photograph of Site - 1992 | 39 |
| Aerial Photograph of Site - 1993 | 40 |
| Aerial Photograph of Site - 1994 | 41 |
| Aerial Photograph of Site - 1996 | 42 |
| Summary of Excavation Areas from Aerial Photo Review, 1947-1986 | 43 |


## APPENDICES


APPENDIX A: SUBSURFACE EXPLORATION

| | |
|---|---|
| Logs of the Borings | Plates A.1 through A.29 |
| CPT Classification Chart | Plate A.30 |
| Log of Boring No. B-1 | Plate A-2.1 |
| Logs of Boring No. B-2 | Plates A-2.2a and A-2.2b |
| Logs of Boring No. B-3 | Plates A-2.3a and A-2.3b |

## CONTENTS -- CONTINUED

### APPENDICES -- CONTINUED

Logs of Boring No. B-4 ..... Plates A-2.4a and A-2.4b
Log of Boring No. B-5 ..... Plate A-2.5
Logs of Boring No. B-CPT-1 ..... Plates A-2.6a and A-2.6b
Logs of Boring No. B-CPT-11 ..... Plates A-2.7a and A-2.7b
Logs of Boring No. B-CPT-13 ..... Plates A-2.8a and A-2.8b
Logs of Boring No. B-CPT-22 ..... Plates A-2.9a and A-2.9b
Key to Terms & Symbols Used on Logs ..... Plate A-2.10

APPENDIX B: LABORATORY TESTING

Summary of Laboratory Test Results ..... Plates B-1a through B-1e
Grain Size Curves ..... Plate B-2
Plasticity Chart ..... Plate B-3
Consolidation Test Results ..... Plates B-4a through B-4d

# INTRODUCTION

## GENERAL STATEMENT

Fugro is pleased to submit this report presenting the results of a geotechnical study for the proposed RiverPark B development at the former Southern Pacific (S.P.) Milling Company plant property, in the El Rio area of Ventura County, California. The site is located on the southeastern bank of the Santa Clara River, approximately 2,000 feet northwest of the intersection of Vineyard Avenue and Simon Way. The general location of the S.P. Milling property, now known as Hanson Aggregates, is shown on Plate 1 - Vicinity Map.

As shown on Plate 2 - Site Map, the subject area for this study is limited to the approximately 81-acre "stockpile" area located at the southwestern end of the property and the approximately 54-acre adjoining "plant" area located immediately to the northeast.

## PURPOSE

The purpose of this geotechnical study was to estimate, primarily through subsurface exploration and aerial photo review, the locations and depths of artificial fills that were placed in mining excavations in the stockpile and plant areas of the former S.P. Milling plant, and to develop geotechnical conclusions and recommendations for mitigation of those fills. On the basis of conversations with Mr. Steven Zacks, the Property Administrator for Hanson Aggregates, the stockpile area was estimated to have been excavated to a depth of about 30 feet below existing grade, and the plant area was anticipated to be largely undisturbed, with the exception of a truck wash-out pit and possible shallow excavations at the west/southwest end of the plant area.

Specifically excluded from this study was the evaluation of potential environmental impairment or soil/groundwater contamination at the site, and the stability of existing nearby mining pit and river levee slopes.

## AUTHORIZATION

The scope of work for this study was set forth in a Fugro proposal dated August 2, 1999, and revised on August 16, 1999, to Keller Equity Group, Inc. An addendum to the revised proposal was prepared on September 22, 1999. This study was authorized with the execution of our Agreement for Professional Services by Mr. Paul Keller of Keller Equity Group, Inc., on August 26, 1999. The addendum to the scope of services was authorized by Mr. Keller on October 4, 1999.

## KEY PERSONNEL

Key personnel associated with this project include:

- Mr. Jim Bond, Senior Project Manager, Keller CMS, Inc.
- Mr. Steven Zacks, Property Administrator, Hanson Aggregates

## PROJECT DESCRIPTION

The information presented herein concerning the proposed RiverPark B development is based on conversations with Mr. Bond of Keller CMS, Inc., and Mr. Zacks of Hanson Aggregates. The proposed development will consist of ± 2000 residences, with associated infrastructure, limited retail, open space, and educational/sports facilities.

Residential development is planned adjacent to the slopes of the existing Brigham, Vickers, and Small Woolsey pits (see Plate 2 for pit locations), located southeast of the stockpile area and east of the plant area. The residential development also will extend as far to the northwest of the stockpile and plant areas as the levee along the Santa Clara River. An evaluation of the stability of the pit and levee slopes is recommended prior to project planning and the preparation of development plans. That evaluation is not a part of the scope services for this study.

## WORK PERFORMED

The scope of work performed for this study was described in our revised proposal, dated August 16, 1999, and addendum dated October 4, 1999. The scope of work included the following tasks:

## REVIEW OF EXISTING REPORTS AND DATA

Existing available geologic, geotechnical, and groundwater data pertinent to the study were compiled from various sources and reviewed. Those data included limited geotechnical reports for the stockpile area and adjacent areas, environmental assessment reports, and onsite monitoring well data. References reviewed and utilized are listed in the References section following the text.

Data from the following limited geotechnical and environmental reports (or portions thereof) for adjacent properties were reviewed:

1. A Phase I and limited Phase B environmental report for the plant site (Padre Associates, 1998).
2. A letter-report for characterization of contaminated soil (Padre Associates, 1999a).

3. A letter-report for characterization of contaminated groundwater (Padre Associates, 1999b).

4. A report evaluating slope stability along the north slope of the Little Woolsey pit (Earth Systems Consultants, 1997).

5. A draft, limited geotechnical evaluation of the stockpile area at S.P. Milling Company (Fugro, 1997).

6. A liquefaction report for property located at the west end of Montgomery Avenue (Buena Engineers, Inc., 1987).

## AERIAL PHOTOGRAPH REVIEW

Existing aerial photographs and topographic maps were obtained from various sources and reviewed to identify former excavations in the stockpile and plant areas. Those materials included published and unpublished topography maps and historical stereo aerial photographs. Maps utilized and photographs reviewed are listed in the References section following the text.

## SUBSURFACE EXPLORATION

The subsurface exploration for this study includes the following:

- Twenty-nine cone penetrometer test (CPT) soundings to depths ranging from about 15 to 70 feet below the existing ground surface (performed August 23 and 24, 1999).
- Nine hollow-stem-auger drill holes ranging from 28 feet to about 51 feet below the ground surface (completed August 27, 1999).

The CPT locations in the stockpile area were laid out in an approximate 400-foot triangular spacing pattern to help assess the uniformity of the fill depth and materials. Four borings were located near selected CPT soundings to better identify layer constituents with physical tests (i.e., laboratory tests) on samples extracted from the subsurface. The laboratory classification tests results were then used to qualitatively calibrate the soil type interpretations from the CPT data. Additionally, the borings were used to extract suspected native soils below the artificial fill for consolidation and classification tests to help differentiate fill from native soil.

The approximate locations of the CPT soundings and borings are shown on Plate 3 - Subsurface Exploration Map. Descriptions of the field exploration and logs of the CPT soundings and borings are presented in Appendix A - Subsurface Exploration. The CPT logs and associated soil classification chart are presented on Plates A.1 through A.30 and the logs of the borings and legend are presented as Plates A-2.1 through A-2.10.

Cross sections that display the subsurface data obtained from the CPT soundings and borings are presented on Plates 4 through 8 - Subsurface Cross Section A-A', B-B', C-C', D-D',

and E-E', respectively. Keys to symbols used on the cross sections are presented on Plates 9a and 9b - Keys to Cross Sections.

## LABORATORY TESTING

Laboratory testing was performed on selected soil samples to estimate pertinent engineering properties for use in the geotechnical evaluation. The laboratory testing program included the following:

- Unit weight and moisture content determinations,
- Index and classification tests (including grain size and Atterberg limits),
- Two one-dimensional consolidation tests,
- Two collapse tests,

The high gravel content in one shelby tube and three liner samples precluded conducting the collapse and consolidation tests assigned to those samples. The results of the laboratory analyses are presented in Appendix B - Laboratory Testing.

## GEOTECHNICAL ENGINEERING AND REPORT

Geotechnical engineering evaluations were performed to estimate the lateral extent, depth, and composition of the artificial fill in the stockpile and plant areas, so that the suitability and cost of ground improvement can be estimated (by others). Engineering evaluations and recommendations summarized in this report include the following:

1. A historical narrative of the chronological development of the milling plant in the stockpile and plant areas based on a stereoscopic review of about 26 sets of aerial photographs and four additional single aerial photographs (i.e., not stereo pairs) dating back to 1947.
2. A general assessment of soil and groundwater conditions in the stockpile and plant areas.
3. Geologic setting and geologic hazards limited to the potential for liquefaction of native materials below the artificial fill.
4. Preliminary assessment of engineering properties of encountered soils, including consolidation and collapse potential of native materials.
5. Excavating conditions.
6. Suitability of onsite soils for use as compacted fill.
7. Estimated shrinkage and subsidence from earthwork activities.
8. Recommendations for remediation of existing artificial fill, including placement of compacted fill.

9. Construction considerations including groundwater, excavation, site preparation and grading, stripping, and subgrade stabilization.

Because deeper and more extensive fills in both the stockpile and plant areas were suggested by the interpreted CPT data during the subsurface exploration and subsequently confirmed through the aerial photo review, the study focus, at the request of Mr. Bond of Keller CMS, Inc., has shifted to concentrating and expanding efforts in researching the distribution of the artificial fill. The expanded exploration effort included increasing, in the plant area, the number of CPT locations from seven to nine and the boring locations from two to five. The expanded aerial photo review included increasing the number of photos checked from about 10 to 30. In addition, some of the stereo pairs (of which there were 26 sets) were reviewed in greater detail, including the use of a parallax bar to estimate spot elevations in the excavations viewed on the photos.

Once project viability relating to the mitigation of the artificial fills has been decided by Keller Equity Group, the potential for seismically-induced hazards (including seismically-induced settlement of dry sands and lateral spreading movements), and also pit slope and river levee stability, should be evaluated.

## SITE CONDITIONS

### TOPOGRAPHY

The proposed RiverPark B site is located, in part, in the stockpile and plant areas of the former S.P. Milling Company plant at 3555 East Vineyard Avenue, in the El Rio area of Ventura County. The property is situated on the southern bank of the Santa Clara River. The elevation across the stockpile area varies between about +60 feet along the southeastern boundary to +110 feet along a fill ridge located near the center. Because the stockpile area has many remnant stockpiles (thus its name), the surface topography is very uneven. The elevation of the plant area varies between about +82 feet near the southwestern corner and +95 feet near the northeastern corner. Several conical-shaped stockpiles are located in the plant area; however, the typical elevation across most areas of the plant is about +90 feet.

### GEOLOGIC CONDITIONS

#### Regional Geology

The RiverPark B site is situated in the southern portion of the Transverse Ranges geomorphic province of California. The province is characterized by east-west-trending mountain ranges composed of sedimentary and volcanic rocks ranging in age from Cretaceous to Recent. Major east-trending folds, reverse faults, and left-lateral strike-slip faults reflect regional north-south compression and are characteristic of the Transverse Ranges. The Transverse

Ranges Geomorphic Province is bounded on the north by the Santa Ynez fault, on the east by the San Bernardino Mountains, on the south by the Transverse Ranges frontal fault zone, and on the west by the Pacific Ocean.

The Ventura basin, including its offshore continuation in the Santa Barbara Channel, is the dominant structural element of the western Transverse Ranges. The basin is filled with a thick sequence of Cenozoic sedimentary rocks estimated to be more than 20,000 feet in total thickness.

### Site Geology

The site is located along the Santa Clara River channel, which is underlain by a 1,000- to 2,000-foot-thick formation of recent (Quaternary age) alluvium and terrrace deposits, which generally are unconsolidated to partially consolidated. The alluvial materials generally consist of older stream channel ($Q_{os}$) and floodplain deposits ($Q_{fp}$) of sand, gravel, silt, and clay, which may be stratified and locally cross-bedded.

## SITE HISTORY

We understand that the project site was used for agricultural purposes prior to development of sand and gravel mining and plant operations in the late 1940s and early 1950s. The numerous aerial photographs reviewed for this study provided intermittent glimpses into the development of the stockpile and plant areas. A summary of our findings from the photo review is presented below.

## INTERPRETATION OF AERIAL PHOTOGRAPHS

To help estimate the depth of mining excavation that has occurred at the site over the past 50 years, we obtained and reviewed 26 sets of aerial photographs, four single aerial photographs, and two regional topographic maps. To facilitate our review, we scanned a photo from each of the sets we reviewed and used Blue Marble's Geographic Transformer software to rotate, translate, scale, and geo-reference each of those photographs. Then, using AutoCAD Map 2000, we placed an outline map of the site, which also included the locations of our subsurface explorations on it, on top of each scanned, geo-referenced aerial photograph.

For many of the sets of photos, stereoscopic coverage was available. Using a mirror stereoscope, we checked for indications of excavation in either the plant site or the stockpile area to the southwest (herein referred to as stockpile site). When we could see excavation operations, lines were drawn on the overlay around the areas on the site where excavation operations were visible on each photo. Because the geo-referencing software did not always produce a close fit between the photographs and the project base map, the mapped locations of the excavations drawn on the overlays should be considered only approximate.

To estimate spot depths at selected points in some of the visible excavations, we used a parallax bar with our stereoscope. Because complete records of the photographic flights were not available to us, in some cases we had to estimate the focal lengths of the cameras used. Also, the technique used to estimate elevations using parallax measurements results in some degree of uncertainty, particularly where the quality of the photographs is poor. Consequently, although the elevations shown can be used to gauge the general depth of past excavations on the site, they could be in error by 5 to 10 feet, or more, depending on photo quality and accuracy of the assumed flight characteristics.

The approximate outlines and depths estimated at selected points in some of the visible excavations have been plotted on the reproduced aerial photographs, included as Plates 10 through 42 - Aerial Photograph of Site.

The following paragraphs provide a chronological summary of our interpretations of site development from the photographs reviewed.

**1947**

The U.S. Geological Survey, on October 20, 1947, took the oldest photographs we reviewed for the site. In those photographs, several pits already had been excavated, or were in the process of being excavated, in the area that is currently occupied by the plant operations equipment. Attempts to estimate the depth of those excavations were generally unsuccessful, but in at least one of them (near CPT-23), the pit bottom appeared to have been excavated to about elevation 70 feet. The stockpile area was still in its natural condition. Plate 10 shows the approximate excavation locations with the estimated point elevation in the southernmost pit in the plant area.

**1953**

On October 7, 1953, the U.S. Department of Agriculture took a set of photos that covered the project site. On those photos, much of the surface of the plant site appeared to have been disturbed, but only two excavations were apparent on the photos. One of them was located in the southeastern portion of the plant site and the other in the northwestern portion. From a parallax measurement, it appears that at least one point in the southeastern pit may have been excavated to an elevation of about 76 feet, but we could not estimate the depth of the other pit. The stockpile area was still undisturbed in 1953. Plate 11 shows the approximate location of those two excavations in the plant area with the estimated point elevation in the southernmost of those two pits.

**1959**

The U.S. Department of Agriculture, on October 2, 1959, took the next set of photographs we reviewed for the site. In those photographs, quarry operations were well under

way. Excavations that had been visible in the 1947 photographs were filled in and mining/processing equipment and buildings had been constructed in some of those areas. Most of the sand and gravel mining excavations visible in those photos appeared to be underway in the area to the northeast of the current plant site. In the current plant site area between B-1 and CPT-28, two relatively small pits are visible on the 1959 photographs. From parallax measurements, those pits appeared to extend to about elevation 63 feet. The stockpile area was still undisturbed in 1959. Plate 2 shows the approximate location of the two small pits excavated in the plant area. The approximate locations of estimated point elevations in each pit are also shown.

**1961**

The Mark Hurd Aerial Surveys company took a series of stereo aerial photographs of the site between 1961 and 1968. The first of those, taken on June 30, 1961, shows the same two pits that were first noted in the 1959 photographs, but the pits appear to be somewhat filled in. Because of the odd size of the photos, no parallax measurements were made. No new excavations were noted within the plant-site area. The stockpile area was still undisturbed in 1961. Plate 13 is a reproduction of the June 30, 1961 aerial photograph.

**1962**

The next Mark Hurd photographs were taken on March 24, 1962. In those photos, no new excavations were apparent within the plant-site area, and the stockpile area was still undisturbed. Plate 14 is a reproduction of the 1962 aerial photograph.

**1963**

In 1963, Mark Hurd flew three aerial surveys over the site. They were flown on January 7, 1963, March 20, 1963, and June 24, 1963. In those photos, again no new excavations were apparent within the plant-site area, and the stockpile area was still undisturbed. The two small pits that were first noted on the 1959 photographs were nearly filled in by the time the June 24, 1963 photos were taken. Plates 15, 16, and 17 are reproductions of the January 7, 1963, March 20, 1963, and June 24, 1963 aerial photographs.

**1964**

The February 14, 1964, Mark Hurd Aerial Surveys photos are the first to show excavation activity in the stockpile area. By the time of those photos, a long, narrow trench had been excavated along the southwestern property line of the stockpile area. That trench was deepest near its southeastern end, where it appears to have approached an elevation of about 49 feet. The approximate location of that excavation and an estimated spot elevation location are shown on Plate 18.

**1965**

By 1965, substantial excavation was underway in the stockpile area. The September 20, 1965, U.S. Department of Agriculture photos show that much of that area had been excavated to an elevation between about 49 to 66 feet, still deepest toward the southeast. Within that area, several linear ridges are visible on the photos and they probably are composed of stockpiled spoil materials. In addition, a large, nearly square excavation is apparent on those photos in the main plant-site area just to the west of the area where the operations buildings are located. The southwestern edge of that square excavation appeared to be deeper than the rest of the hole. The elevation along the southwestern edge looked as though it might have approached an elevation of about 57 feet whereas much of the rest of the square excavation seemed to be at about elevation 71 feet. Plate 19 shows the approximate excavation locations and estimated spot elevations captured on the 1965 aerial photograph.

**1966**

Another set of Mark Hurd Aerial Surveys photos was taken on July 5, 1966. In those photos, the grading in the stockpile area continued to expand, primarily toward the southeast with some additional excavation in the northwestern corner. The expanded excavation toward the southeast also appears to be deeper than in any of the areas observed in the earlier photos we reviewed. Although parallax measurements were difficult in the deepest portion of that excavation (because over-exposure of the film in that area left it nearly featureless), we estimate that the lowest portions of the pit may have approached an elevation of about 9 feet. That deepest area looked like it could have been some type of exploratory pit, because most of that expanded excavation appeared to approach an elevation of about 20 to 30 feet. The excavation in the northwestern corner of the stockpile area looked as though it may have approached an elevation of about 34 to 48 feet. Plate 20 shows the approximate excavation locations and estimated spot elevations captured on the 1966 aerial photograph.

**1967**

In the beginning of the year, on March 1, 1967, the County of Ventura had aerial photographs taken to develop 1"=200' scale topographic base maps of the area. We obtained a copy of the County's topographic map and superimposed the boring/CPT locations on it. That map shows a slight increase in the southeastern portion of the mined area from the area shown on the July 5, 1966 photos, but a more significant increase in the mined area just to the north of that. Also in 1967, the U.S. Geological Survey once again took aerial photographs of the area. Those photos, taken on August 12, 1967, a few months after the County's, showed a slight increase in the mined area during that time period. Parallax measurements from the U.S. Geological Survey photos suggest that the excavations may have approached an elevation of about 6 to 27 feet in the southeastern corner of the site. In addition, two relatively small, rectangular pits were first noted in the area northeast of the main plant site, on the August 12, 1967, U.S.G.S. aerial

photographs. Those two small pits may have approached an elevation of about 85 feet. A reduced reproduction of the county's topographic map is included as Plate 21. The approximate locations of the excavations and estimated spot elevations from the 1967 aerial photograph are shown on Plate 22.

**1968**

We reviewed some relatively poor-quality prints of some Mark Hurd Aerial Survey photography taken on July 22, 1968. Much of the detail appeared to be missing from our prints, but it appeared that the stockpile area was further expanded toward the southeast and an additional excavation area was created in the southwestern portion of the plant-site area. A spot elevation of about 74 feet was estimated for a point in the southeastern expansion area, but we could not estimate the depth of the new pit area in the southwestern portion of the plant-site area. The approximate locations of the excavations and estimated spot elevation from the 1968 aerial photograph are shown on Plate 23.

**1970**

On October 29, 1970, the County of Ventura had the entire county flown to create 1"=500'-scale topographic base maps. A scanned copy of that generalized topography for the site is included in this report. The map shows the continued expansion of the stockpile area excavation toward the southeast and it also shows removals in the area to the southeast of the main plant site (outside of the current study area). Backfill operations appear to have begun in the southwestern and central portions of the stockpile area. Also shown on the topographic map is an elevation of 41 feet near the center of the main plant site. In the County of Ventura's files, we reviewed 1"=500'-scale photo maps made from prints of the original photography that was used to create the topographic maps. Along the edges of two of those photo maps, we had limited stereo coverage of the area where the 41-foot elevation was plotted. From that stereo coverage it did not appear to us that the area had been excavated to an elevation of 41 feet. Instead, it appeared that the area was about a 40-foot-high stockpile mound, so we suspect that the "41" foot elevation is a typographical error and the correct elevation was probably 141 feet. A reduced reproduction of that portion of the county's topographic map covering the plant and stockpile areas is included as Plate 24.

**1973**

The first of a series of aerial photographs taken by Pacific Western Aerial Surveys was taken on August 23, 1973. In those 1973 photos, the stockpile area was further expanded toward the southeast. In addition, a narrow, trough-shaped pit was excavated near the southwestern property line of the stockpile area, presumably within previously placed backfill materials, but it may have excavated some of the marginal slopes of previous excavations. Also, the photos showed that the previously deep excavations in the southeastern portion of the stockpile area had

been significantly backfilled by that time. Plate 25 shows the approximate outline of the expanded excavations and estimated spot elevations in those excavations.

**1975**

The March 17, 1975, Pacific Western photo is the earliest color photograph that we reviewed. That aerial survey was not flown in stereo, so we can not be sure of the elevations at that time, but we suspect that some continued filling was underway in the stockpile area. Plate 26 is a color reproduction of the 1975 Pacific Western aerial photograph. Plate 27 is a reproduction of the 1975 Teledyne Geotronics aerial photograph.

A second set of 1975 photos was taken by Teledyne Geotronics on July 29, 1975. Those black and white photos were flown in stereo, but we were only able to get partial coverage. From the photos we obtained, we confirmed that some continued filling was underway in the stockpile area.

**1977**

In the March 14, 1977, Teledyne Geotronics black and white photographs, a large portion of the southwestern portion of the stockpile area had been filled in. The beginnings of some deep excavation in the area southeast of the main plant were also visible. Plate 28 is a reproduction of the 1977 Teledyne Geotronics aerial photograph.

**1978**

By the time of the May 16, 1978, Pacific Western Aerial Surveys color photographs, most of the southwestern portion of the stockpile area had been filled to an elevation higher than the area was before mining was started. Also visible on those photos is a large conical-shaped fill in the southeastern portion of the stockpile area. That conical-shaped fill looked as though materials transported into the area by a conveyor belt system had created it. Some deep excavation to the area southeast of the main plant site appeared to extend to elevations below sea level. Plate 29 shows the approximate location of the expanded excavation southeast of the stockpile area and estimated spot elevations in that area and at the southeastern end of the stockpile area.

**1979**

The July 7, 1979, Pacific Western Aerial Surveys flight was not performed in stereo, so we were not able to be sure of the elevations at that time. However, it appears that a branch conveyor belt had been created to help feed materials toward the southeastern portion of the pit in the stockpile area. Plate 30 is a color reproduction of the 1979 aerial photo.

**1981**

By the time of the June 15, 1981, Pacific Western Aerial Surveys photographs, most of the southeastern portion of the stockpile area had been filled. Only a small low area still remained in the extreme southeastern corner of the area. Plate 31 is a color reproduction of the 1981 aerial photograph.

**1984**

The January 11, 1984, Pacific Western Aerial Surveys photos indicate that some of the backfill materials that had been placed near the southeastern half of the northern quarter of the stockpile area had been removed. Those removals were primarily in the areas of CPT-8, CPT-11, and CPT-12. Plate 32 is a color reproduction of the 1984 aerial photograph.

**1986**

Pacific Western Aerial Surveys photos taken on December 10, 1986, show more removal in the area of CPT-8 and CPT-12. In a localized area near CPT-12, parallax measurements suggest that the removals extended down to an elevation of about 44 feet. Also, a rectangular pad was cut in the area of CPT-17 and CPT-18. Plate 33 shows the approximate excavation location and estimated spot elevation.

**1987**

In the January 12, 1987, Pacific Western Aerial Surveys photos, it does not appear that much has changed, but that is not surprising because the previous photos were taken only a month before. Plate 34 is a color reproduction of the 1987 aerial photograph.

**1988**

Only partial stereo coverage was available on the January 20, 1988, Pacific Western Aerial Surveys photos. However, from the available photos, it appears that some minor excavation continued from the area near CPT-8 and CPT-12. The second Pacific Western Aerial Surveys flight that year, on October 10, 1988, is available in stereo. Photos from that flight also show continued excavation from the area near CPT-8 and CPT-12, in addition to some substantial fill removal from the area east of CPT-19. Plates 35 and 36 are color reproductions of the January 20, 1988 and October 10, 1988 aerial photographs, respectively.

**1989**

Pacific Western Aerial Surveys photos dated May 23, 1989, show further excavation of fill from the area of CPT-19 as well as removal of fill materials previously placed in the area between CPT-4 and CPT-8. Plate 37 is a color reproduction of the 1989 aerial photograph.

**1990**

The November 8, 1990, Pacific Western Aerial Surveys photos were not flown in stereo. It appears that only minor removals continued in the area between CPT-16 and CPT-19. Plate 38 is a color reproduction of the 1990 aerial photograph.

**1992**

The September 19, 1992, Pacific Western Aerial Surveys flight shows that the removals in the area of CPT-19 were extended toward the southwest, into the area of CPT-18 and CPT-17. Plate 39 is a color reproduction of the 1992 aerial photograph.

**1993**

Pacific Western's December 29, 1993, photos were not flown in stereo and they were flown at a relatively small scale. Consequently, it is difficult to determine the extent of the modifications at that time, but it appears that some additional fill had been removed from the area of CPT-17, CPT-18, and CPT-21. Plate 40 is a color reproduction of the 1993 aerial photograph.

**1994**

In the February 24, 1994, Pacific Western Aerial Surveys photos, further fill removals from the area of CPT-17, CPT-18, and CPT-21 are visible. Also, along the southeastern margin of the stockpile area, a long, narrow excavation appears adjacent to the property line. That trench, which extended from the area of CPT-20 to the area of CPT-22, may have been excavated to extract native materials left along the side slopes of previous excavations in that area. Plate 41 is a color reproduction of the 1994 aerial photograph.

**1996**

The most recent Pacific Western photo for the area that was reviewed for this study was taken on January 8, 1996. That flight was not in stereo, so we cannot be sure of the modifications at that time. However, it appears that some fill removals were occurring in the vicinity of CPT-7. Plate 42 is a color reproduction of the 1996 aerial photograph.

A map showing a compilation of the approximate locations of the excavations and estimated spot elevations enumerated above from the aerial photographs from 1947 to 1986, is included as Plate 43 - Summary of Excavation Areas from Aerial Photo Review, 1947 to 1986.

# FINDINGS

## EARTH MATERIALS

On the basis of the data interpreted from the 29 CPT soundings and the boring logs from the nine borings advanced for this study, the soil profile generally consists of artificial fill in about the upper 20 to 50 feet in the stockpile area and in the upper few to about 20 feet in the plant area. Fill materials typically consist of sand, silty sand, silt, and clay. Gravel was common in the sand and silty sand fill encountered in the borings excavated in the plant area. Below the artificial fill, native materials encountered in the CPT soundings and borings generally consisted of sand with gravel, underlain by alternating layers of silt and clay. The CPT and boring data are limited, so the estimated distribution and thickness of earth materials could differ significantly from estimates given in this report.

Plates 4 through 8 - Subsurface Cross Section, A - A' through E - E', depict the generalized interpreted stratigraphy across the stockpile and plant areas inferred from our subsurface exploration and data collected from our aerial photo review. The locations of the cross sections are shown on Plate 3.

### Stockpile Area

From the interpreted CPT and boring log data, the artificial fill materials encountered at the exploration locations in the stockpile area consisted predominantly of sand and silty sand fill with scattered layers of silt and clay in the upper 20 to 50 feet. The predominant fill soil type encountered in the upper 20 to 40 feet in CPT-1, CPT-13, and CPT-20 through 22 was silt and clay, with discontinuous layers of sand, typically in the upper 5 to 10 feet.

Below the artificial fill, at locations where the exploration depth extended at least 5 feet below the estimated bottom of fill, a 5- to 10-foot-thick (or more) layer of silty sand and sand with gravel was common. That sand layer (when penetrated by deeper exploration) was typically underlain by alternating layers of silt and clay. For example, at CPT-3, the silt and clay layers encountered extended from a depth of about 28 feet (i.e., El. +53-1/2 feet) to the final exploration depth of about 70 feet (i.e., El. +11-1/2 feet).

### Plant Area

The artificial fill materials encountered at the CPT and boring locations in the plant area consisted predominantly of sand with gravel and silty sand, with a few discontinuous layers of silt. A predominantly silt profile was interpreted from the data from CPT-23 to the exploration depth of 20 feet.

In the exploration locations on the southeastern half of the plant site, below the artificial fill (i.e., below depths of about 3 to 20 feet), silty sand and sand with gravel was encountered to

the final exploration depth, as deep as 51-1/2 feet, in the exploration locations on the southeastern half of the plant site. At the exploration locations in the western quarter of the plant site (CPT-24, B-4, and B-5), interlayered clay and silt was encountered below the native sand at a depth of about 30 feet and extended as deep as 51-1/2 feet (B-4).

## ENGINEERING PROPERTIES OF EARTH MATERIALS

Limited laboratory tests were performed on the soil samples extracted from the borings at selected locations and depths for classification and correlative purposes and to help characterize the artificial fill and native materials. Additionally, the interpreted strength data from the CPT soundings were used to help differentiate between artificial fill and native deposits.

### Stockpile Area

The sands typically encountered in the upper 20 feet ranged from loose to dense, with a very dense sand layer common in the upper 5 feet (probably resulting from frequent heavy equipment passes at the active material plant). Silt layers, when encountered, were loose. The cone tip resistance of the sand in the upper 20 feet was typically between about 80 and 160 tons per square foot (tsf). The cone tip resistance of the silt in the upper 20 feet ranged from about 10 to 80 tsf. The tip resistance of the sand encountered below 20 feet to about 35 feet generally ranged from about 150 to 250 tsf. (The values for tip resistance have been normalized; i.e., corrected to 1 tsf overburden stress.)

Consolidation test results (presented on Plate B-4d in Appendix B) suggest that the clay encountered in boring B-CPT-11 at a depth of 26 feet, is overconsolidated. The overconsolidation ratio (OCR) for the clay is about 3; the recompression ratio $C_{\varepsilon r}$, is about 0.02; and the compression ratio, $C_{\varepsilon c}$, is about 0.1.

### Plant Area

The sand encountered in the upper 30 feet at the exploration locations in the plant area varied from loose to very dense. The measured dry densities of the sand ranged from about 91 pounds per cubic foot (pcf) to 113 pcf. Moisture contents in the sand materials encountered typically were between about 4 and 7 percent. Cone tip resistance in the sand ranged from about 200 to 500 tsf, with the exception of the sand in boring B-4, wherein the tip resistance ranged from about 180 to 270 tsf. Silt layers, where encountered (i.e., CPT-24 between about 8 and 15 feet, CPT-26 in the upper 7 feet, CPT-28 between about 5 and 10 feet, and CPT-23), generally had tip resistances between about 20 and 100 tsf.

Consolidation test results (presented on Plate B-4c in Appendix B) suggest that the clay encountered in boring B-4 at a depth of 36 feet, is slightly overconsolidated. The overconsolidation ratio (OCR) for the clay is about 1.5; the recompression ratio, $C_{\varepsilon r}$, is about 0.02; and the compression ratio, $C_{\varepsilon c}$, is about 0.1.

## ESTIMATED DEPTH OF ARTIFICIAL FILL

The interpreted CPT data, boring logs, aerial photo review summary, and laboratory test results were compiled, compared, and evaluated to estimate general fill depths in the stockpile and plant areas. The results of that evaluation are summarized below.

### Fill Depth Estimated from CPT Logs

The CPT logs were reviewed to estimate the fill depths suggested by each log. Fill was suggested by low tip resistance, generally less than 200 tsf for sand and silty sand, because the fill placed on the plant property is not believed to have been deliberately compacted as a controlled or engineered fill. Once a sand layer with a high tip resistance on the order of 300 to 500 tsf was penetrated, that usually abrupt transition was assumed to indicate the bottom-of-fill elevation. Dense sand layers between about 2 and 5 feet thick at the ground surface were generally considered to be fill because the elevated tip resistance in that zone was attributed to frequent heavy equipment passes in the heavily trafficked plant and stockpile areas. The CPT soundings were typically extended to depths between 30 and 50 feet below existing grade unless refusal or very high tip resistance, suggestive of the bottom of the fill was encountered. In some locations (i.e., CPT-16, CPT-18, and CPT-19), the bottom-of-fill was not apparent to the depth explored.

Refusal of the cone tip because of very high tip resistance from dense sand or gravelly sand encountered in the CPT sounding could suggest that the fill was fully penetrated or alternatively could be the result of refusal of the cone on a foreign object or a rock. Because obstructions such as those often cannot be penetrated by CPT soundings, differentiating between refusal on dense native sand or dense sand with gravel and refusal on an isolated rock or foreign object is not possible. Consequently, the fill depth estimated from CPT soundings may not be correct and should only be used as a general indication.

### Fill Depth Estimated from Boring Logs

Borings were drilled adjacent to several CPT soundings and also at selected isolated locations. The borings were sampled at 5-foot intervals with the standard penetration test (SPT) split spoon sampler. The SPT resistance during driving the sampler was measured as blow counts. We interpreted that high blow counts suggest native soils and that low blow counts suggest fill materials. The boring logs were compared to the CPT logs, particularly for consistency in depth of transition from loose to very dense soil. Soil samples also were submitted to the laboratory for grain-size tests to help calibrate or check the CPT material-type interpretations for selected soil layers.

### Fill Depth Estimated from Diesel Spray Rack Excavation

An excavation to remove contaminated soil from a former diesel spray rack site located on the northeastern quarter of the plant, was started on September 18, 1999. The excavation extended to a depth of about 20 feet below the existing ground surface. Observations of the excavation sidewall suggest that there is an approximately 3- to 4-foot-thick fill in that area. An approximately 6- to 8-inch-thick layer of asphaltic concrete pavement was encountered at approximately 3 feet below the existing ground surface in that area. An approximately 1-foot-thick layer of open-framework gravel (i.e., little or no matrix soil) was observed in the excavation wall at a depth of about 11 feet. The excavation was backfilled with compacted soil under the supervision of Padre Associates during the following week. The approximate location of that excavation is shown on Plate 43.

### Fill Depth Estimated from Parallax Measurements off Aerial Photos

As discussed previously, the approximate locations of former excavations were plotted on a project site plan (Plate 43). Spot parallax measurements estimating the depth of the excavation bottoms also were plotted on that plan. The parallax depth estimates from the aerial photo review suggest that some of the excavations extended to depths of about 65 to 85 feet (approximately El. +6 feet to +20 feet), or more, below the general ground surface elevation in the southeastern half of the stockpile area.

The aerial photos offer intermittent glimpses of the excavation operations at the subject property. Excavations could have extended deeper and/or been more laterally extensive at times between aerial surveys. If so, those deeper and/or wider excavations could be absent from the historical photo record.

### Evaluation of Fill Depths

For the evaluation of the fill depths, the CPT and boring locations were plotted on Plate 43 along with the approximate excavation locations and pit bottom elevations estimated from the aerial photo review. The depth of fill at each CPT location was estimated based on the interpreted CPT tip resistance and the fill depth at each boring location was estimated from the blow count data. The resulting fill depths were then compared with local excavation depths estimated from the aerial photos.

**Stockpile Area.** In general, the fill depths estimated from the CPT data and boring logs were consistent (i.e., within several feet) with excavation depths estimated from the aerial photographs. However, at the locations of CPT-12, CPT-16, CPT-18, and CPT-21, nearby excavation depths from the photo review did not compare very well with the fill depths estimated from the CPT data. For example, from the data interpreted from CPT 12, the depth to fill was estimated at about 20 feet below existing grade, or El. +65. However, the estimated depth of a former excavation in that area using a parallax measurement from a 1986 aerial photo is about

40 feet. The two locations are about 25 feet apart. Additionally, an excavation bottom elevation located about 60 feet northwest of CPT-21 was estimated from a 1967 aerial photograph at about El. +13. The estimated depth of fill from CPT-21 was about 30 feet or a bottom elevation of about +54 feet. The differences in fill depth between those CPT data and the parallax estimates may be due to uncertainties in the parallax measurements, local variations in the excavation topography, or those CPT soundings may have met refusal on a rock or locally densified zone instead of the assumed dense native sand that typically underlies the fill.

The logs for CPT-16, CPT-18, and CPT 19 do not suggest that a dense sand layer was encountered to the maximum exploration depth of 31 to 35 feet. A comparison of the bottom of exploration elevation for each of those CPT locations with the nearest former excavation elevation estimated from the aerial photo review suggests that CPT-16 and CPT-18 did not extend deep enough to encounter the native soil. Therefore, at those locations the elevations of the bottom-of-fill estimated from the aerial photos may provide a better estimation of the fill depth.

At CPT-19, the exploration depth was 31 feet (EL. +52.5). That depth is deeper than the local bottom-of-pit elevations estimated from the aerial photo review (i.e., between El. +64 and El. +66 feet). The data from the interpreted CPT log suggest that the excavations in the vicinity of CPT-19 may have extended deeper than what was suggested in the aerial photos. The exploration location for CPT-19 represents the one instance from the study where a boring or CPT sounding suggested fill much deeper (i.e., greater than 10 feet) than what was locally estimated from the aerial photographs. That example illustrates that the low excavation bottom estimated from the aerial photographs for any pit may not represent the lowest historical excavation depth.

**Plant Area.** A procedure similar to that used in estimating and evaluating the fill depth in the stockpile area was used for the plant area. However, because the quantity and quality of the aerial photos from the time of the most significant excavations (circa 1947) was not optimal, only one depth measurement was estimated in one of the three excavations viewed from the 1947 photo set. That excavation bottom was estimated at El. +70. Additionally, no boring or CPT locations fell inside those excavations. Consequently, the estimated fill depths in the plant area rely heavily on the aerial photo parallax estimates. On the basis of those estimates, several excavations in the northwestern half and in the southwestern corner of the plant site may have extended down to about El. +70 feet, or about 20 feet below existing grade (assuming existing grade is about El. +90 feet). Several smaller excavations appear to have been scattered over the plant site at the estimated elevations shown on Plate 43.

Note that for both the stockpile and plant areas, the estimated locations and fill depths are based on limited information. For example, the aerial photo excavation depth estimates reflect approximate elevations at specific instances in time since 1947. Wider and deeper excavations could have been made at other times that were missed by the aerial photos reviewed for this

study. Also, the CPT and boring data were obtained at widely scattered locations, which may not have encountered the areas of the deepest fill. Because of the gaps in the aerial photo record, uncertainties in the aerial photo interpretation methods, and the limited number of borings and CPT soundings, fill depths interpreted from the data presented in this study may be inaccurate and must be used with caution.

## GROUNDWATER CONDITIONS

Groundwater, as measured in the borings and estimated from dissipation tests at selected CPT locations across the stockpile site, was encountered between elevations of about 52 feet and 62-1/2 feet during the time of the field exploration (i.e., between August 23 and 27, 1999). In the plant area, the groundwater levels ranged from about El. 54-1/2 feet to 64 feet, suggesting a drop in the water level toward the southeast. The existing pits southeast of the stockpile and plant areas appear to influence the local groundwater levels, as does the Santa Clara River to the northwest, whereas the central portions of both the stockpile and plant areas appears to have the most depressed groundwater level. Note that near an active river channel environment, such as the subject site, the groundwater level likely will fluctuate significantly over the seasons and from one year to the next, depending on rainfall, runoff volumes, recharge, and irrigation.

The following table summarizes the groundwater levels measured during the subsurface exploration for this study.

**Table 1. Groundwater Observations**

| CPT/Boring | Estimated Depth to Groundwater (feet) | Elevation as Encountered | CPT/Boring | Estimated Depth to Groundwater (feet) | Elevation as/as not Encountered[2] |
|---|---|---|---|---|---|
| B-CPT-1 | 19 | 60 | CPT-24 | 31 | 59 |
| CPT-2[1] | 18-1/2 | 62-1/2 | B-1 | not encountered | <58-1/2[2] |
| CPT-9[1] | 36 | 61 | B-2 | 34 | 58-1/2 |
| B-CPT-11 | 19 | 59 | B-3 | 37 | 54-1/2 |
| B-CPT-13 | 25 | 56-1/2 | B-4 | 26 | 64 |
| CPT-15[1] | 27 | 52 | B-5 | 28 | 62 |
| B-CPT-22[1] | 19-1/2 | 61-1/2 | | | |

[1] Groundwater depth measured from dissipation test.

[2] Where groundwater level was not encountered, elevation corresponds to maximum exploration depth where groundwater was not encountered.

An existing monitoring well (I.D. No. 02N22w15R02S), installed in 1998, is located near CPT-17. Periodic water level readings suggest that the current water level (as of September 22, 1999) is at a low of El. +49 feet. Several other monitoring wells, MW-1, MW-2, and MW-3, installed by Padre Associates on September 13, 1999, are located in the northwestern quarter of

the stockpile area. Water level readings taken from those wells on September 16, 1999, were as follows:

- MW-1 El. +56.5 feet,
- MW-2 El. +60.5 feet, and
- MW-3 El. +52 feet.

The locations of the monitoring wells are shown on Plate 3.

## LIQUEFACTION

### General

Soil liquefaction results from the earthquake-induced temporary buildup of excess pore water pressure, which can result in a condition of near-zero effective stress and the temporary loss of strength. Soil materials considered to be susceptible to liquefaction include loose, saturated sand and non-plastic silt. Clay soil or sand and silt with more than 15 percent clay-sized particles (particles less than 0.005 mm) typically are considered to be nonliquefiable.

According to Seed (1979), two subsurface conditions have been observed to exist at most sites where liquefaction has occurred. Those conditions are: 1) groundwater is shallower than a depth of about 15 feet, and 2) the liquefied layer is shallower than a depth of about 45 feet. However, Seed (1979) states that those conditions should not be construed to indicate that liquefaction cannot be induced at greater depths in response to earthquake shaking.

### Stockpile Area

The stockpile area contains fills that may extend about 20 feet deep along the northwestern end of the site (parallel to the river) to possibly as deep as about 75 feet in the southeastern half of the site. In their present state, the fills vary from loose to dense and because of the uncontrolled nature of their placement, will require complete removal and replacement as compacted fill. Once the compacted fills are placed, the liquefaction potential in the artificial fill below the groundwater level will be mitigated. However, the underlying native materials may still be vulnerable to liquefaction.

In the limited number of areas where we observed the native materials underlying the fill in the stockpile area, those materials appeared to consist of dense silty sand and sand with varying amounts of gravel. On the basis of the blow count data from the borings excavated in the stockpile area, those materials generally do not appear to be loose, and are not likely to experience liquefaction-induced settlement of more than about 1 inch. Additionally, the clay layers that were encountered below the artificial fill at the deeper exploration locations in the stockpile area do not appear to be susceptible to liquefaction because the clay content of those layers appears to exceed 15 percent.

The exploration depths in the stockpile area generally were between about 30 and 40 feet; usually terminated from refusal on the dense native sand. The native materials below the fill to a depth of about 50 feet from the average site grade should be explored at a few additional locations to further evaluate their liquefaction potential. That exploration could be performed in conjunction with other studies on the property, such as slope stability.

**Plant Area**

At our exploration locations in the plant site, dense sand was common below a depth of about 10 to 15 feet. Measured blow counts in the sand typically were greater than about 40 blows per foot. On that basis, the potential for liquefaction at the plant site appears to be low.

## CONCLUSIONS

On the basis of the interpreted CPT data, boring logs, and the aerial photo review, the artificial fill materials encountered in the stockpile area appear to be quite variable in thickness, density, and composition. Because uncontrolled fills by their very nature typically are random and highly variable, they should not be relied upon in their present condition as stable subgrade upon which to construct roads and structures.

The fill materials encountered in the stockpile area vary from clay, to silt, to sand across the site. On the southeastern half of the stockpile site, the sand fill materials appear to be concentrated near the outlet point of the conveyor that dumped spoils from the plant into the former excavations on the southeastern half of the stockpile site. The fine-grained fill materials encountered in CPT-13, CPT-20, CPT-21, and CPT-22 suggest that those materials may have been washed farther beyond the conveyor outlet to areas near the perimeter of the former excavation. On the northwestern half of the site, predominantly fine-grained fill materials were encountered in CPT-1 and CPT-3, with lesser amounts in CPT-2, CPT-4, CPT-6, CPT-7, CPT-8, CPT-11, and CPT-12. Little or no fine-grained fill layers were detected in CPT-9 and CPT-10.

The variability of the fill materials in density, composition, and thickness poses difficulties in achieving a uniform degree of mitigation by the application of a single ground improvement method. For example, deep dynamic compaction (DDC) and stone columns are less effective in fine-grained materials than in sands. DDC is also not effective in densifying sands thicker than about 35 feet. Therefore, overexcavation and recompaction of the fill materials appears to be the most reliable means of remediating the artificial fill in the stockpile area. Additionally, excavation of the fill probably is the best way to verify that the fill has been completely mitigated (i.e., throughout its entire depth) because complete removals down to native soil can be observed and verified.

The plant area does not appear to have been excavated to the lateral or vertical extent of the stockpile area. The aerial photo review suggests local fill depths in the northwestern quarter

and the northern half of the southwestern quarter of about 20 feet, assuming an average surface elevation of +90 feet. Several other former pits (now backfilled), generally smaller in lateral extent, are scattered across the plant site as shown on Plate 43. Additionally, fill was suspected in the upper approximate 15 feet of boring B-3, located near the center of the plant site, outside of the excavation pits observed on the aerial photographs reviewed. Fill materials vary from predominantly silt and clay in CPT-23 and CPT-26 to predominantly sand with intermittent silt and/or clay layers in CPT-24, CPT-27, CPT-28, and boring B-3.

Because of the variability in the fill materials from fine- to coarse-grained, ground improvement methods such as DDC and stone columns to not appear to be practical. Overexcavation and recompaction of artificial fill in the plant area appears to be the best option, primarily because all fill can be removed and verified in an excavation, leaving little doubt that additional fill is left behind.

## GRADING, EARTHWORK, AND EXCAVATION

### General

On the basis of the lateral extent, depth, and variability in composition of the artificial fill materials in the stockpile and plant areas, overexcavation of the fill down to native materials is recommended to mitigate the potential for settlement. The grading recommendations presented below should be incorporated into the project plans and specifications, and should be adhered to during construction. Grading should be performed in accordance with the Ventura County grading ordinance and Chapter 33 of the Uniform Building Code (1997).

Grading plans should be reviewed by Fugro for consistency with our recommendations prior to contract bidding.

### Site Preparation

Organic material and vegetation, hazardous materials, old foundations from demolished structures, underground utilities, debris, unsuitable fill materials, or other deleterious materials should be stripped, removed, and wasted from construction areas. Abandoned below grade or underground structures such as wells, cesspools, pipelines, mining equipment, old foundations, etc., not relocated prior to grading should be removed or treated in a manner prescribed by the controlling governmental agencies. Backfilling of excavations created as a result of the removal of below-grade or underground structures should be performed in accordance with recommendations presented herein.

### Artificial Fill Removal

**Stockpile Area.** The existing artificial fill in the stockpile area should be removed down to dense native sand or firm native clay, in all areas encountered. The removals in the

southeastern half of the stockpile area will extend below the current groundwater level. Dewatering of that area will be required. Other areas such as the southeastern half of the northern quarter of the stockpile area are likely to require dewatering. The removal bottom should be observed by Fugro. If fill remains in the excavation bottom, the excavation will require deepening until the fill is completely removed. The bottom should be firm or dense and unyielding. If unstable conditions are encountered, stabilization of the excavation bottom will be necessary. General recommendations for stabilization of subgrade are presented below.

**Plant Area.** The entire plant area should be overexcavated to a minimum depth of 4 feet below existing grade. The bottom of the excavation should be observed by Fugro prior to processing. Areas where artificial fill is exposed in the bottom will require deeper removals, so that the existing artificial fill is completely removed. The deeper removals are anticipated in at least those areas outlined on Plate 43. Additional fill areas not shown on Plate 43 are likely to be encountered during the overexcavation of the plant area.

To reduce differential settlements in the fill, areas adjacent to deepened removals should be excavated to a depth such that the variation in fill thickness does not exceed 20 percent. Alternatively, areas where the fill thickness variation exceeds 20 percent should be designated for nonstructural use (e.g. greenbelt use), because differential settlements should have less significant impacts on nonstructural improvements than on pavements and buildings. Additionally, removals should overlap a sufficient distance into the adjacent constructed fill to ensure that existing artificial fill is removed and the compactness of the fill being placed is consistent throughout.

**Excavation Considerations**

**Equipment.** We believe grading and excavation can be performed with conventional heavy-duty earthmoving equipment in good working order.

In excavations near the groundwater level, the use of equipment that imparts light loads to the subgrade should be considered. Minimizing the equipment and traffic loads in the excavation bottom may help avert "pumping" subgrade conditions.

Additionally, lightweight equipment may be advantageous for compacting backfill placed on the excavation bottom until "bridging" over potentially unstable pumping subgrade soil is accomplished.

**Dewatering.** On the basis of our field exploration, the current groundwater level is anticipated between elevations of about +52 and +63 feet. The groundwater level could rise above the highest level encountered at the time of our exploration, or it could be deeper, depending on rainfall conditions prior to and during grading.

The dewatering contractor should be responsible for the design of the dewatering system. Appropriate design considerations should be included to prevent piping and soil migration or erosion. The dewatering system should draw down the water level a minimum of 5 feet below the bottom of the deepest part of the excavation.

**Temporary Slopes.** Sloped excavations are anticipated during artificial fill removals. The temporary slopes should be continuously monitored by the contractor and loose or unstable soil masses should be removed immediately. Temporary slopes and excavations should conform to federal Occupational Safety and Health Administration (OSHA) and/or California Division of Occupational Safety and Health (DOSH) regulations, and other applicable local ordinances and building codes, as required. However, the contractor should be made responsible for all safety issues affecting open excavations. Stockpiled material or equipment should not be placed within a distance from the slope crest equal to the height of the slope.

Runoff should be directed away from temporary slopes and should not be allowed to flow across slope faces and excavations. In addition, provisions should be made for collecting and pumping seepage or runoff water out of excavations, if water is encountered during construction.

The artificial fill materials encountered during the subsurface exploration (i.e., silty sand, sand, and sand with gravel) will have a potential for caving and sloughing.

**Excavation Bottoms.** Excavation bottoms should be free of artificial fill and should be observed by Fugro prior to processing. Once the bottom has been accepted by Fugro, the exposed surface should be scarified to a depth of 8 inches, aerated or moistened as required to bring the soil to within 2 percent of optimum moisture content, and compacted to a minimum of 93 percent relative compaction, according to ASTM D1557. If the excavation bottom requires stabilization or if scarification is likely to induce pumping conditions, scarification of excavation bottoms near the groundwater level may be waived by Fugro. General recommendations for stabilization of the excavation bottom are presented below.

### Special Subgrade Stabilization Measures

Special stabilization measures may be required if soft or pumping subgrade is encountered during grading (e.g., excavation bottom near groundwater level). Those measures may be required (and should be anticipated) to provide a firm and unyielding subgrade surface. Special subgrade stabilization measures may consist of:

- Use of a geosynthetic fabric, such as Mirafi 600X, or equivalent, placed beneath a minimum 1 foot lift of gravel or rock fill,
- Working of rock fill into clayey subgrade soils, or
- Working cement into sandy subgrade or lime into clayey subgrade.

Whether those measures are required or not will depend on the elevation of the excavation relative to the groundwater level at the time, the moisture content of the subgrade materials, and the nature of the construction activities (e.g., vibratory compaction equipment, equipment wheel loads, number of equipment passes, trafficability, etc.).

Past experience with wet subgrade soils suggests that rockfill thicknesses between 1 and 2 feet may be required to provide a suitable subgrade surface (i.e., firm and unyielding) upon which fill materials may be placed and compacted.

A geosynthetic fabric placed beneath the rockfill is needed to separate the rockfill from the underlying soft materials and a filter fabric should encapsulate the gravel layer to reduce migration of fines into the gravel. Rockfill materials successfully used in the past include filter rock materials in accordance with Ventura County specifications or quarry run rockfill available locally.

Such special measures suggested herein should be considered if soft or pumping subgrades become a nuisance during construction. We suggest that contract documents should include contingency items for procurement of geosynthetics or rockfill, in case the need arises.

**Fill Selection and Compaction**

**General**. In general, onsite materials (including removals) are suitable for use as fill. Onsite materials used as backfill should be free of organic material, hazardous material, debris, or any other deleterious materials. Backfill in deep removal areas (i.e., exceeding 25 feet in depth) should consist of granular materials in the lower 50 feet. Fat clay (i.e., potentially expansive) materials should not be placed in the upper 10 feet of backfill.

Rock or gravel less than 4 inches in maximum dimension may be utilized in the fill, provided those materials are not placed in concentrated pockets and provided they have sufficient sand-sized material surrounding the individual rock fragments. Fill material should not contain more than 20 percent material larger than 2 inches.

**Imported Fill.** Imported fill materials may be used for fill provided that the imported fill is equal to or better than onsite materials in gradation, strength, and expansive characteristics. Imported fill material should be evaluated by the geotechnical engineer to verify suitability for its intended use.

**Compaction Requirements**. All fill materials should be placed in layers that do not exceed 8 inches in loose thickness. Each layer should be spread evenly, moisture-conditioned to within within 2 percent above or below optimummoisture content, and processed and compacted to obtain a uniformly dense layer. The fill should be placed and compacted on near-horizontal planes to a minimum of 93 percent (relative compaction) of the maximum dry density determined from ASTM D1557.

## LIMITATIONS

This report has been prepared for Keller Equity Group solely for the preliminary planning and site development of RiverPark B. The applicability of this report is specifically limited to current considerations for the planned development. This study does not include evaluation of the adjacent mining pit slope or the levee slope. Those concerns should be addressed at another stage of the planning process.

In performing our professional services, we have used that degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical engineers currently practicing in this or similar localities. No other warranty, express or implied, is made as to the professional advice included in this report.

We recommend that Fugro West, Inc., be provided the opportunity to review geotechnical aspects of the grading plans and specifications to evaluate whether the recommendations in this report have been properly interpreted and implemented in the design and specifications. In addition to the need for a slope stability study, additional design-level studies are recommended for the proposed residential, retail, and educational structures as the scope for the work performed for this study was developed as a preliminary study to provide data to interpret the lateral and vertical extent of existing fills.

An investigation and discussion of potential subsurface contamination is beyond the scope of this geotechnical study, as are environmental assessments for the presence or absence of hazardous/toxic materials in the soil, surface water, ground water, or atmosphere. Any statements or absence of statements in this report or data presented herein regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous/toxic assessment.

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Buena Engineers, Inc. (1987), "Addendum to Soil Engineering Report, Tract 4210, El Rio Area, Ventura County, California," Job No. B-16597-V1, Report No. 87-2-109, February 9.

Earth Systems Consultants, Inc. (1997), "Slope Instability Analyses of Borrow Pit Slopes Along Montgomery and Lambert Streets," Job No. SS-21229-V1, Report No. 97-10-112, October 24.

Fugro West, Inc. (1997), "Geotechnical Evaluation of Stockpile Area A, El Rio Facilities," unpublished draft report prepared for Southern Pacific Milling Company, FWI Project No. 97-71-1601, June 26.

Padre Associates (1998), "Phase I Environmental Site Assessment, Limited Phase B Environmental Site Assessment," prepared for Southern Pacific Milling Company, Project No. 9805-1271, December 8.

_____ (1999a), "Letter-Report, Environmental Site Assessment Services to Characterization of Petroleum Hydrocarbon-Containing Soil at the Former Diesel Spray Rack, Southern Pacific Milling Company, El Rio Facility, Oxnard, Ventura County, California," Project No. 9805-1276, January 12.

_____ (1999b), "Letter-Report, Environmental Site Assessment Services - Characterization of Petroleum Hydrocarbon-Containing Groundwater at the Former Diesel Fuel Spray Rack, Southern Pacific Milling Company, El Rio Facility, Oxnard, Ventura County, California," Project No. 9805-1277, March 18.

Seed, H.B. (1979), "Soil Liquefaction and Cyclic Mobility Evaluation for Level Ground During Earthquakes," *Journal of Geotechnical Engineering Division*, ASCE, vol. 105, no. GT2, pp.201-255.

Uniform Building Code (UBC) (1997), International Conference of Building Officials, April.

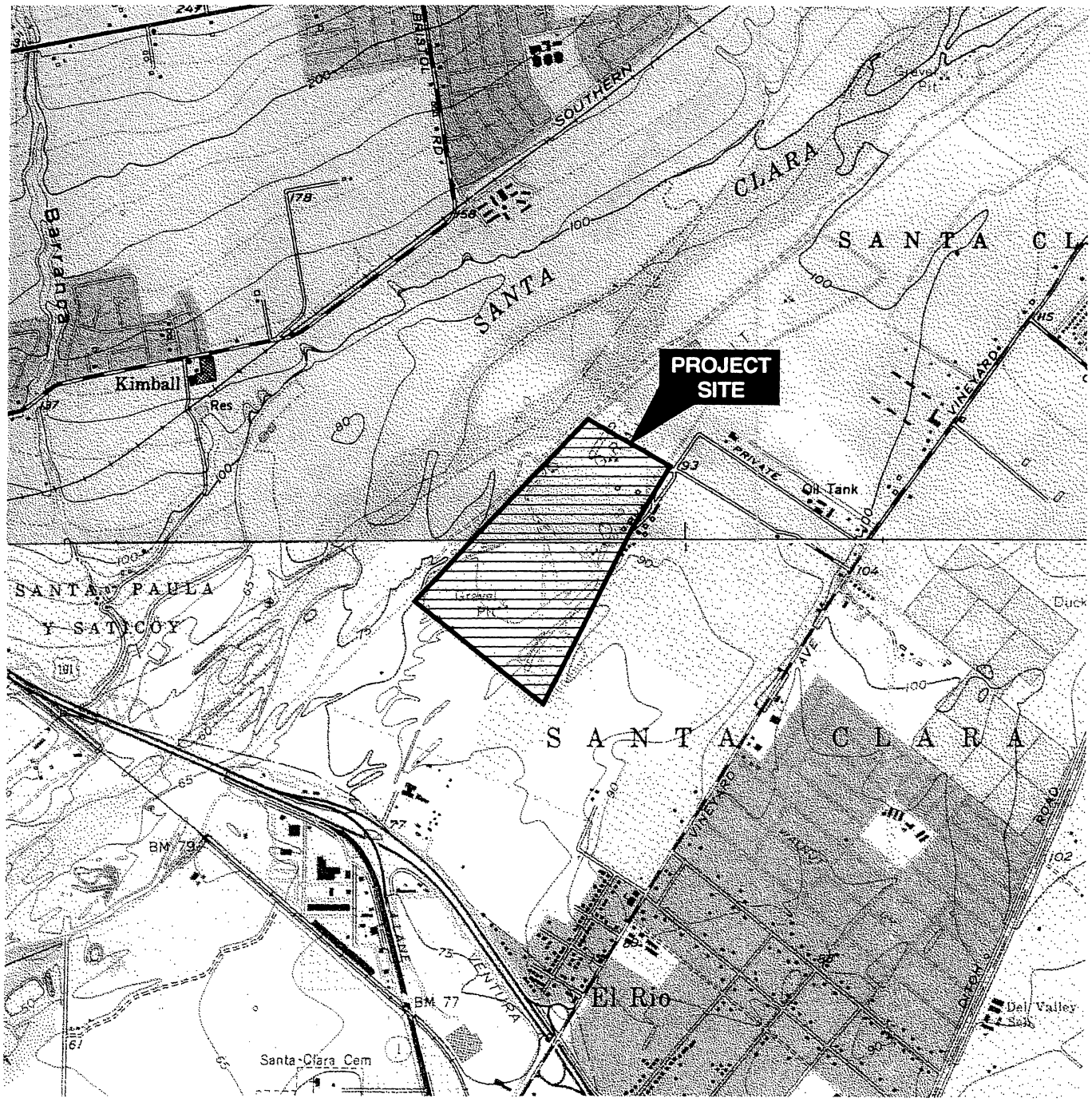
Ventura County Public Works Agency (1967, photo revised 1975), 200-Scale Topography Map Nos. 272-1644-2 and 276-1644-2.

_____ (1971), 500-Scale Topography Map Nos. 256-1632-5, and 276-1632-5.

# AERIAL PHOTOGRAPHS REVIEWED

| Source | Flight No. | Date | Frame Nos. | Stereo |
|---|---|---|---|---|
| USGS | GS-EM | 8/20/47 | 74, 75 | Yes |
| U.S. Dept. of Agriculture (USDA) | AXI | 10/7/53 | 92,93 | Yes |
| USDA | AXI | 10/2/59 | 133, 134 | Yes |
| Mark Hurd | HA-LS | 6/30/61 | 37, 38, 39 | Yes |
| Mark Hurd | HA-OH | 3/24/62 | 51, 52, 53 | Yes |
| Mark Hurd | HA-RR | 1/7/63 | 110, 111 | Yes |
| Mark Hurd | HA-SH | 3/20/63 | 108, 109, 110 | Yes |
| Mark Hurd | HA-TG | 6/24/63 | 10, 11, 12 | Yes |
| Mark Hurd | HA-WE | 2/14/64 | 23.24, 37, 38 | Yes |
| USDA | AXI | 9/20/65 | 84, 85 | Yes |
| Mark Hurd | HB-IA | 7/5/66 | 54, 55 | Yes |
| USGS | GS-VBUK | 8/12/67 | 86, 87, 88 | Yes |
| Mark Hurd | HB-MA | 7/22/68 | 3, 4 | Yes |
| Pacific Western | VEN | 8/23/73 | 83, 84 | Yes |
| Pacific Western | 4918 | 3/17/75 | 1 | No |
| Teledyne Geotronics | 7500C | 7/29/75 | 5,6 | Yes |
| Teledyne Geotronics | 7700 | 3/14/77 | 14, 15 | Yes |
| Pacific Western | VEN-2 | 5/16/78 | 34, 60, 61 | Yes |
| Pacific Western | 9034 | 7/7/79 | 1 | No |
| Pacific Western | VEN-3 | 6/15/81 | 70, 71, 114, 115 | Yes |
| Pacific Western | VEN-4 | 1/11/84 | 114, 115 | Yes |
| Pacific Western | VEN-5 | 12/10/86 | 110, 111 | Yes |
| Pacific Western | VEN-5 | 1/12/87 | 122, 123, 124 | Yes |
| Pacific Western | 28847-3 | 1/20/88 | 35, 49 | No |
| Pacific Western | VEN-6 | 10/10/88 | 82, 83 | Yes |
| Pacific Western | VEN-7 | 5/23/89 | 112, 113 | Yes |
| Pacific Western | VEN-8 | 11/8/90 | 113 | No |
| Pacific Western | VEN-9 | 9/19/92 | 83, 84, 113, 114 | Yes |
| Pacific Western | 51706 | 12/29/93 | 1 | No |
| Pacific Western | 52043 | 2/24/93 | 3, 4 | Yes |
| Pacific Western | VEN-12 | 1/8/96 | 83 | No |

# PLATES




**BASE MAP:** USGS 7.5' Saticoy and Oxnard, California quadrangle maps (both photorevised 1967).

NORTH

0 1000 2000

FEET

## VICINITY MAP

RiverPark II
Former S.P. Milling Property
El Rio Area, Ventura County, California

PLATE 1

9942100 21vicn.ds(f(1-3)

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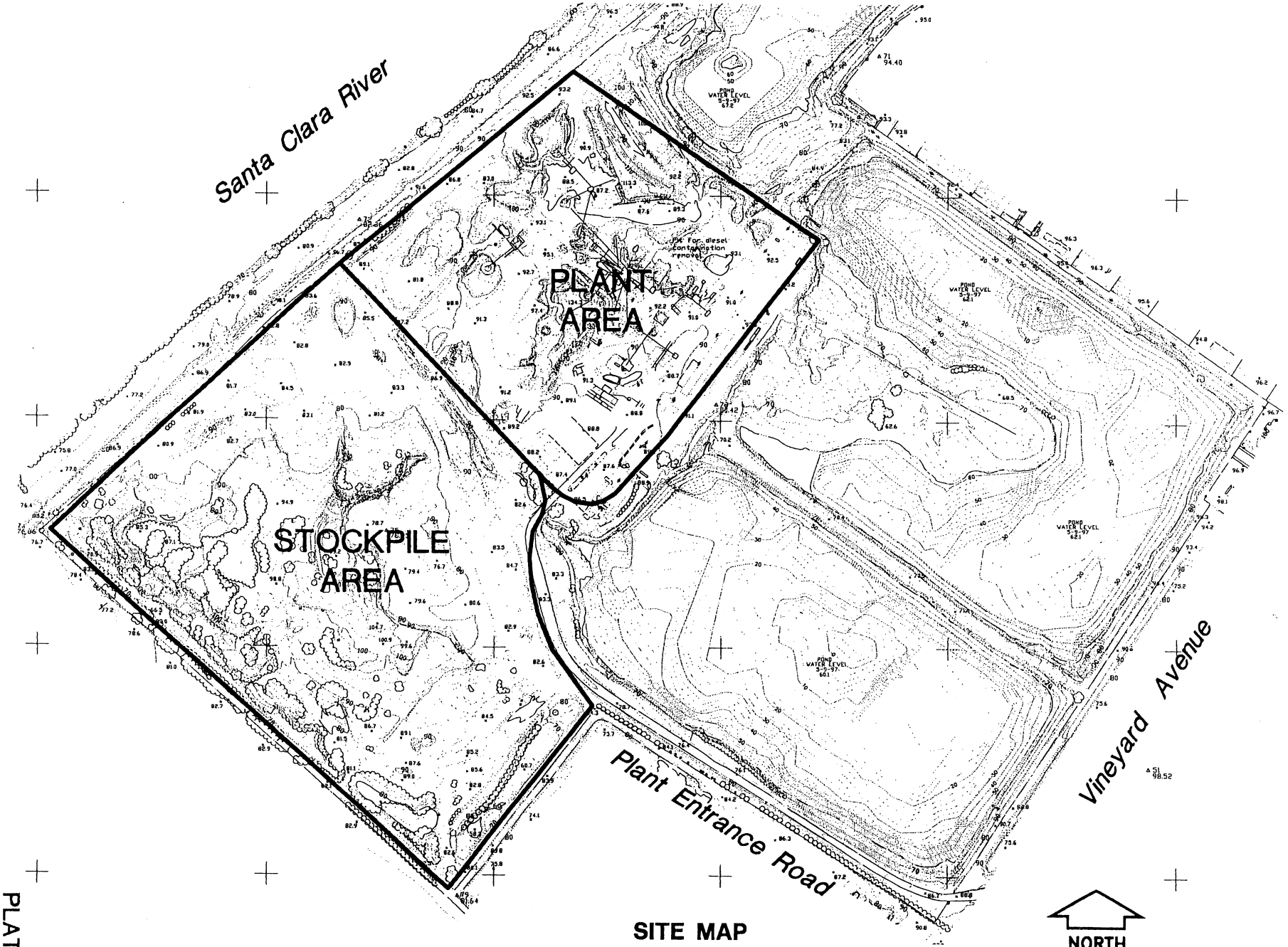



**SITE MAP**
RiverPark II
Former S.P. Milling Property
El Rio Area, Ventura County, California

PLATE 2

October 1999
Project No. 99-42-0021

FUGRO

oversize poket

## LEGEND

- B-1 — Location of Boring
- CPT-1 — Location of CPT
- CPT-5 — Location of CPT Not Performed (Inaccessible)
- MW-1 — Monitoring Well (MW-1, 2, 3 by Padre Associates)
- 59' — Groundwater Elevation Estimated from Dissipation Test
- 64' — Groundwater Elevation First Encountered when Drilling
- 67' — Estimated Elevation of Bottom-of-Fill from CPT Interpretation
- 53' — Estimated Elevation of Bottom-of-Fill from Boring Log
- A — A' — Cross Section

NOTE: The estimated bottom-of-fill elevations shown on this map are based on interpretations of the CPT and boring log data. Several interpretive methods were used to make those estimates, as described in the text of this report. The presence of rock, foreign objects, or locally dense zones in the fill could have yielded misleading data that might have caused underestimation of fill depths. Consequently the fill-bottom elevations estimated on this map may be inaccurate.

NORTH

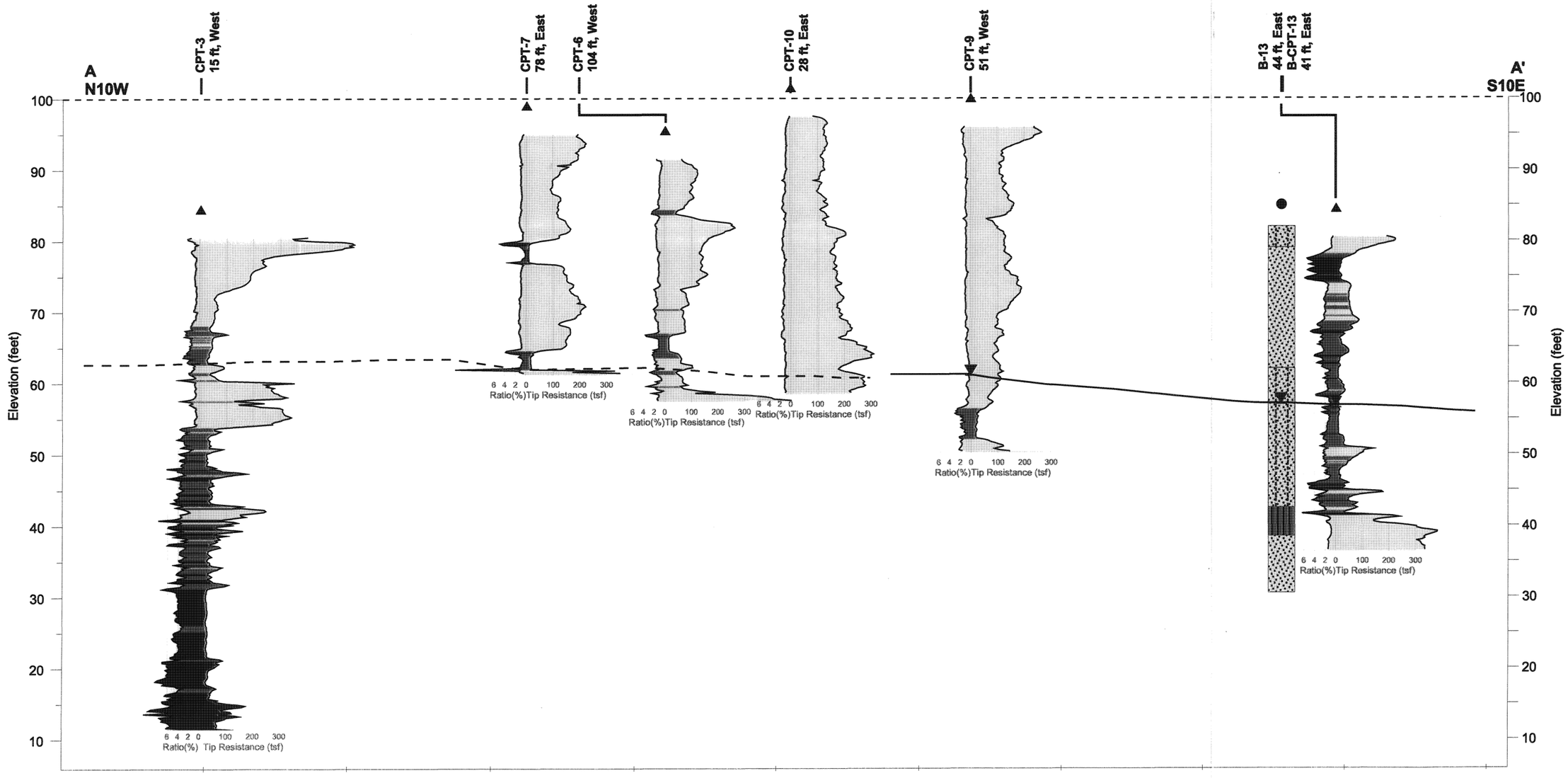
0 100 200 400 600 800
Feet

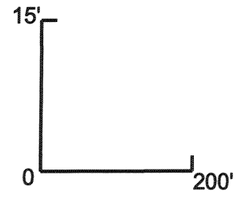
FUGRO WEST, INC.
5855 Olivas Park Drive, Ventura, California 93003
Tel.: (805) 650-7000, FAX: (805) 650-7010

# SUBSURFACE EXPLORATION MAP
## RiverPark B

Client: KELLER EQUITY GROUP, INC.

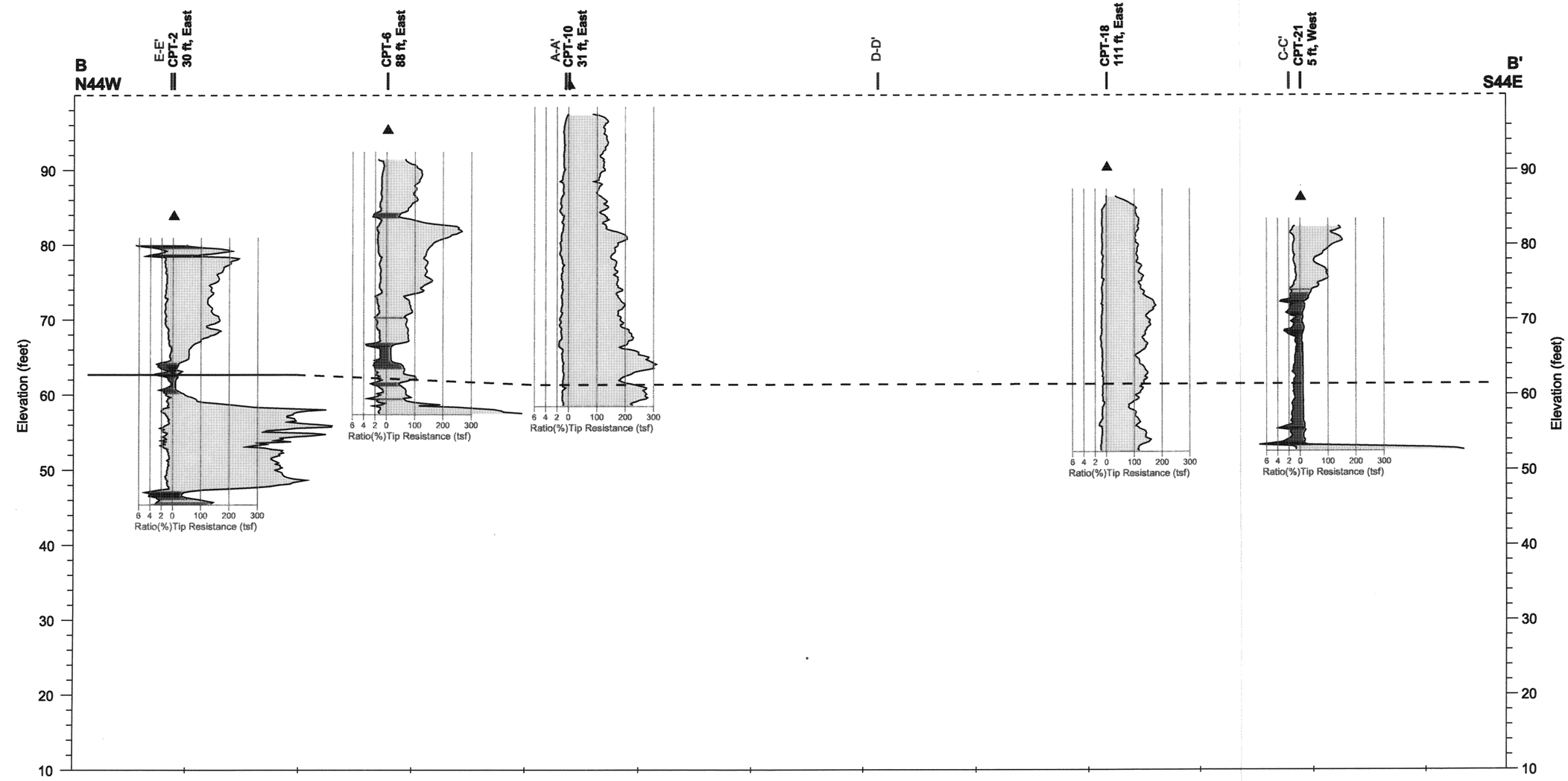
99-42-0021 October 1999 PLATE 3

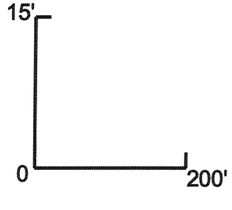



**SUBSURFACE CROSS SECTION A-A'**
**River Park B**
**Stockpile and Plant Areas of Former S.P. Milling Property**
El Rio Area, Ventura County, California

PLATE 4




**SUBSURFACE CROSS SECTION B-B'**
**River Park B**
**Stockpile Area of Former S.P. Milling Property**
El Rio Area, Ventura County, California

PLATE 5

C
N20W

CPT-4
19 ft, West

E-E'

CPT-8
48 ft, East

CPT-11
4 ft, West
B-11
16 ft, West

CPT-15
6 ft, East
LD

CPT-18
30 ft, West

B-B'
CPT-21
4 ft, East

C'
S20E

Elevation (feet)

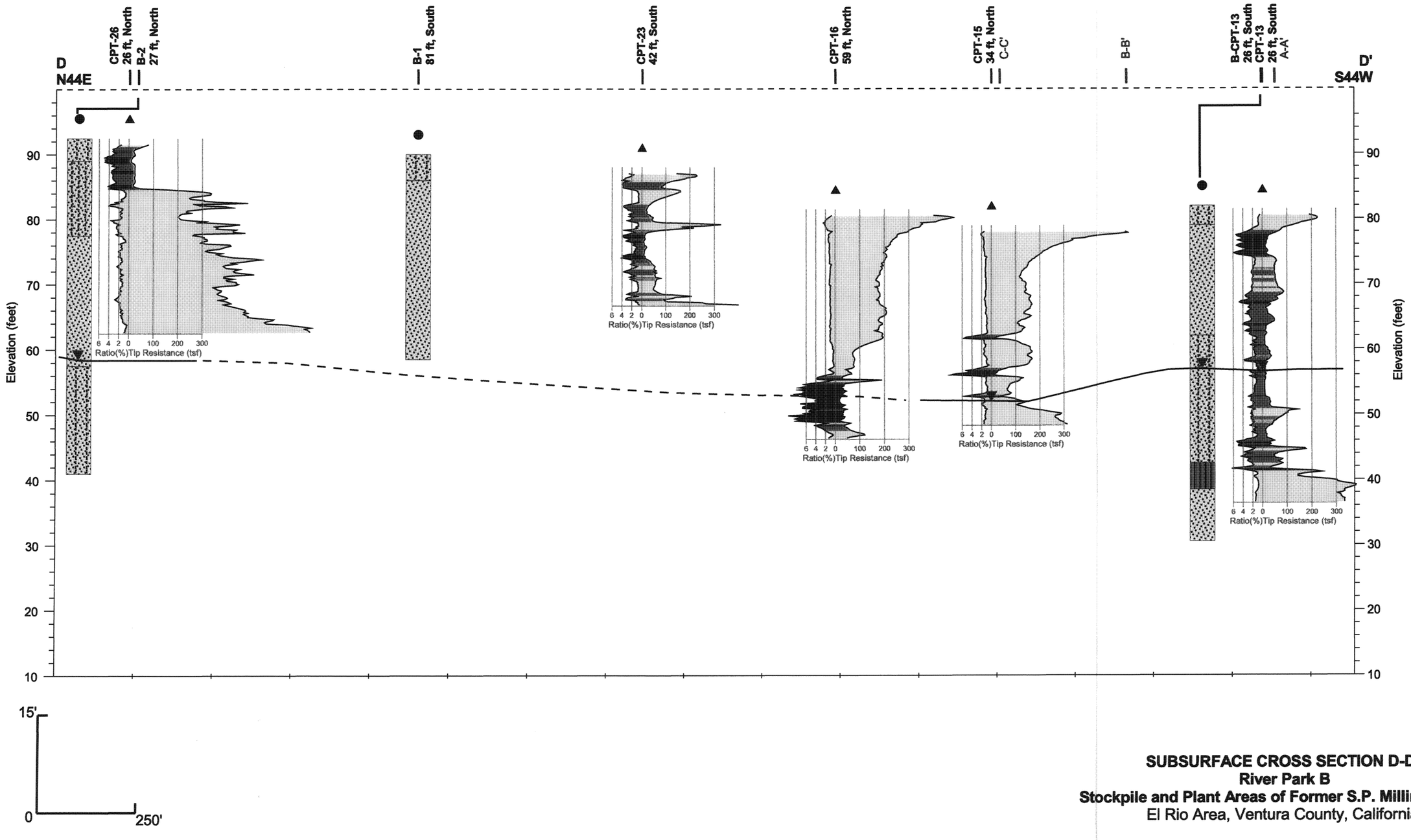
90
80
70
60
50
40
30
20
10

6 4 2 0 100 200 300
Ratio(%)Tip Resistance (tsf)

15'
0
200'

**SUBSURFACE CROSS SECTION C-C'**
**River Park B**
**Stockpile Area of Former S.P. Milling Property**
El Rio Area, Ventura County, California

PLATE 6




**SUBSURFACE CROSS SECTION D-D'**
**River Park B**
**Stockpile and Plant Areas of Former S.P. Milling Property**
El Rio Area, Ventura County, California

PLATE 7

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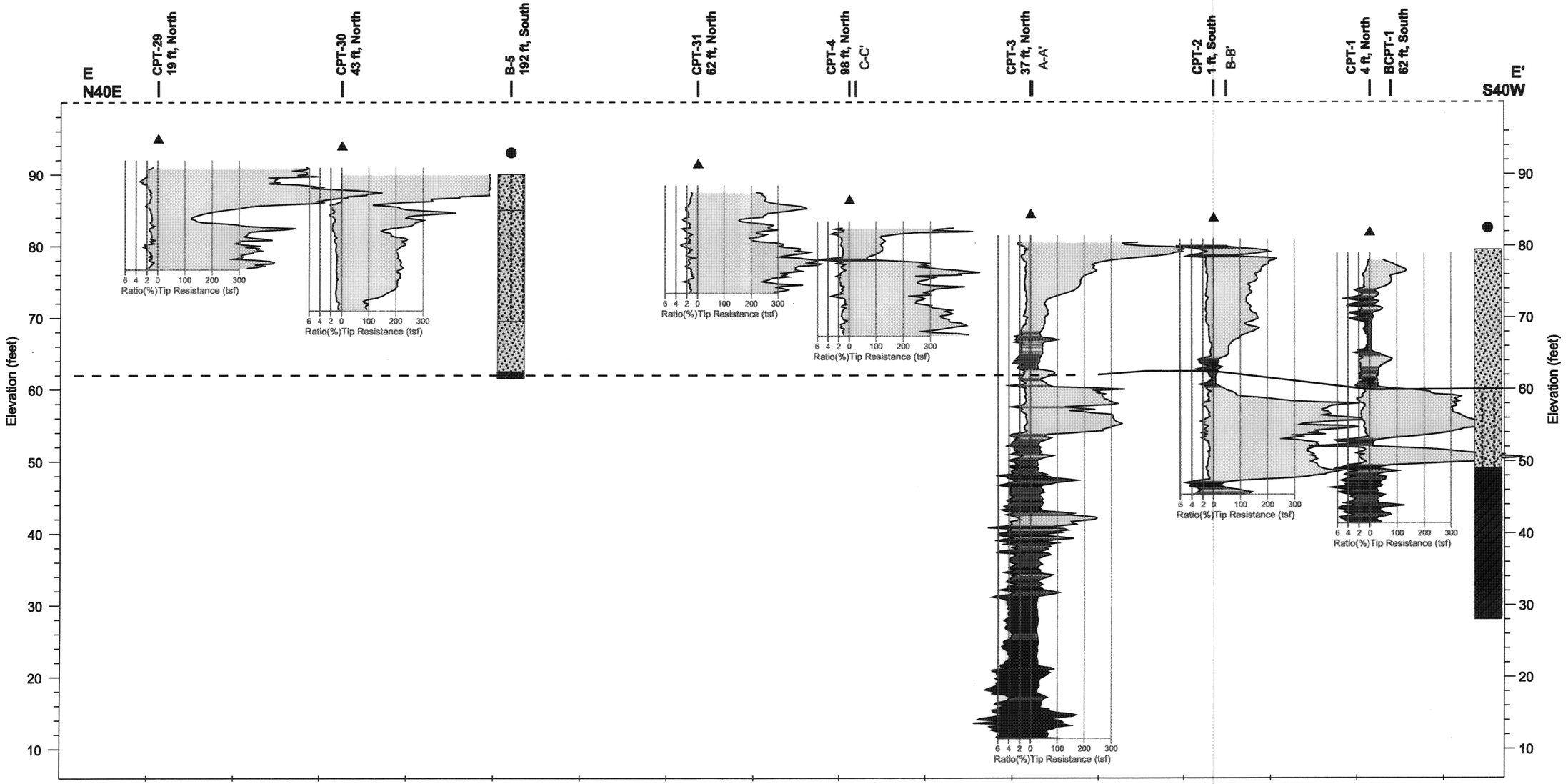
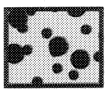
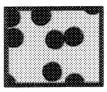


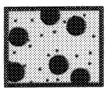

**SUBSURFACE CROSS SECTION E-E'**
**River Park B**
**Stockpile and Plant Areas of Former S.P. Milling Property**
El Rio Area, Ventura County, California

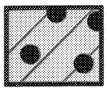
PLATE 8

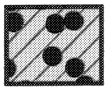
## Key to Soil Lithology Symbols

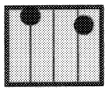

Well graded GRAVEL (GW)

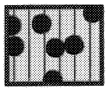

Poorly graded GRAVEL (GP)

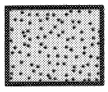

GRAVEL with sand (GP or GW)

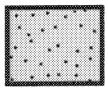

GRAVEL with clay (GP-GC)


Clayey GRAVEL (GC)

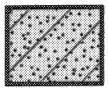

GRAVEL with silt (GP-GM)

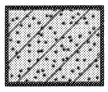

Silty GRAVEL (GM)

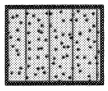

Well graded SAND (SW)

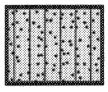

Poorly graded SAND (SP)

SAND with gravel (SP or SW)


SAND with clay (SP-SC)


Clayey SAND (SC)


SAND with silt (SP-SM)


Silty SAND (SM)

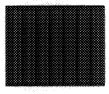
Fat CLAY (CH)

Sandy fat CLAY (CH)

Lean CLAY (CL)

Sandy lean CLAY (CL)

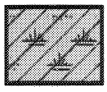
Silty CLAY (CL-ML)

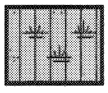

Elastic SILT (MH)

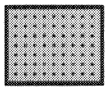
SILT (ML)

Sandy SILT (ML)

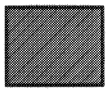
Clayey SILT (ML/CL)


Highly Plastic ORGANICS (OH)

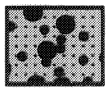

Low plasticity ORGANICS (OL)


SANDSTONE (Rx)

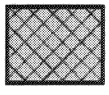
SILTSTONE (Rx)


CLAYSTONE (Rx)

Interbedded Rock Strata (Rx)

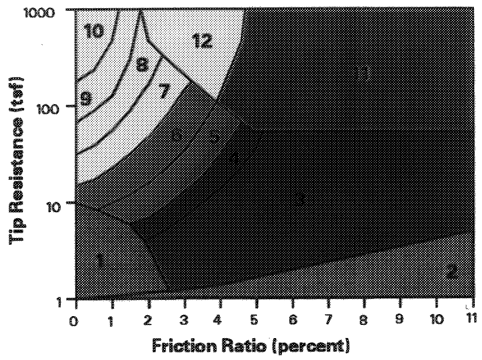

CONGLOMERATE (Rx)

Rock Fragments


PAVEMENT

**KEY TO CROSS SECTIONS**
**BORINGS**
RiverPark B

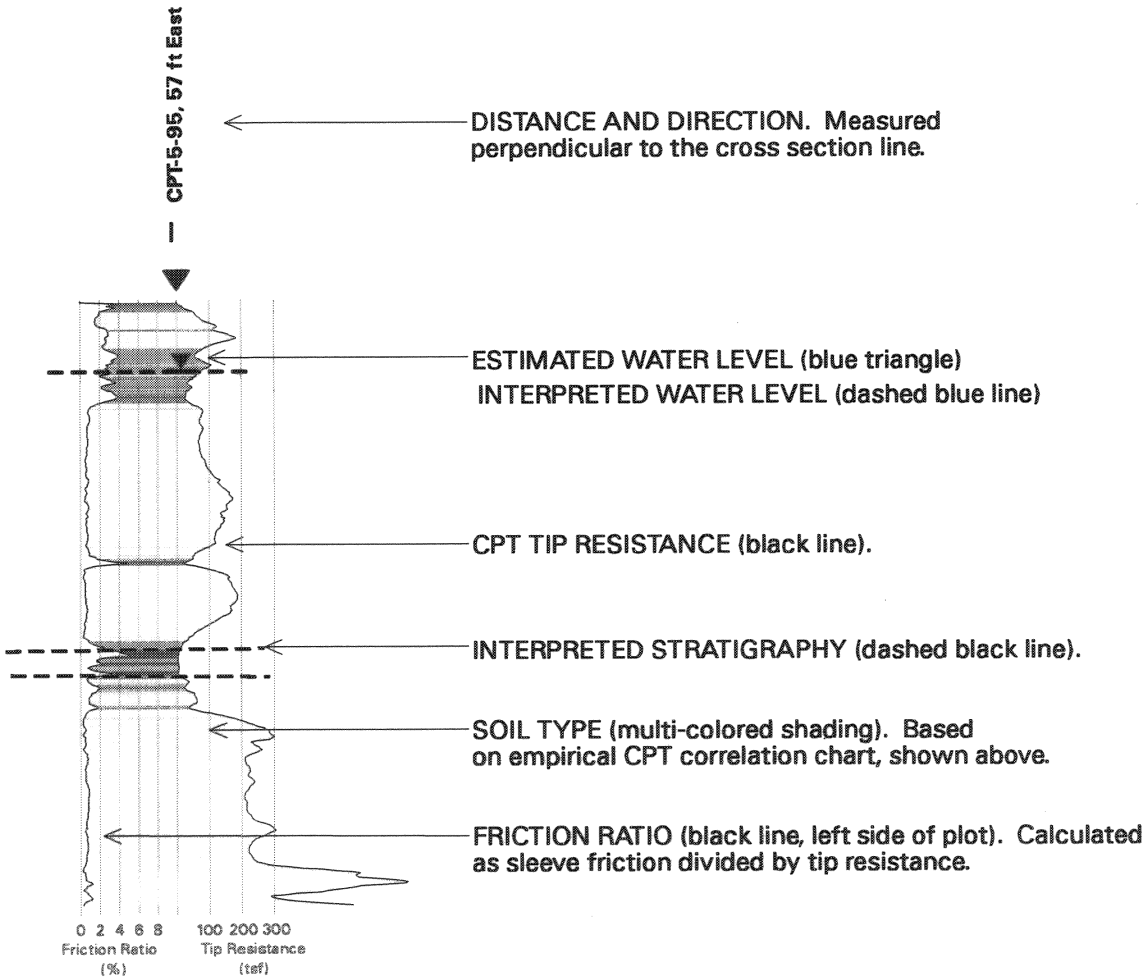
PLATE 9a




| Zone | Soil Behavior Type | U.S.C.S. |
|---|---|---|
| 1 | Sensitive Fine-grained | OL-CH |
| 2 | Organic Material | OL-OH |
| 3 | Clay | CH |
| 4 | Silty Clay to Clay | CL-CH |
| 5 | Clayey Silt to Silty Clay | MH-CL |
| 6 | Sandy Silt to Clayey Silt | ML-MH |
| 7 | Silty Sand to Sandy Silt | SM-ML |
| 8 | Sand to Silty Sand | SM-SP |
| 9 | Sand | SW-SP |
| 10 | Gravelly Sand to Sand | SW-GW |
| 11 | Very Stiff Fine-grained * | CH-CL |
| 12 | Sand to Clayey Sand * | SC-SM |

* overconsolidated or cemented

**CPT CORRELATION CHART (Robertson and Campanella, 1984)**




## KEY TO CROSS SECTIONS
## CPT LOGS
RiverPark B

PLATE 9b

October 1999
Project No. 99-42-0021

FUGRO

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1947**
(8/20/47)
RiverPark B
Former S.P. Milling Property

PLATE 10

9942\0021expl.dwg(0.2-0,20,20o),pa.0021expl_001.ctb

October 1999
Project No. 99-42-0021

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1953**
(10/7/53)
RiverPark B
Former S.P. Milling Property

PLATE 11

9942\0021expl.dwg(0.2,-9.21,21c),pa,0021expl_001.ctb

FUGRO

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1959**
(10/2/59)
RiverPark B
Former S.P. Milling Property

PLATE 12

October 1999
Project No. 99-42-0021

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1961**
(6/30/61)
RiverPark B
Former S.P. Milling Property

PLATE 13

9942\0021expl.dwg(0,2-9,23),pe.0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1962**
(3/24/62)
RiverPark B
Former S.P. Milling Property

PLATE 14

9942\0021evpl.dwg(0.2-9.24),pa,0021evpl_001.ctb

October 1999
Project No. 99-42-0021

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800

FEET

**AERIAL PHOTOGRAPH**
**OF SITE - 1963**
**(1/7/63)**
**RiverPark B**
**Former S.P. Milling Property**

PLATE 15

9942\(021expl.dwg(0,2-9,25),ps,0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH**
**OF SITE - 1963**
(3/20/63)
RiverPark B
Former S.P. Milling Property

PLATE 16

9942\0021expl.dwg(0.2=9.26),pe,0021expl_001.db

October 1999
Project No. 99-42-0021

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH**
**OF SITE - 1963**
(6/24/63)
RiverPark B
Former S.P. Milling Property

PLATE 17

9942\0021expl.dwg(0.2=9.27),pa.0021expl_001.ctb

October 1999
Project No. 99-42-0021

9942\0021swpl.dwg(0.2=9.28,28o),pa.0021swpl_001.ctb

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

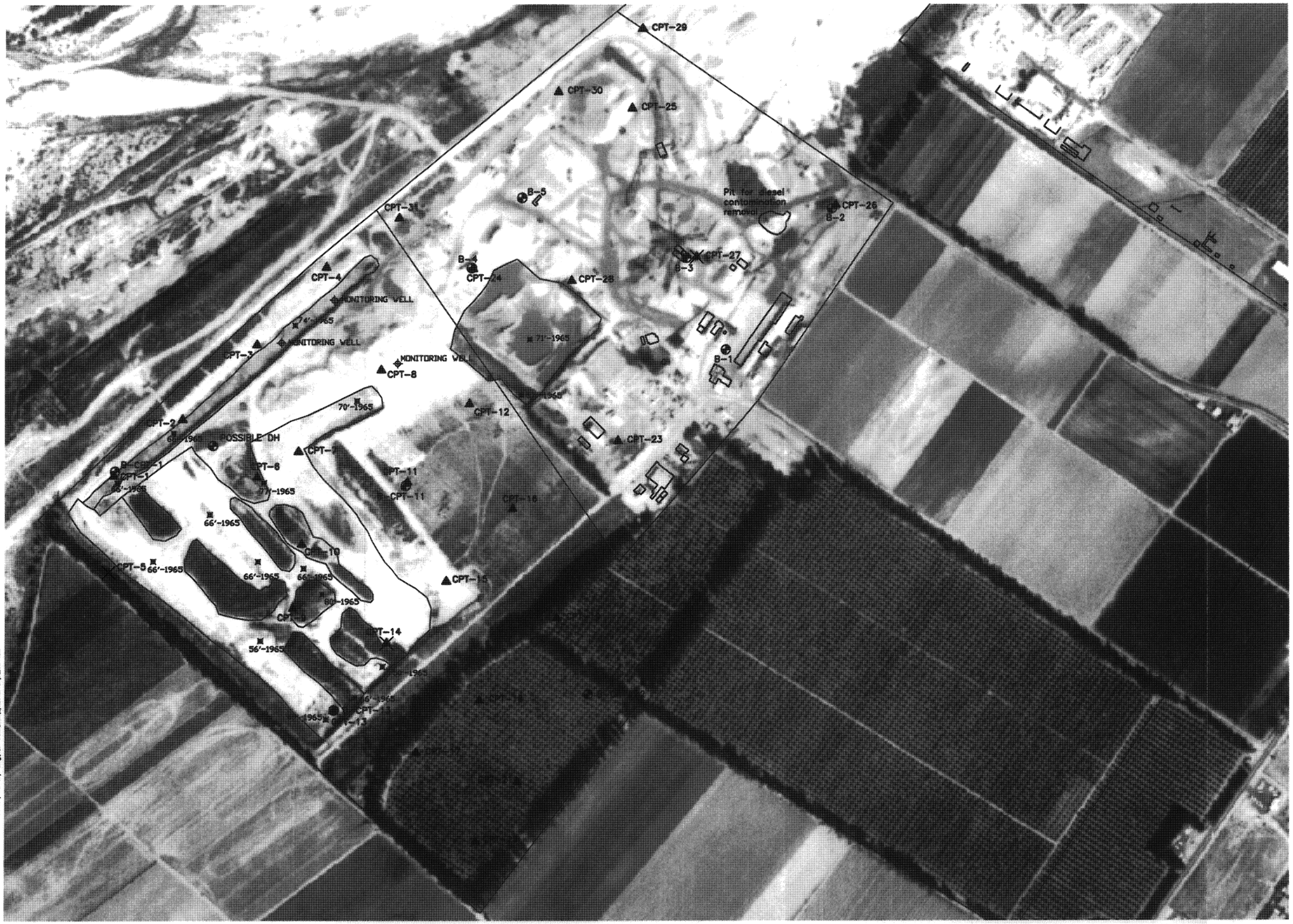
NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1964**
(2/14/64)
RiverPark B
Former S.P. Milling Property

PLATE 18

October 1999
Project No. 99-42-0021




9942\0021expl.dwg(0.2-9.29.29a),ps_0021expl_001.ctb

LEGEND

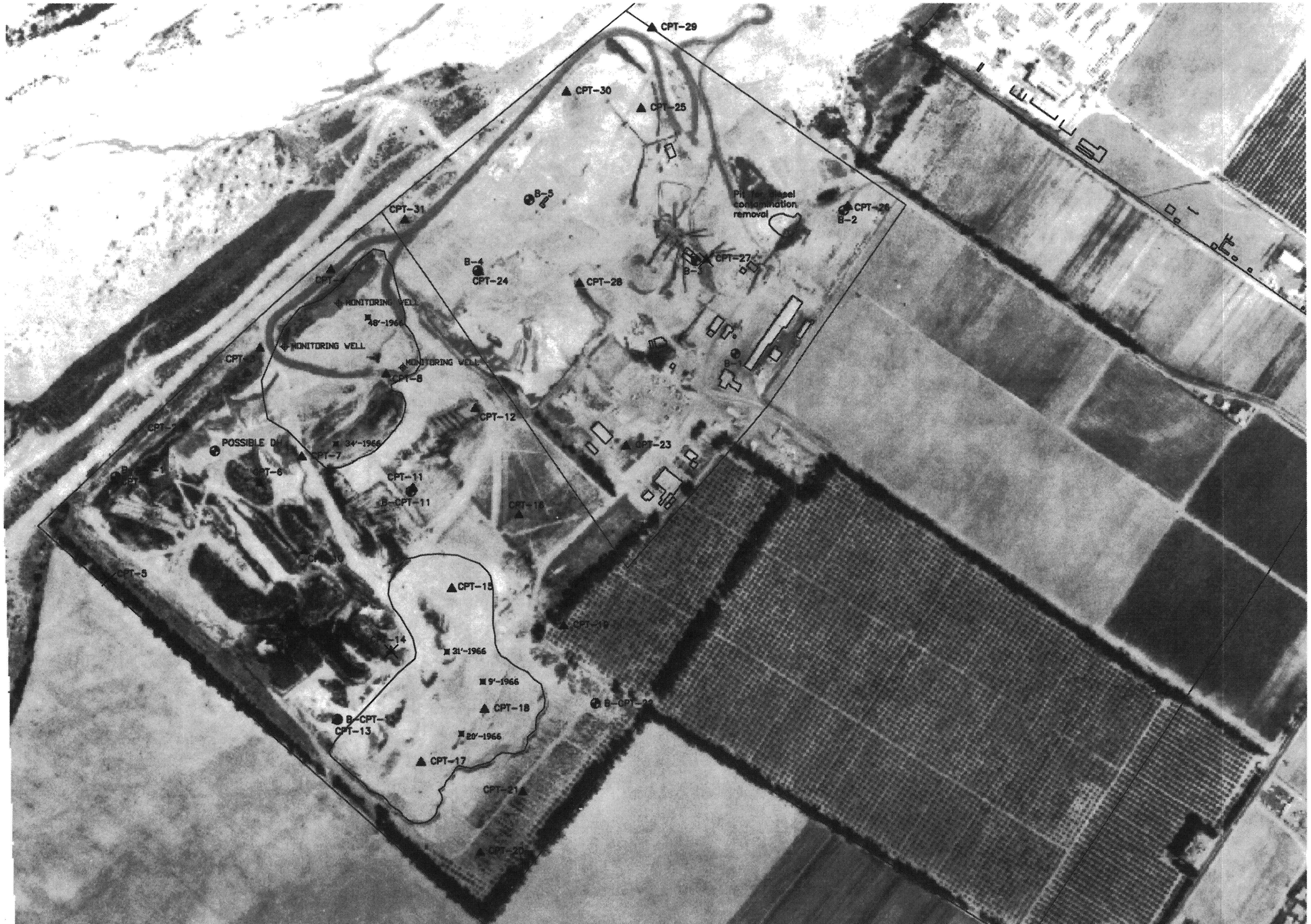
| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1965**
(9/20/65)
RiverPark B
Former S.P. Milling Property

PLATE 19




LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| (outline) | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

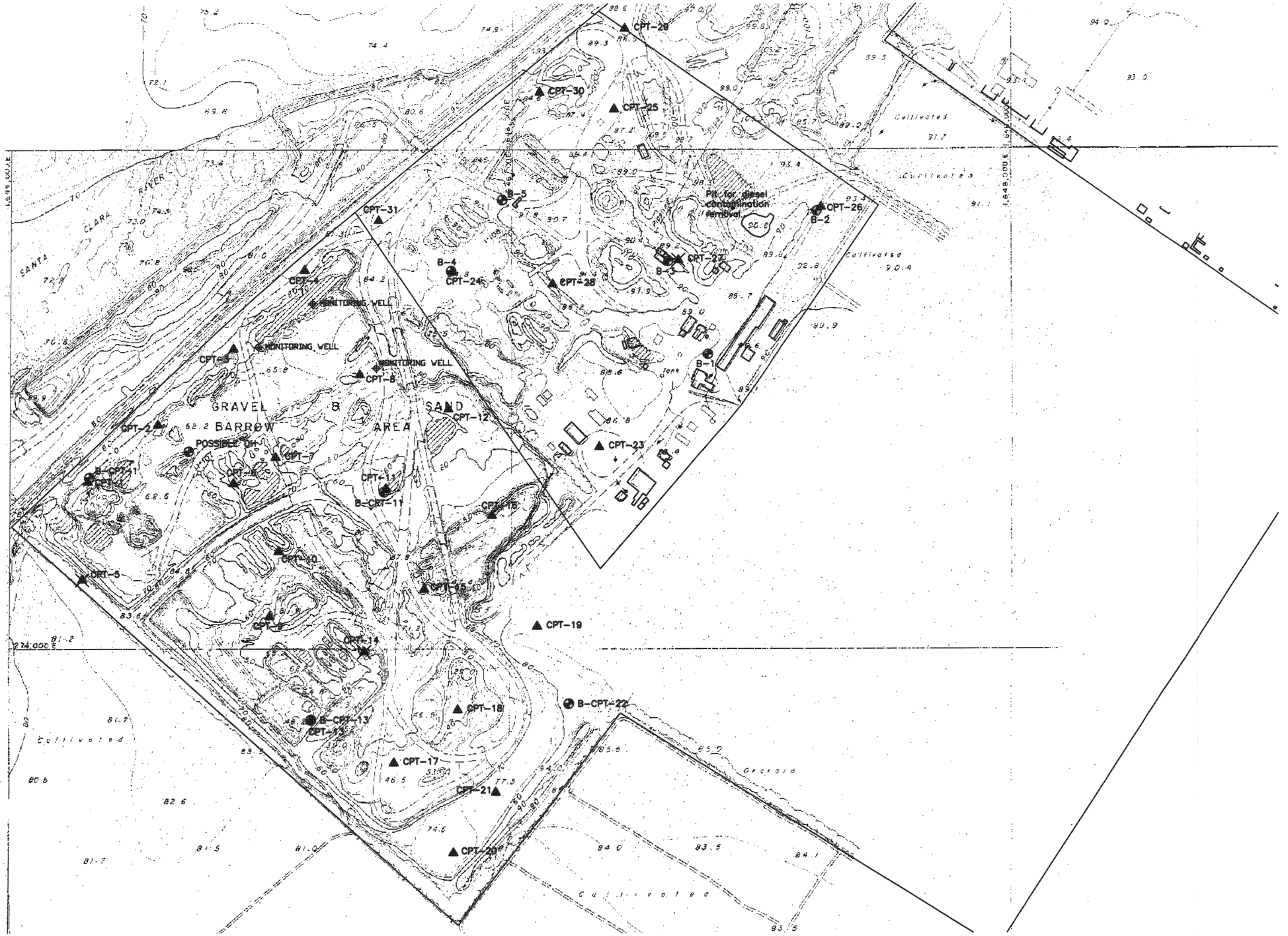
0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1966**
**(7/5/66)**
**RiverPark B**
**Former S.P. Milling Property**

**PLATE 20**

October 1999
Project No. 99-42-0021

FUGRO




LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**TOPOGRAPHY**
**OF SITE - 1967**
(3/1/67)
RiverPark B
Former S.P. Milling Property

PLATE 21

9942\0021expl.dwg(0.2-9.32),pa,0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO

9942\V0221expl.dwg(0.2-+9.31.31o),pe_0021expl_001.ctb

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1967**
**(8/12/67)**
**RiverPark B**
**Former S.P. Milling Property**

**PLATE 22**

October 1999
Project No. 99-42-0021

FUGRO

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1968**
(7/22/68)
RiverPark B
Former S.P. Milling Property

PLATE 23

9942\0021expl.dwg(0.2-9.33,33x0).ps.0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO

CPT-29
CPT-30
16
CPT-25
1,647,000 E
502,000
R5
B-5
Pit for diesel contamination removed
CPT-26
B-2
CPT-31
B-4
CPT-24
CPT-27
B-3
CPT-28
41
100
100
100
CPT-4
MONITORING WELL
MONITORING WELL
CPT-3
MONITORING WELL
CPT-8
CPT-12
CPT-2
POSSIBLE DH
CPT-7
B-CPT-1
CPT-1
ROCK
CPT-6
SAND
CPT-11
B-CPT-11
CPT-16
CPT-23
AREA
CPT-10
CPT-5
CPT-15
CPT-9
CPT-19
CPT-14
B-CPT-13
CPT-13
B-CPT-22
CPT-17
CPT-20
90
95
1,647,000 E
16
R5
49
R5
SOUTH
MONTGOMERY AVE.
2127
2127
MONTGO
TRUCK
HAUL
RD.
VINEYARD
RANCHO SANTA CLARA

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

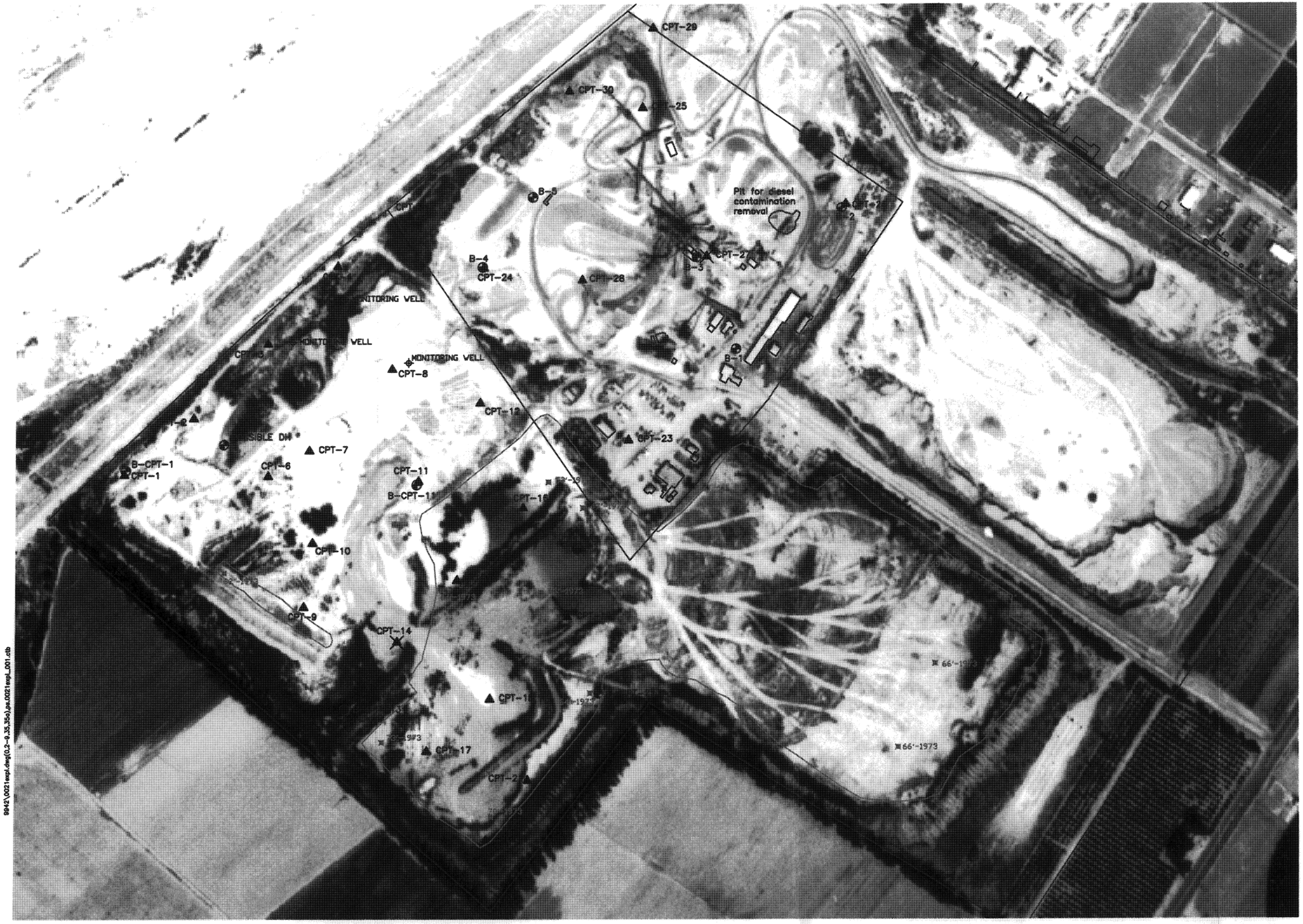
**TOPOGRAPHY OF SITE - 1970**
(10/29/70)
RiverPark B
Former S.P. Milling Property

PLATE 24

99421\0021expl.dwg(0.2-9-34).pa.0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO




99-42\0021\expl.dwg(0.2-9.35,35o),pa.0021rep1_001.ctb

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

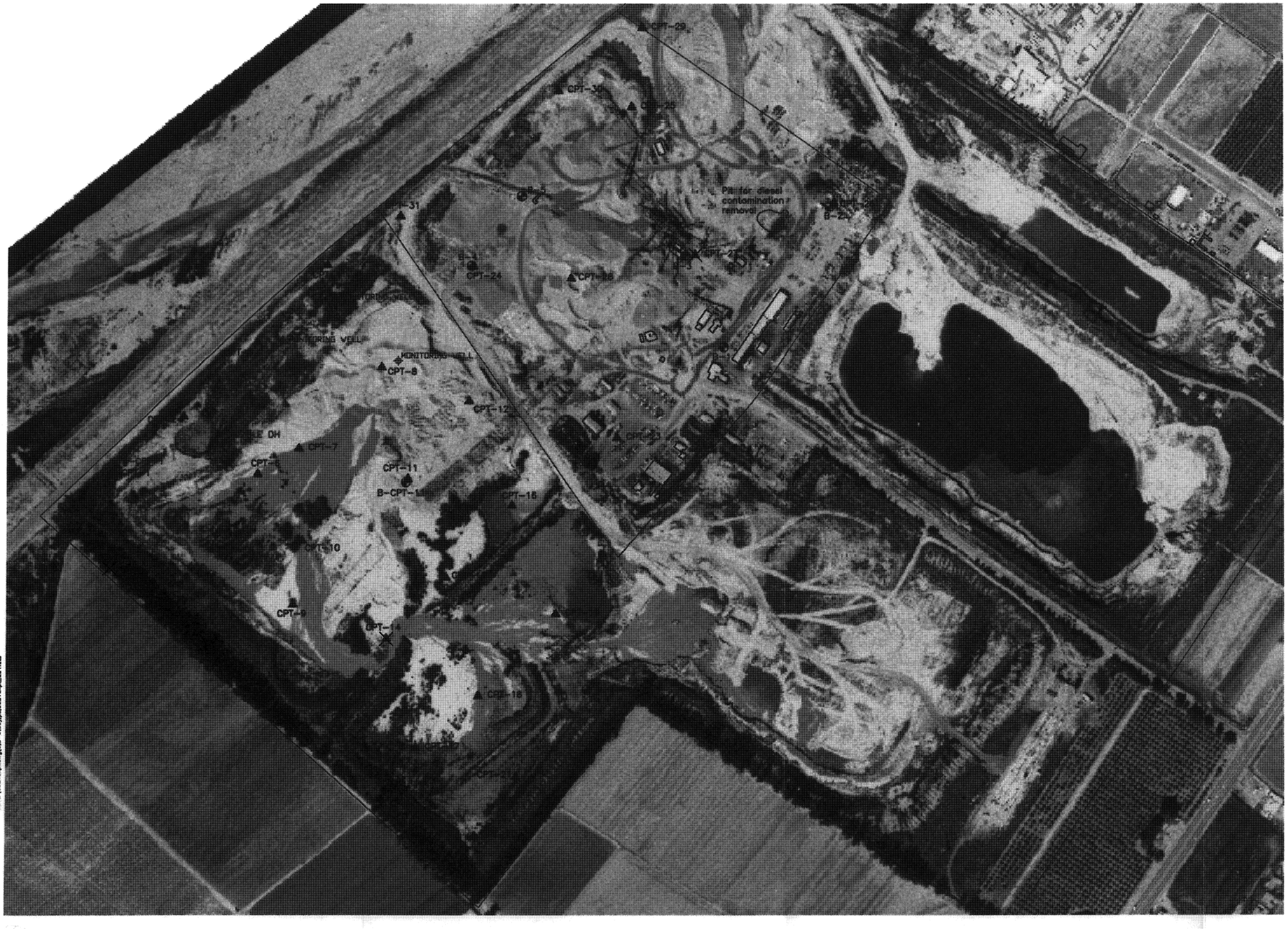
NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1973**
(8/23/73)
RiverPark B
Former S.P. Milling Property

PLATE 25

October 1999
Project No. 99-42-0021




9942\0021expl.dwg(0.2-9.36),pa,0021expl_001.ctb

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1975**
(3/17/75)
RiverPark B
Former S.P. Milling Property

PLATE 26

October 1999
Project No. 99-42-0021

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1975**
(7/29/75)
RiverPark B
Former S.P. Milling Property

PLATE 27

9942\0021expl.dwg(0.2-9.37),pa,0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

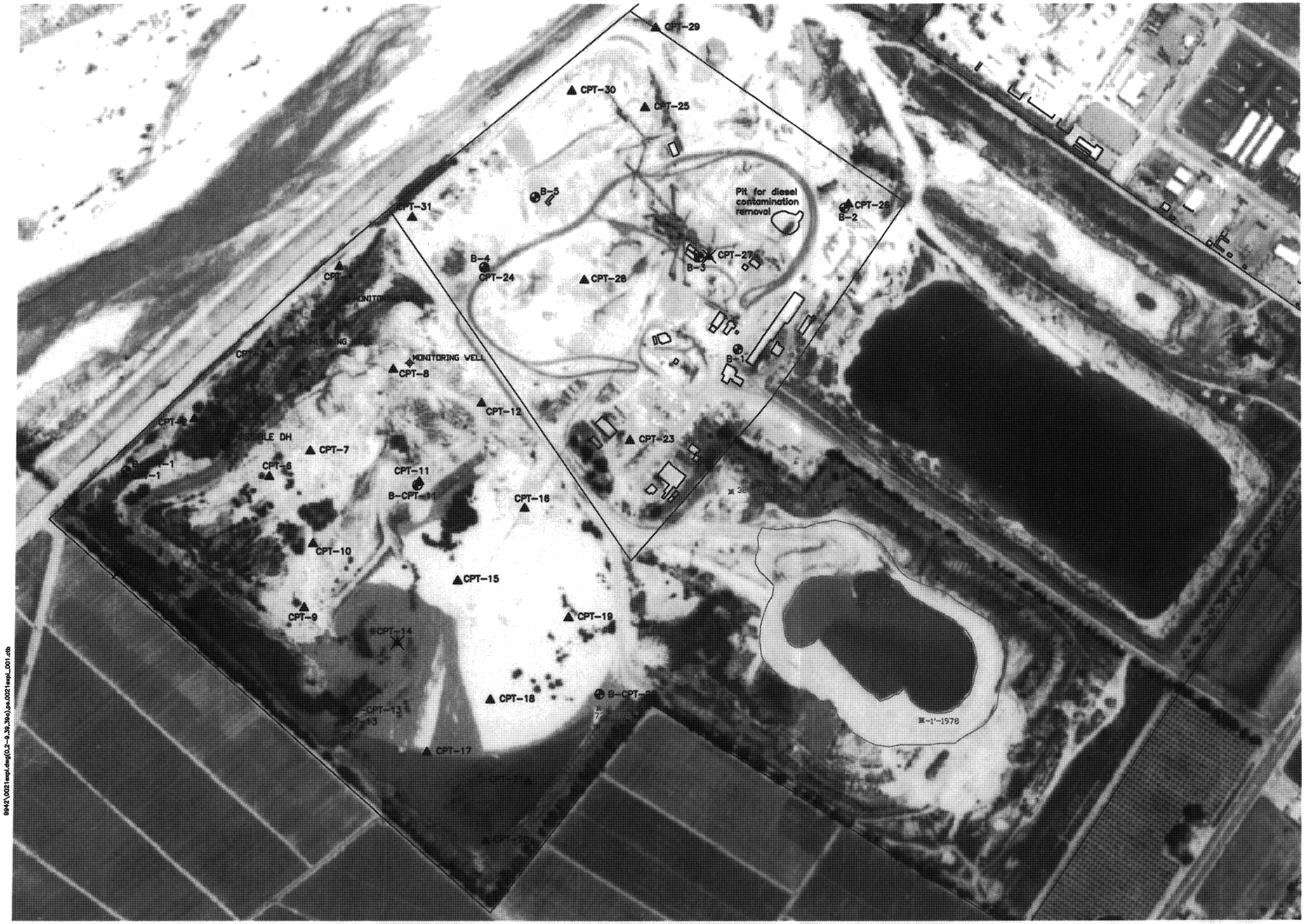
**AERIAL PHOTOGRAPH OF SITE - 1977**
(3/14/77)
RiverPark B
Former S.P. Milling Property

PLATE 28

9942\(0021expl.dwg(0.2=9.38),pe,0021expl_001.db

October 1999
Project No. 99-42-0021

FUGRO




LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

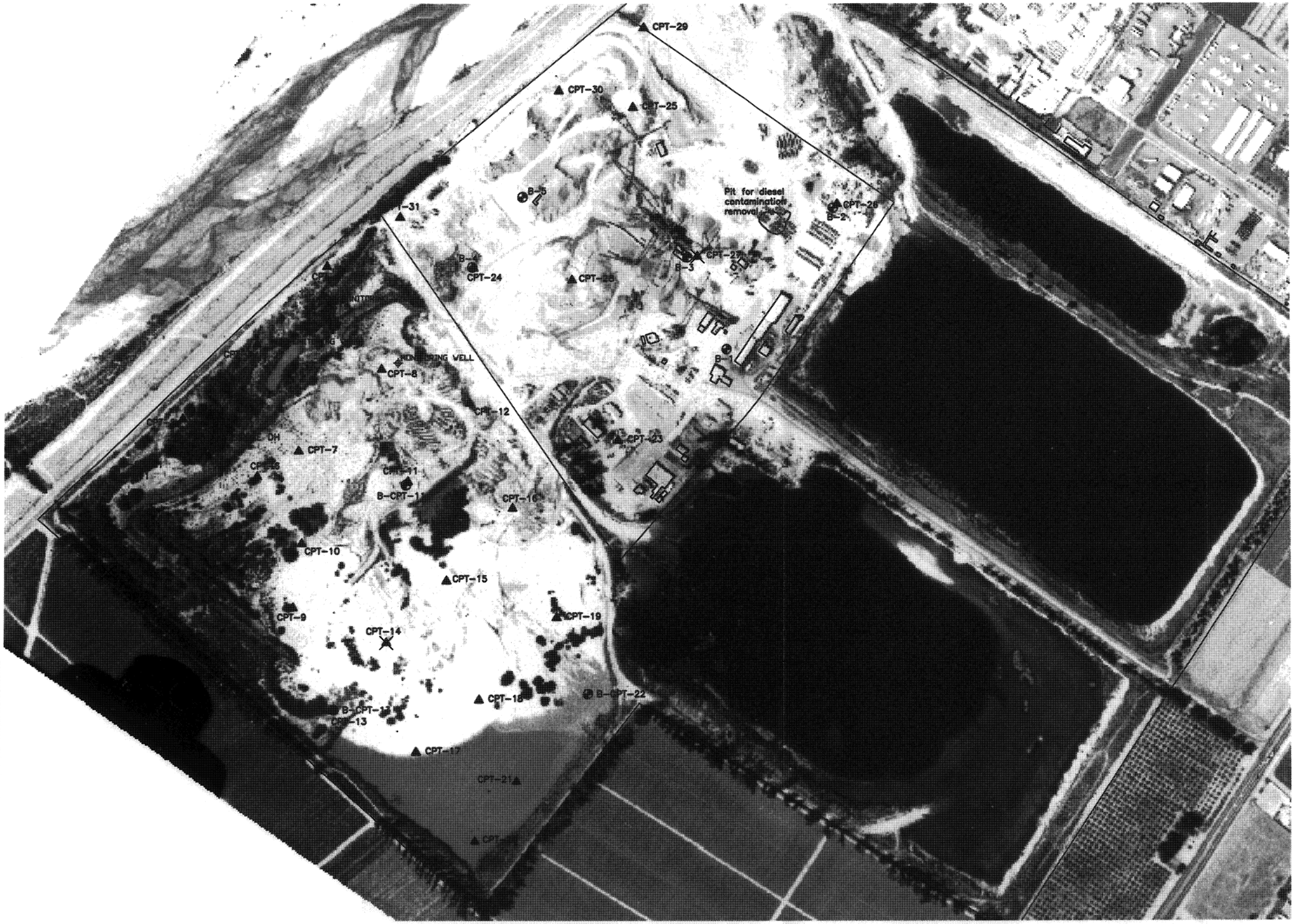
0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1978 (5/16/78) RiverPark B Former S.P. Milling Property**

PLATE 29

9942\0021espl.dwg(0.2=9.39,39e),ps.0021espl_001.ctb

October 1999
Project No. 99-42-0021




LEGEND

- DH-1 — Location of Boring
- CPT-1 — Location of CPT
- MONITORING WELL — Groundwater Monitoring Well by Padre Associates

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1979**
(7/7/79)
RiverPark B
Former S.P. Milling Property

PLATE 30

9942\0021expl.dwg(0.2=9.40),pa,0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO

9942\0021expl.dwg(0.2-9.41),pa.0021expl_001.ctb

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1981**
(6/15/81)
RiverPark B
Former S.P. Milling Property

PLATE 31

October 1999
Project No. 99-42-0021

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

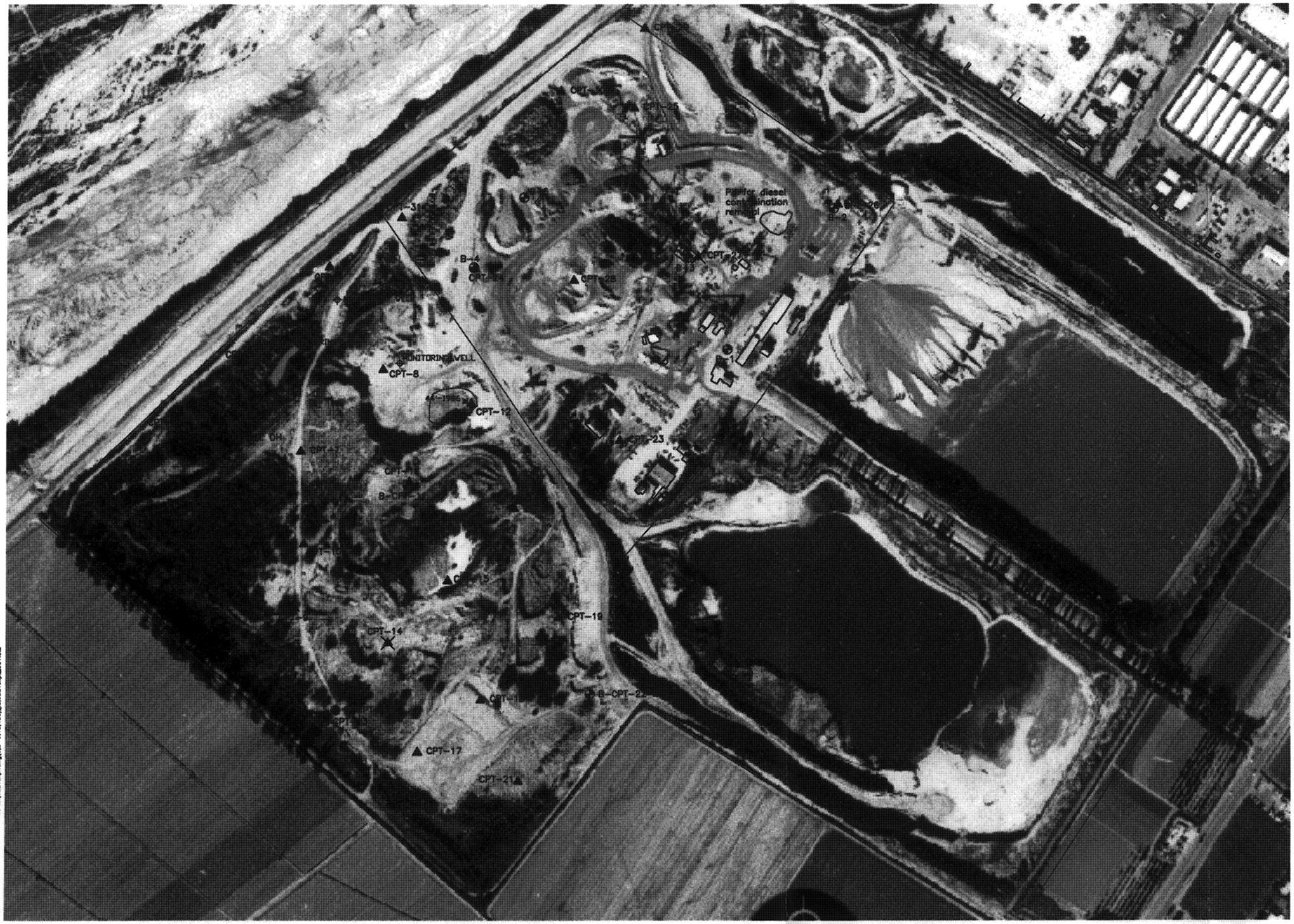
**AERIAL PHOTOGRAPH**
**OF SITE - 1984**
(1/11/84)
RiverPark B
Former S.P. Milling Property

PLATE 32

9942\0021expl.dwg(0.2--0.42),pa,0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO




LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1986**
**(12/10/86)**
**RiverPark B**
**Former S.P. Milling Property**

**PLATE 33**

9942\0021expl.dwg(0.2=9.43,43o),ps.0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

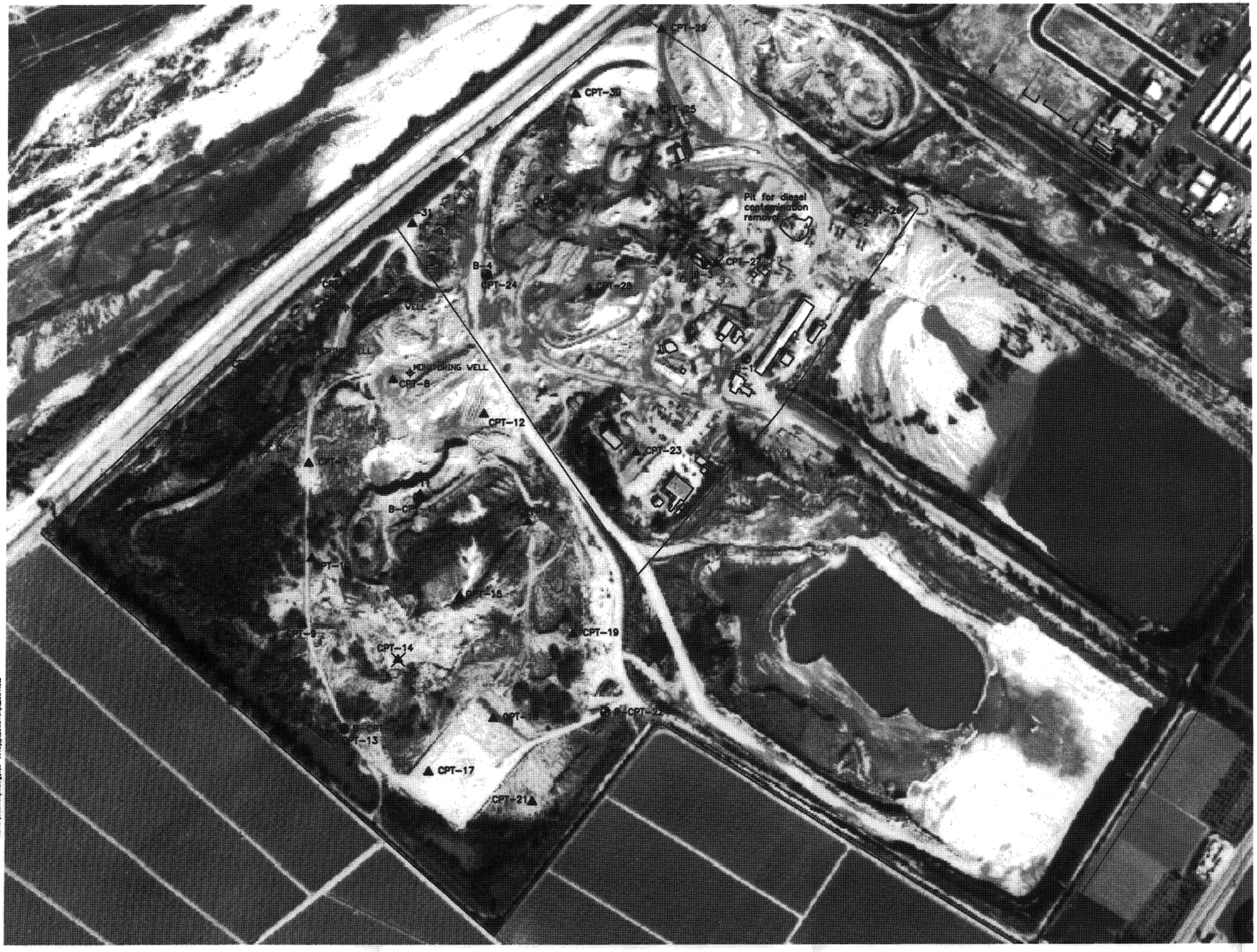
0 200 400 800
FEET

**AERIAL PHOTOGRAPH**
**OF SITE - 1987**
(1/12/87)
RiverPark B
Former S.P. Milling Property

PLATE 34

9942\0021expl.dwg(0.2-9.44),pa,0021expl_001.ctb

October 1999
Project No. 99-42-0021




LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH**
**OF SITE - 1988**
**(1/20/88)**
**RiverPark B**
**Former S.P. Milling Property**

PLATE 35

9942\0021expl.dwg(0.2=9.45),pa,0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1988**
(10/10/88)
RiverPark B
Former S.P. Milling Property

PLATE 36

9942\(0221wpl.dwg(0.2=9.46),pa,0221wpl_001.ctb

October 1999
Project No. 99-42-0021

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1989**
(5/23/89)
RiverPark B
Former S.P. Milling Property

PLATE 37

9942\0021sepl.dwg(0.2=9.47),pa.0021sepl_001.ctb

October 1999
Project No. 99-42-0021

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH**
**OF SITE - 1990**
(11/8/90)
RiverPark B
Former S.P. Milling Property

PLATE 38

9942\0021expl.dwg(0.2=0.48),pa,0021expl_001.ctb

October 1999
Project No. 99-42-0021

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

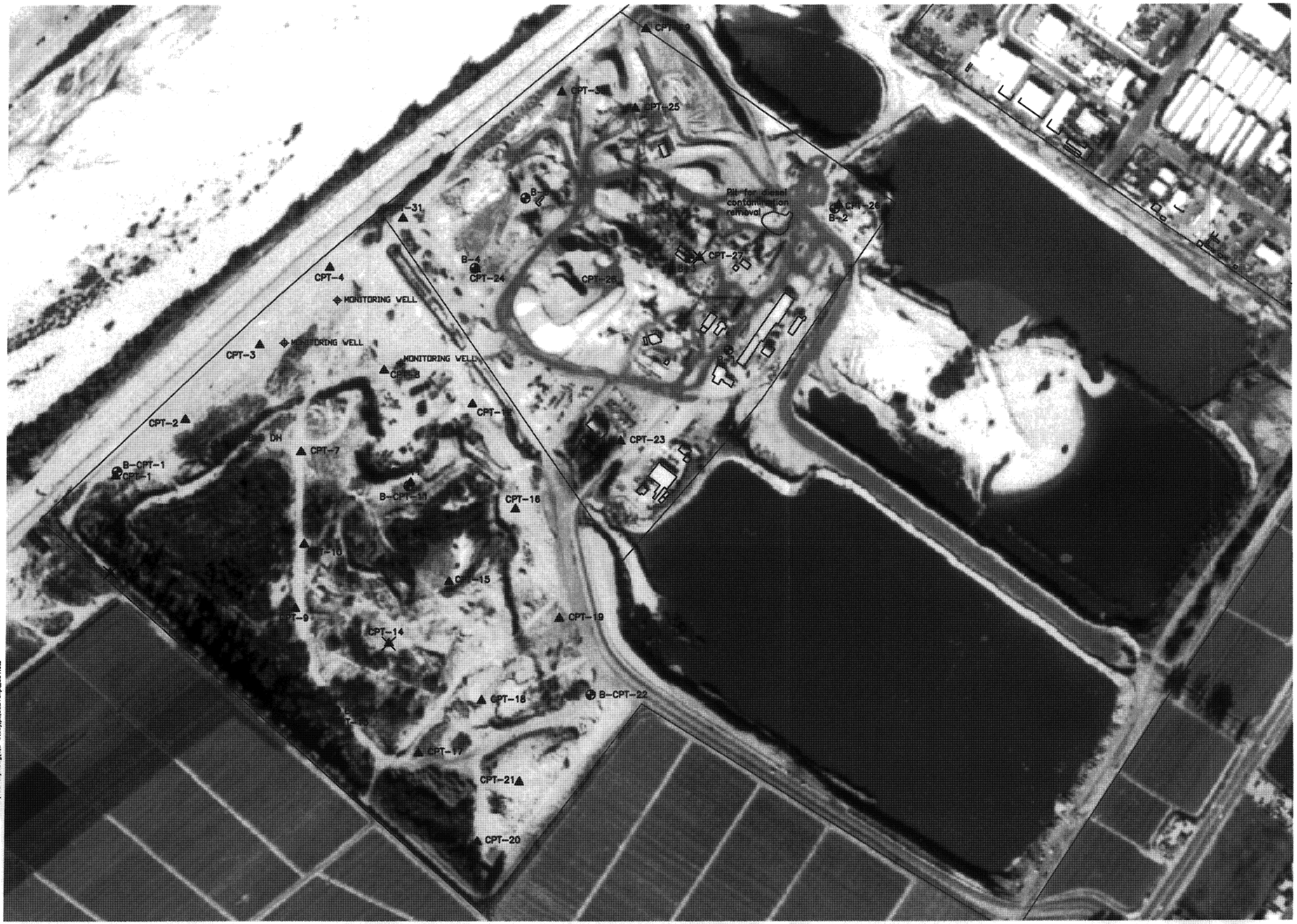
**AERIAL PHOTOGRAPH OF SITE - 1992**
(9/19/92)
RiverPark B
Former S.P. Milling Property

PLATE 39

9942\0021expl.dwg(0.2-9.49),pe,0021expl_001.ctb

October 1999
Project No. 99-42-0021

FUGRO




9842\0021expl.dwg(0.2=9.50),pc.0021expl_001.ctb

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

**AERIAL PHOTOGRAPH**
**OF SITE - 1993**
(12/29/93)
RiverPark B
Former S.P. Milling Property

PLATE 40

LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

0 200 400 800
FEET

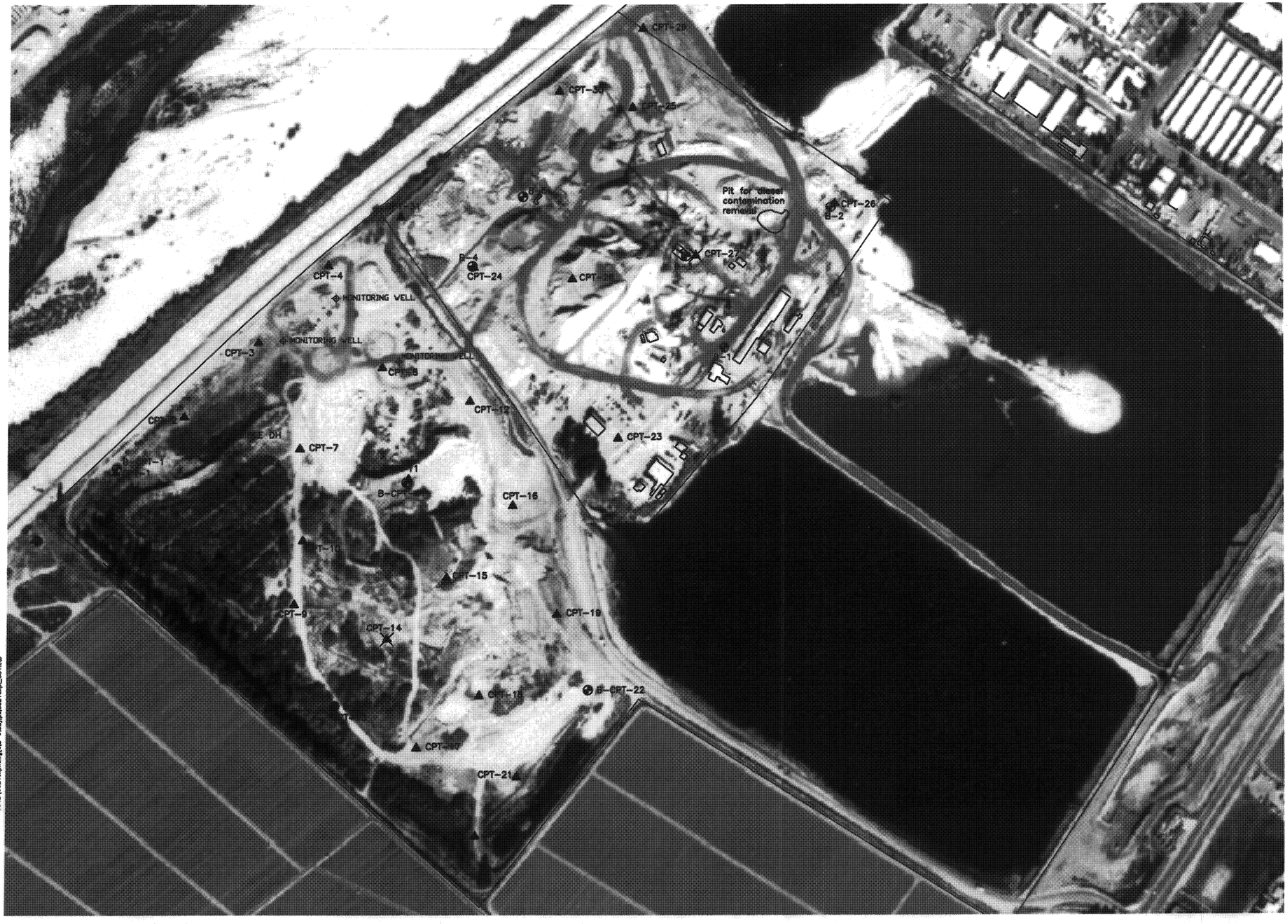
**AERIAL PHOTOGRAPH OF SITE - 1994**
(2/24/94)
RiverPark B
Former S.P. Milling Property

PLATE 41

9942\0021expl.dwg(0.2-9.51),pe,0021expL_001.ctb

October 1999
Project No. 99-42-0021

FUGRO




LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |

NORTH

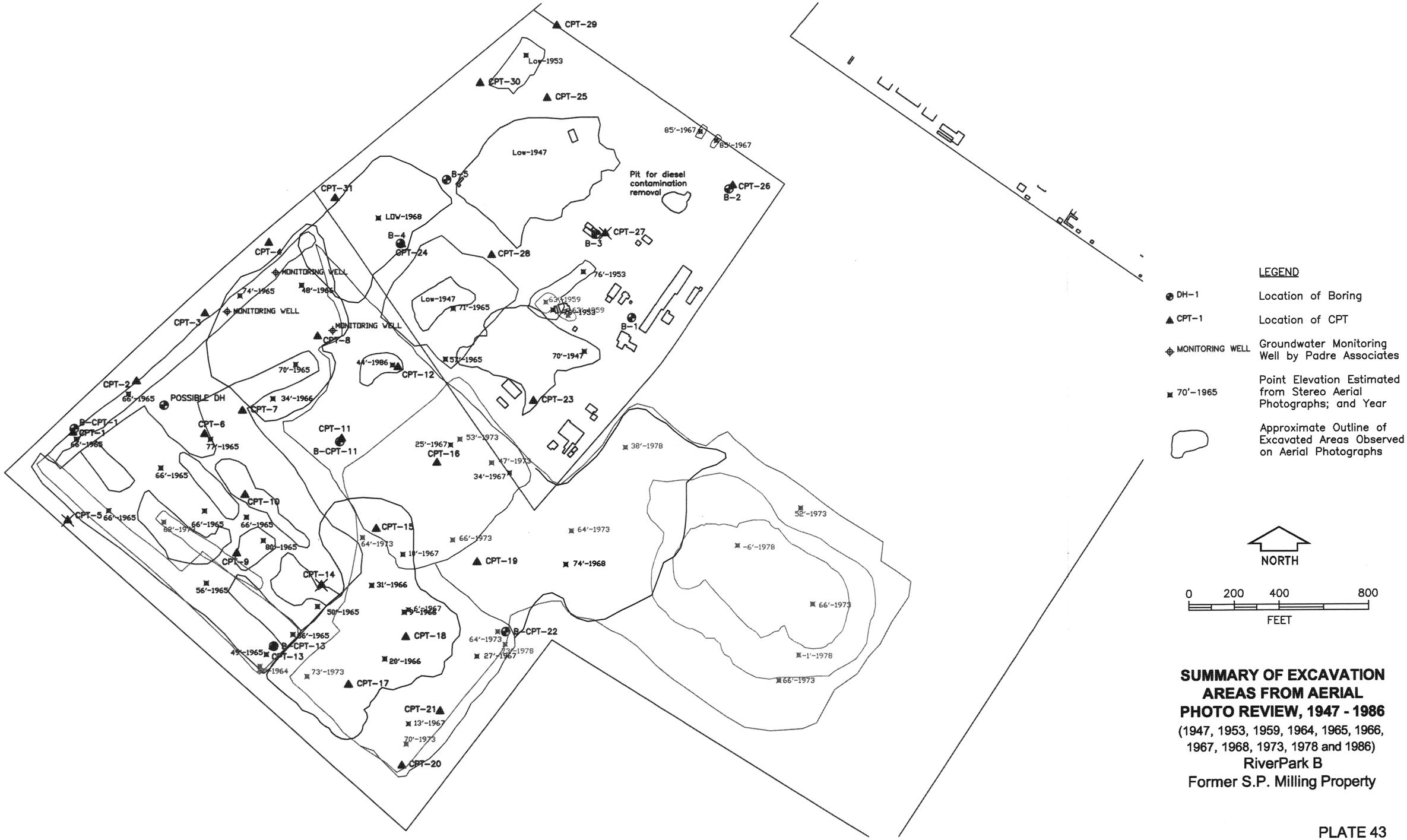
0 200 400 800
FEET

**AERIAL PHOTOGRAPH OF SITE - 1996**
(1/8/96)
RiverPark B
Former S.P. Milling Property

PLATE 42

9942\0021expl.dwg(0.2--9.52),pa,0021expl_001.ctb

October 1999
Project No. 99-42-0021




LEGEND

| | |
|---|---|
| DH-1 | Location of Boring |
| CPT-1 | Location of CPT |
| MONITORING WELL | Groundwater Monitoring Well by Padre Associates |
| 70'-1965 | Point Elevation Estimated from Stereo Aerial Photographs; and Year |
| | Approximate Outline of Excavated Areas Observed on Aerial Photographs |

NORTH

0 200 400 800
FEET

**SUMMARY OF EXCAVATION AREAS FROM AERIAL PHOTO REVIEW, 1947 - 1986**

(1947, 1953, 1959, 1964, 1965, 1966, 1967, 1968, 1973, 1978 and 1986)

RiverPark B
Former S.P. Milling Property

PLATE 43

9942\0021expl.dwg(0,2-9,20o,21o,22a,28o,29a,30o,31o,33o,35o,39a,43o),ps,0021expl_001.ctb

# APPENDIX A
# SUBSURFACE EXPLORATION

# APPENDIX A
# SUBSURFACE EXPLORATION

## Introduction

The contents of this appendix shall be integrated with the geotechnical engineering study of which it is a part. They shall not be used in whole or in part as a sole source for information or recommendations regarding the subject site.

## Field Study

The subsurface conditions at the stockpile and plant areas of the former S.P. Milling Company Plant were explored by the excavation and sampling of 9 hollow-stem-auger borings and the advancement of 29 cone penetrometer test (CPT) soundings. The approximate exploration locations are shown on Plate 3. CPT and borings were located using a Trimble Pathfinder PRO-XR GPS beacon receiver. Positions were estimated by averaging about 12 5-second measurements at each location. Carrier-phase processing techniques were used to differentially correct the data. The resulting locations have an estimated horizontal accuracy (95 percent probability) of about 2 to 4 feet. Their locations should be considered accurate only to the degree implied by the method used.

**Cone Penetration Tests.** The CPT soundings were performed by Gregg In-Situ, Inc. of Signal Hill, California, and ranged from about 15 to 70 feet in depth. (CPT-27 met refusal at a depth of 1 foot after five attempts.) The CPTs were performed to provide nearly continuous subsurface data at each location for evaluating the engineering characteristics of the subsurface soils. The logs of the CPT soundings are presented as Plates A-1.1 through A-1.29. A soil classification chart is presented on Plate A-1.30 - CPT Classification Chart.

The CPT is mounted on a 20-ton truck and consists of a 38 millimeter-diameter rod with a 10-square-centimeter, 60-degree-apex-angle cone at the base. The cone has a tip area of 15 square centimeters. And, friction sleeve area of 225 square centimeters. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.85. The cone is equipped with electronic load cells that measure both point resistance and frictional resistance between the soils and the cylinder side of the cone. For this study, a cone equipped with a pore pressure transducer, known as a piezocone, was utilized to measure pore pressures during penetration. The pore pressure transducer is located on the friction sleeve part of the cone. The primary purpose of performing CPTs were to provide a nearly continuous log of the earth materials and soil stratigraphy between drill hole locations and sample depths.

Although many factors influence CPT profiles, including: physical cone properties, vertical effective stress, pore pressure, soil compressibility and fabric, and depositional characteristics, the classifications are generally consistent with the laboratory classification data

and with the visual descriptions made during the soil borings (Plate A-1.30 presents one example of soil classification using CPT data).

**Pore Pressure Dissipation Tests.** Plate A-1.31 through A-1.34 - Pore Pressure Dissipation Record, presents the results of pore pressure dissipation tests that were performed in CPT- 2, CPT-9, CPT-15, and CPT-24. The dissipation tests were performed by stopping the advancement at a designated depth and measuring the pore pressure response with time until a relatively constant pressure is attained.

**Drilling and Sampling.** A total of nine borings were advanced to depths ranging from about 28 to about 51 feet on August 25 through 27, 1999. The borings were excavated with a truck-mounted CME 85 drilling rig supplied by A&R Drilling, Inc., of Gardena, California. The borings were backfilled with the native cuttings.

The borings were sampled at approximate 2-1/2-foot intervals in the upper 6 feet (plant area only) and approximate 5-foot intervals below 10 feet (below ground surface in stockpile area) to the completion depth. Samples were extracted from the subsurface using a 2-3/8-inch-inside-diameter (ID) Modified California sampler above the groundwater level (as encountered) and with a 1-1/2-inch-ID standard penetration test (SPT) split-spoon sampler below the groundwater level. The samplers were driven by a 140-pound automatic-trip hammer free falling from a height of 30 inches. Samples of fine-grained materials were also obtained with 3-inch-O.D. Shelby tubes advanced by the hydraulic system of the drilling rig. With Shelby tubes, relatively undisturbed samples (relative to samples obtained using SPT or California liner samplers) can be obtained for laboratory testing. Minimizing sample disturbance of fine-grained soft soil samples is especially critical for consolidation testing.

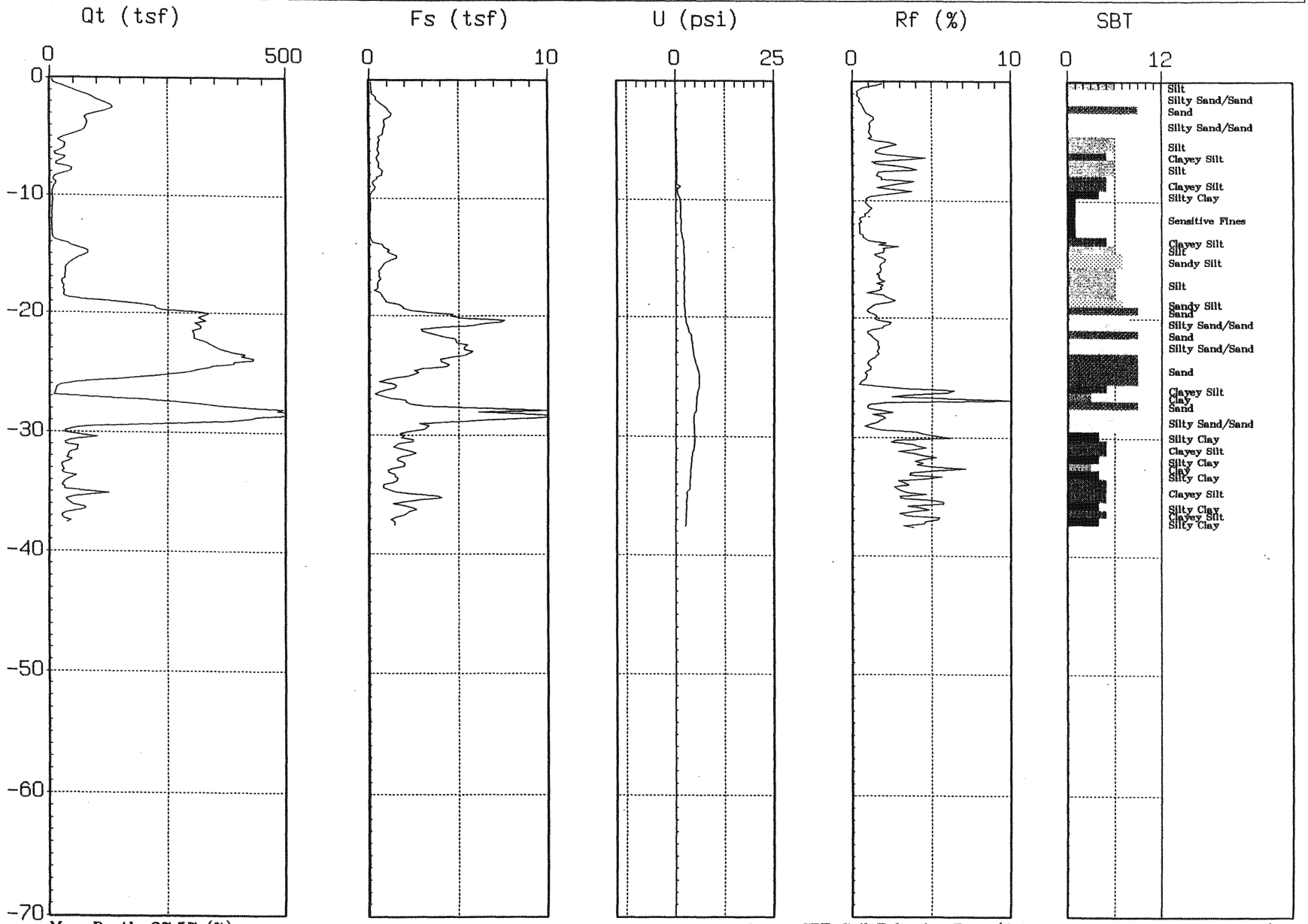
The logs of the borings describe the earth materials encountered, sampling method used, and field and laboratory tests performed. The logs also show the location, boring number, date of start and completion, and the name of the logger and drilling subcontractor. The borings were logged by a staff geologist using ASTM D2487 for visual classification of soils. The boundaries between soil types shown on the logs are approximate because the transition between different soil layers may be gradual and may change with time. The logs of the borings are presented as Plates A-2.1 through A-2.9 - Log of Boring. A legend to the logs is presented on Plate A-2.10 - Key to Terms & Symbols Used on Logs.

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-1

Prj. Manager : C. WOCKNER
Date : 08:23:99 12:50




Max. Depth: 37.57 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

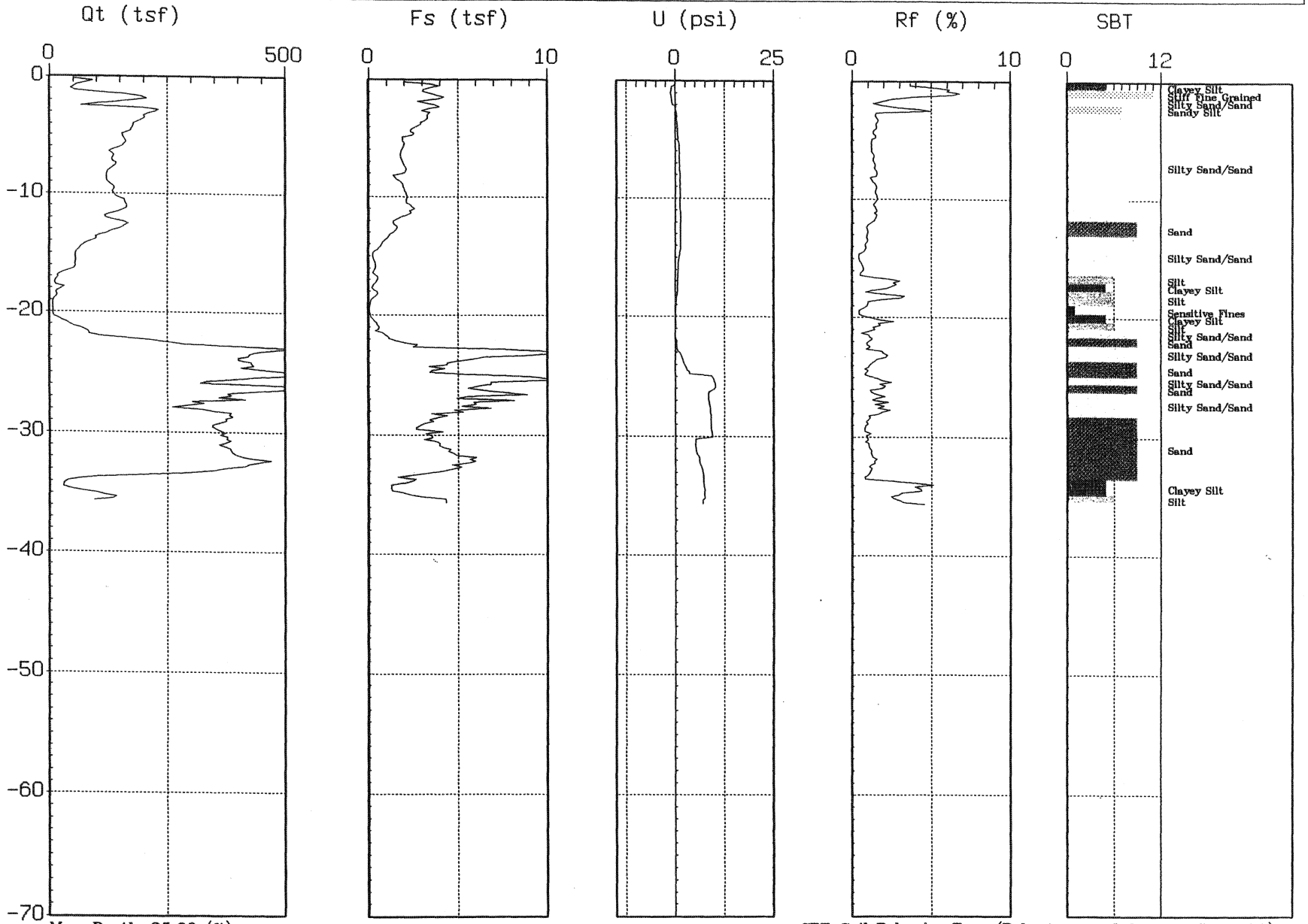
PLATE A.1

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-2

Prj. Manager : C. WOCKNER
Date : 08:23:99 12:03




Max. Depth: 35.60 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

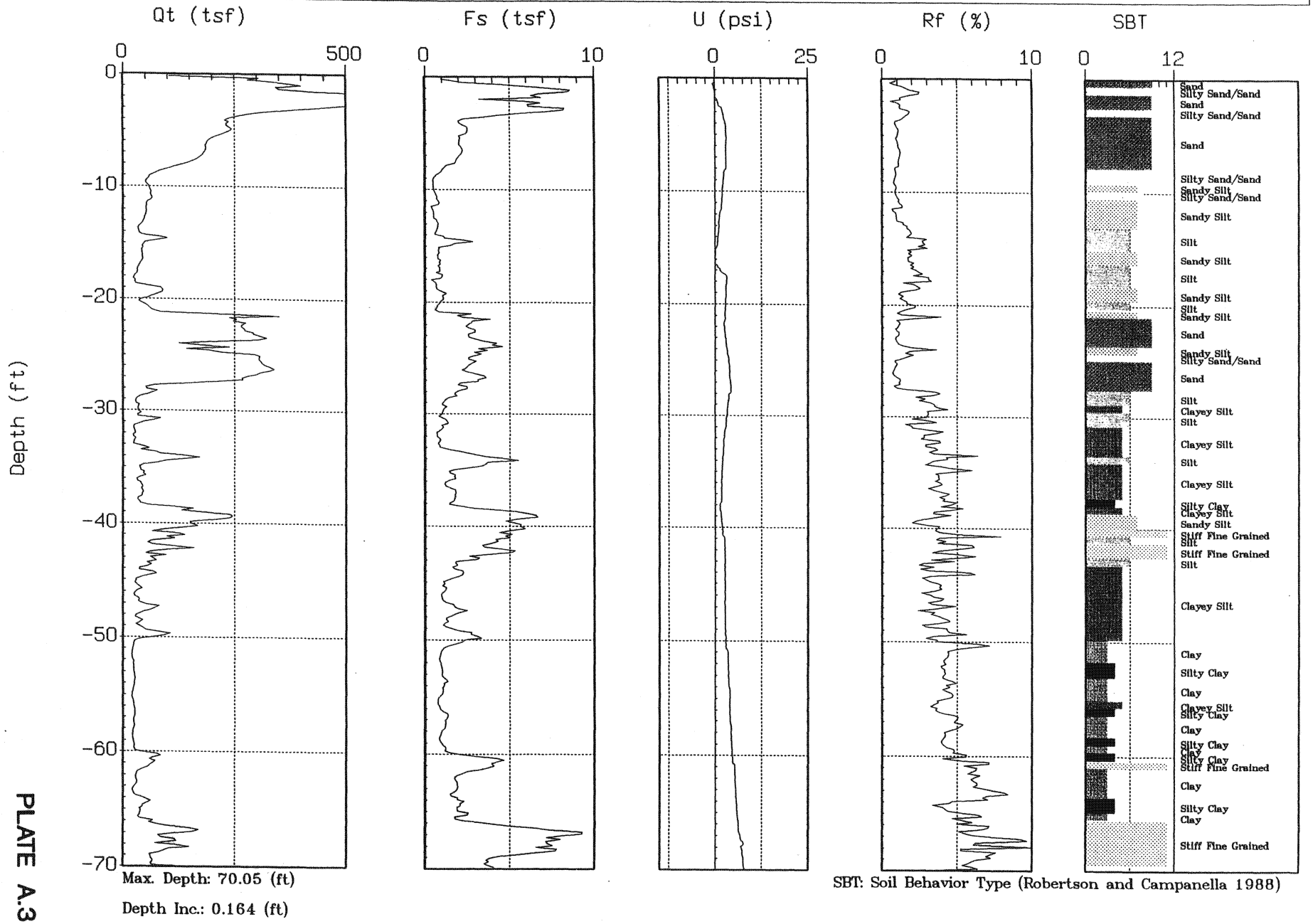
PLATE A.2

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-3

Prj. Manager : C. WOCKNER
Date : 08:23:99 11:12




Max. Depth: 70.05 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

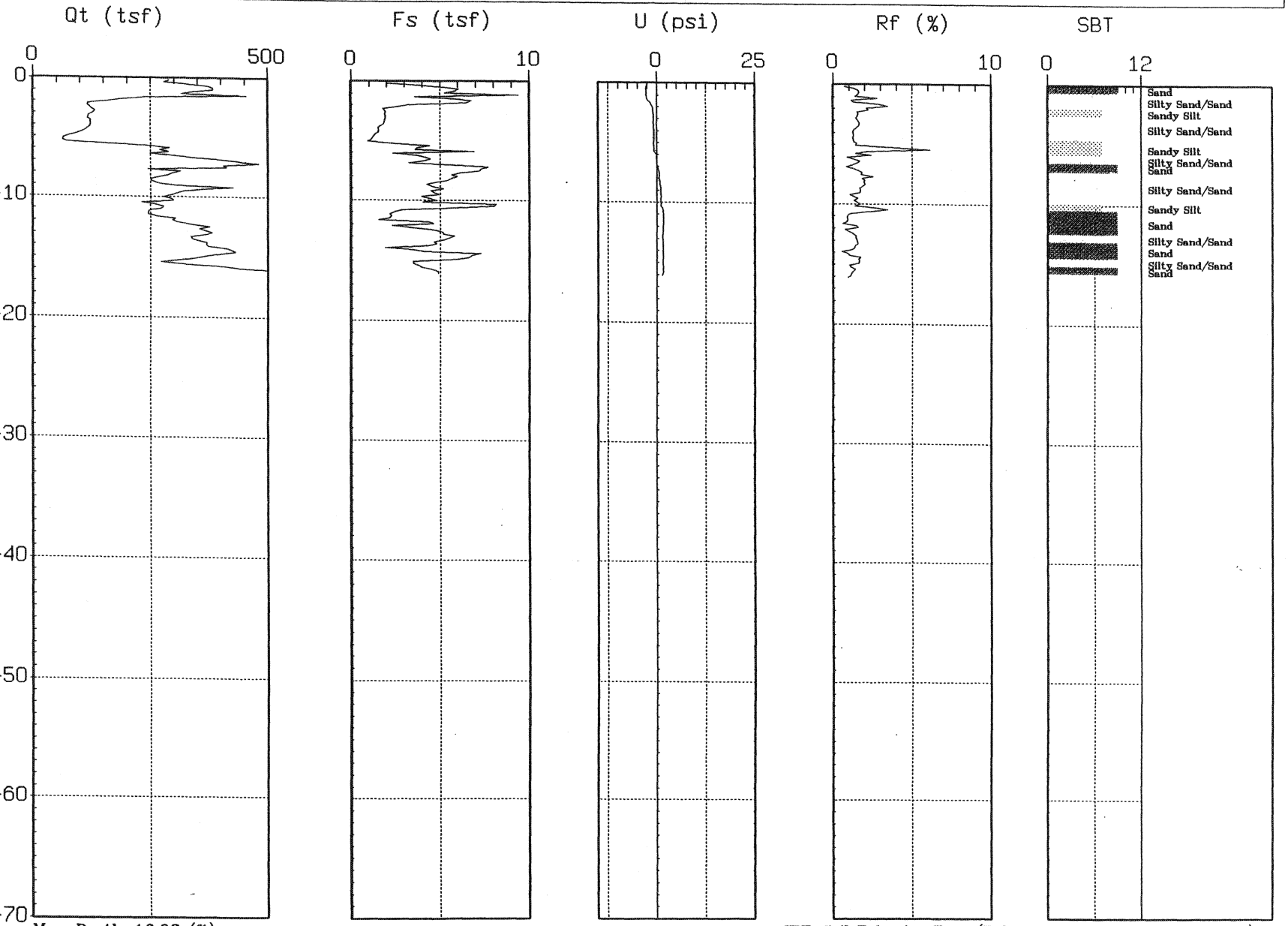
PLATE A.3

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-4

Prj. Manager : C. WOCKNER
Date : 08:23:99 13:38




Max. Depth: 16.08 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

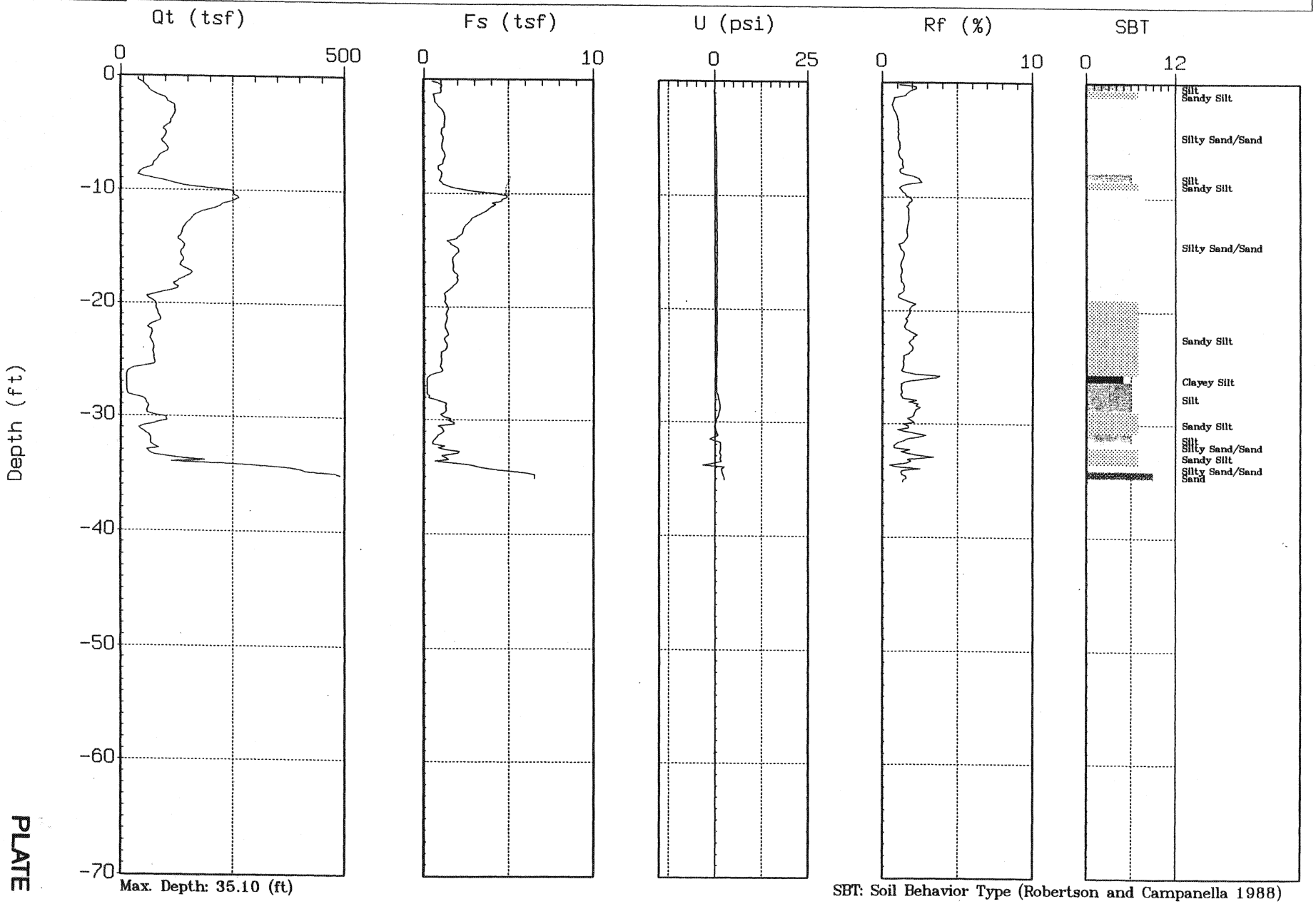
PLATE A.4

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-6

Prj. Manager : C. WOCKNER
Date : 08:24:99 08:15




Max. Depth: 35.10 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

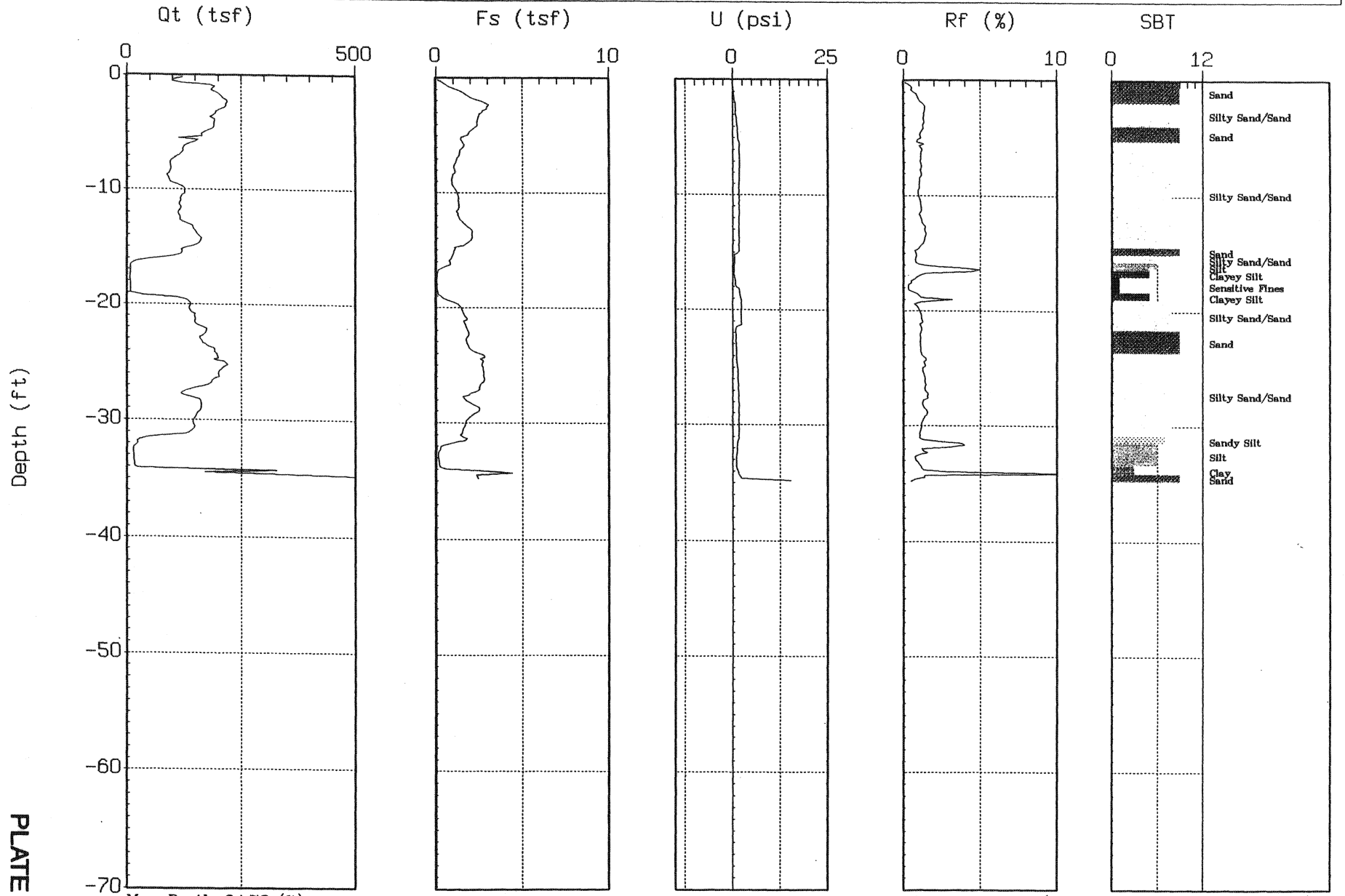
PLATE A.5

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-7

Prj. Manager : C. WOCKNER
Date : 08:23:99 10:05




Max. Depth: 34.78 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

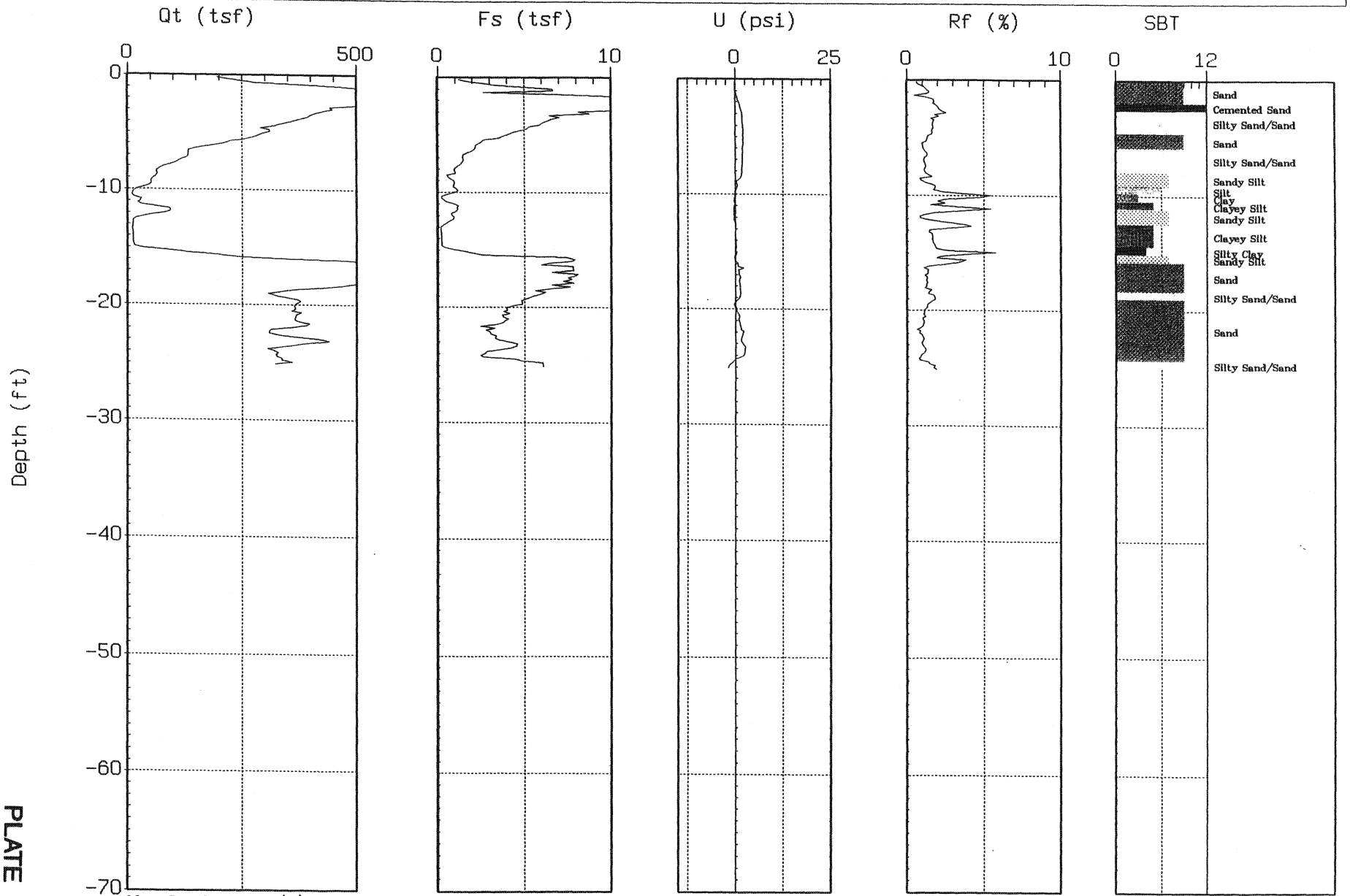
PLATE A.6

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-8

Prj. Manager : C. WOCKNER
Date : 08:23:99 14:06




Max. Depth: 25.10 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

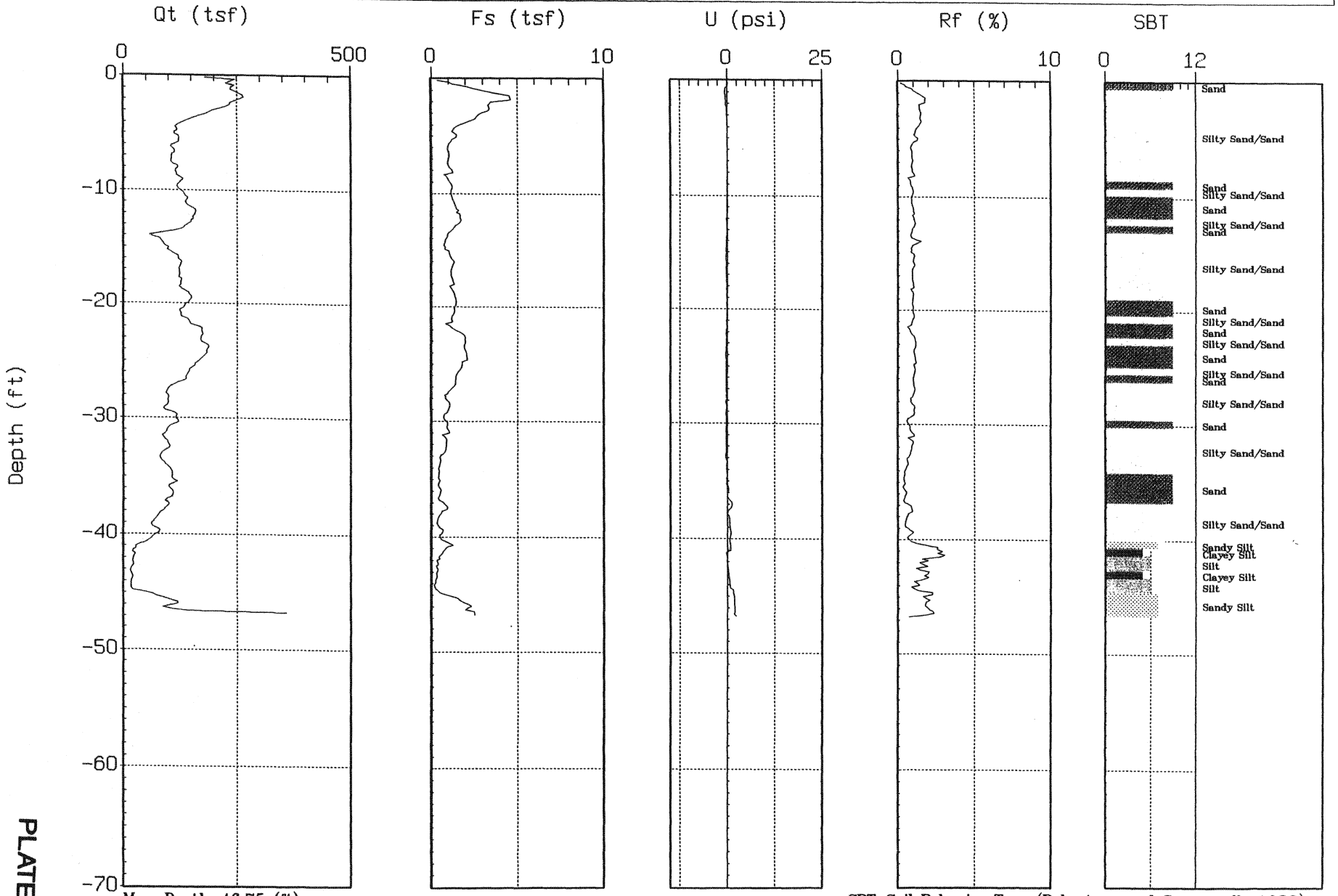
PLATE A.7

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-9

Prj. Manager : C. WOCKNER
Date : 08:23:99 09:15




Max. Depth: 46.75 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

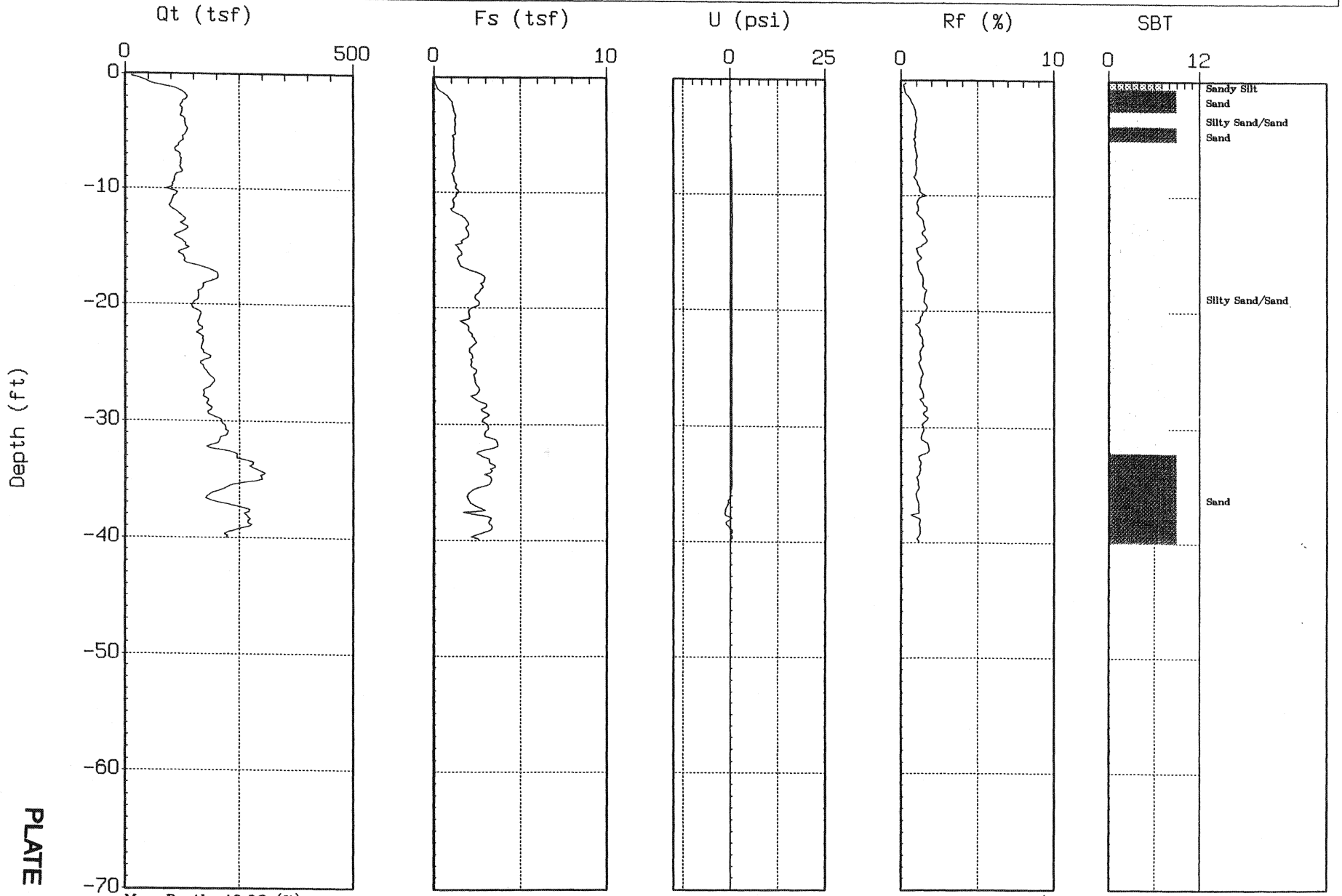
PLATE A.8

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-10

Prj. Manager : C. WOCKNER
Date : 08:24:99 08:52




Max. Depth: 40.03 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

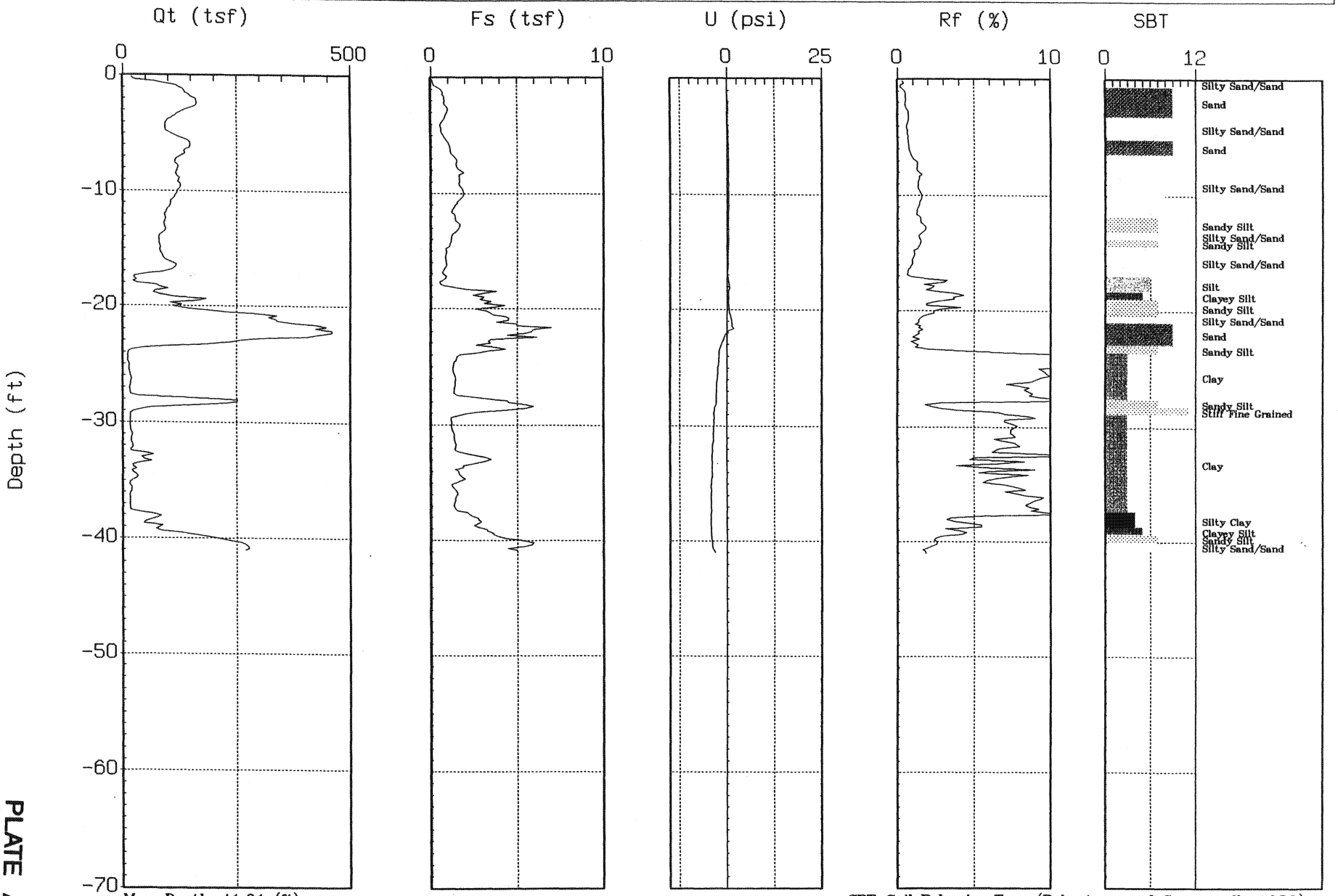
PLATE A.9

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-11

Prj. Manager : C. WOCKNER
Date : 08:23:99 14:31




Max. Depth: 41.01 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

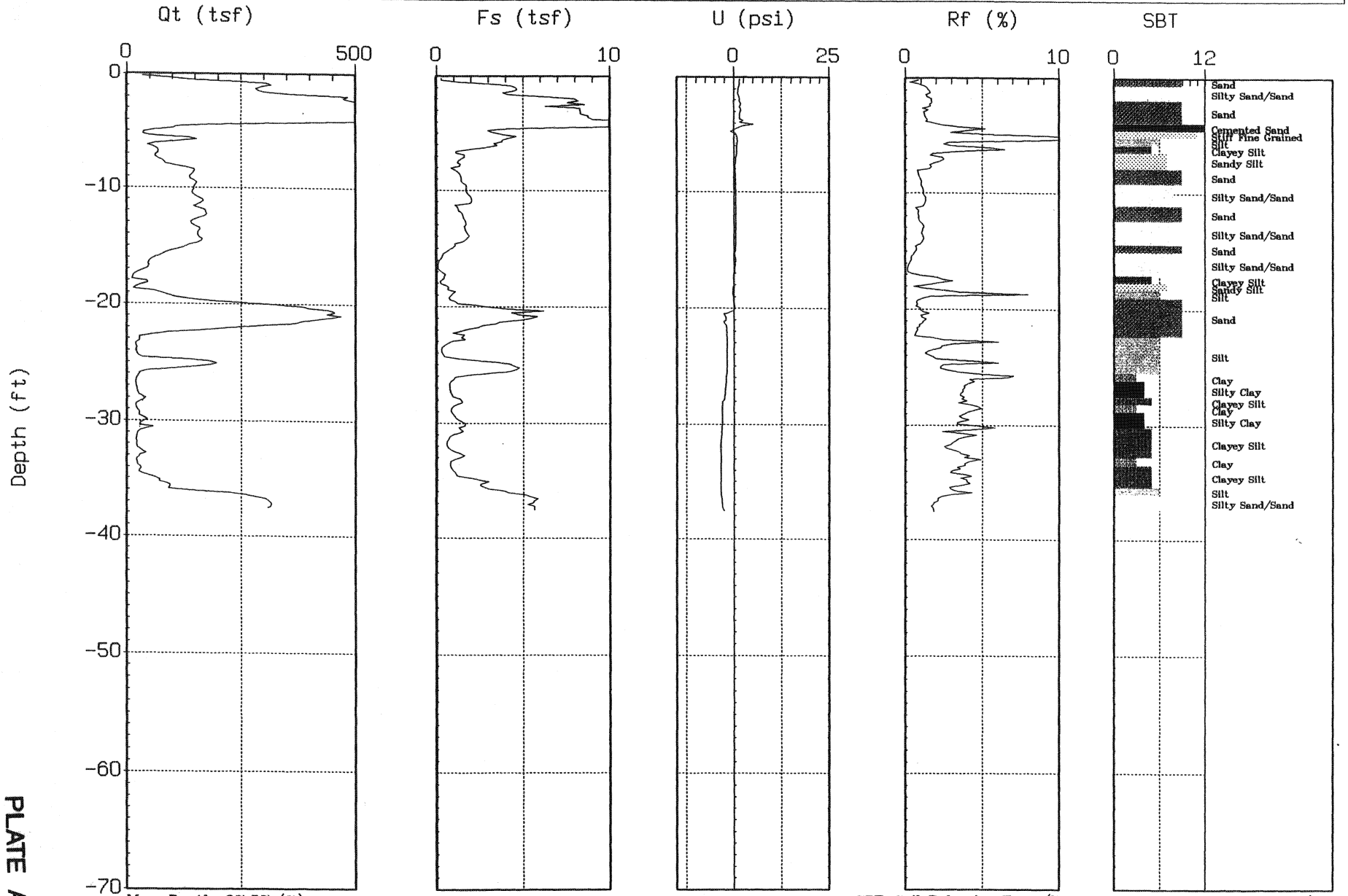
PLATE A.10

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-12

Prj. Manager : C. WOCKNER
Date : 08:24:99 06:19




Max. Depth: 37.57 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

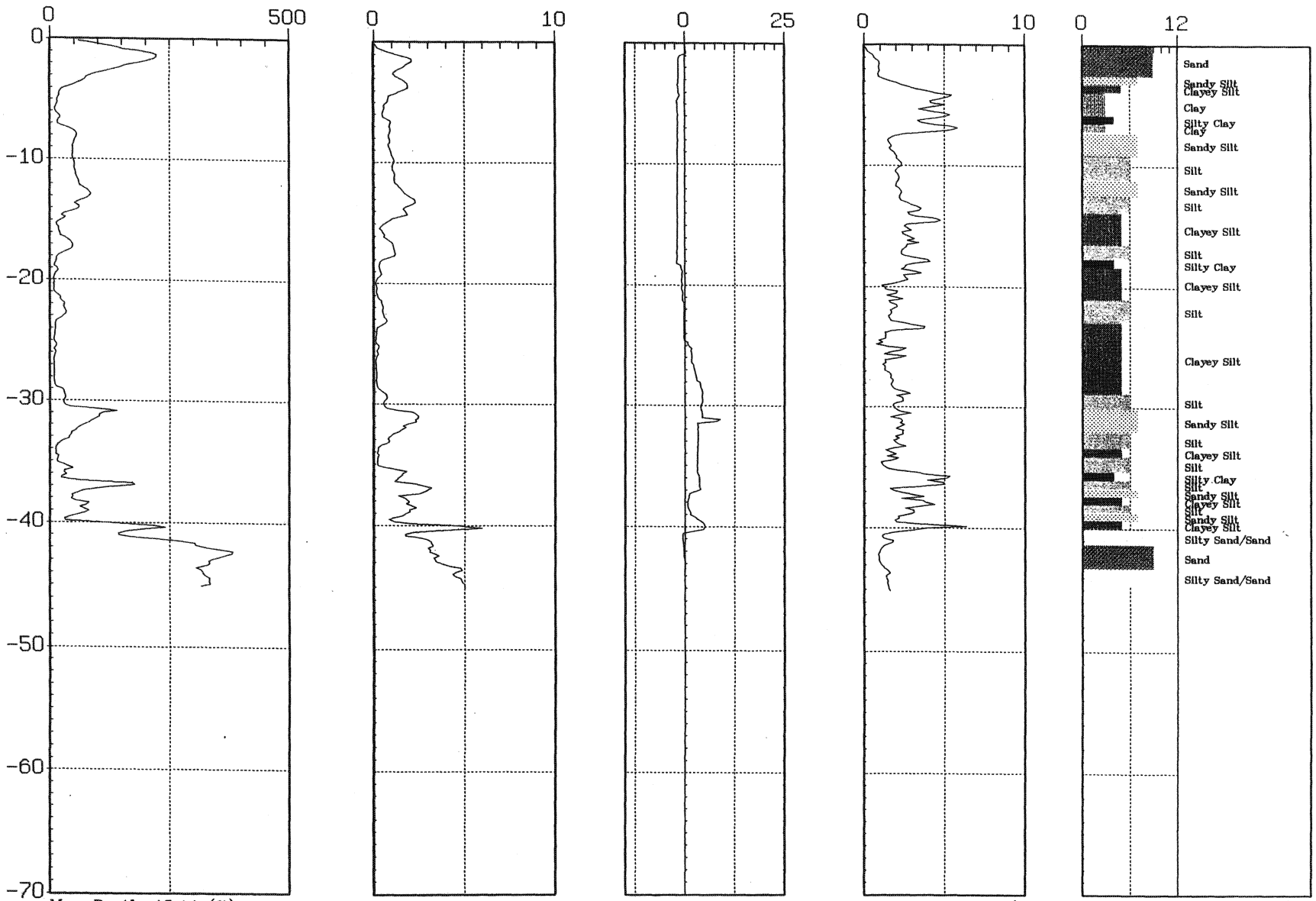
PLATE A.11

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-13

Prj. Manager : C. WOCKNER
Date : 08:23:99 08:45




Max. Depth: 45.11 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

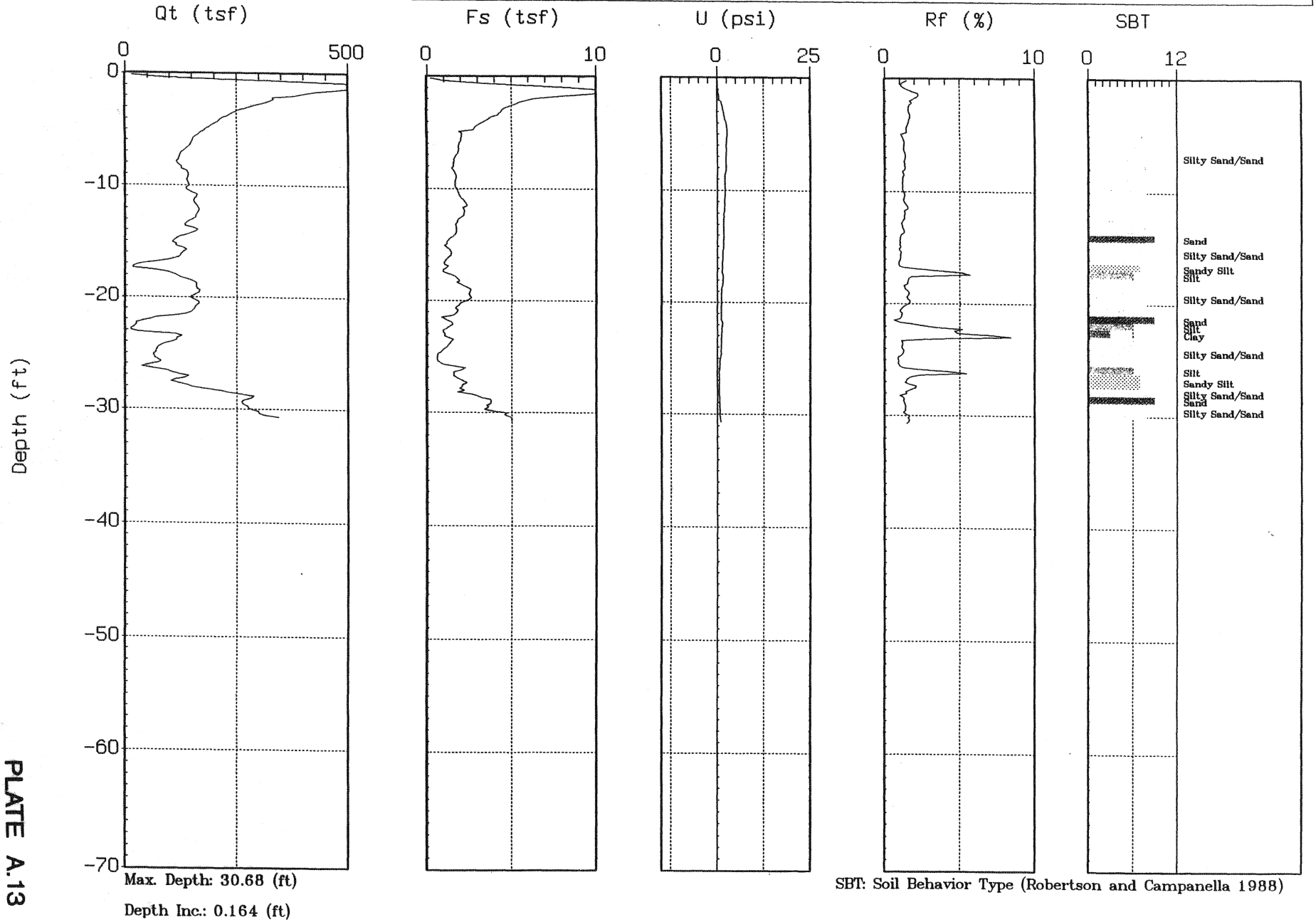
PLATE A.12

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-15

Prj. Manager : C. WOCKNER
Date : 08:23:99 15:00




Max. Depth: 30.68 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

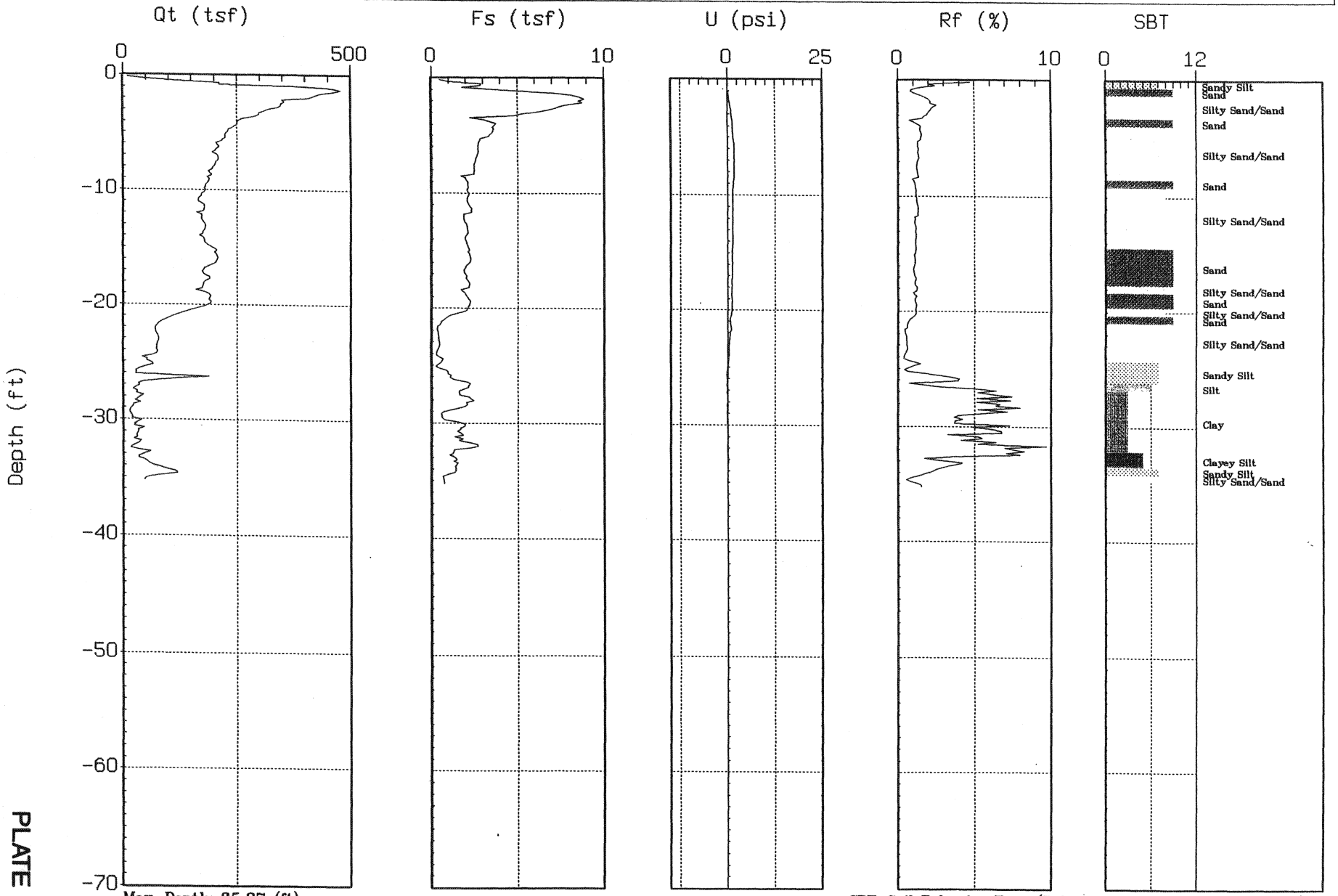
PLATE A.13

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-16

Prj. Manager : C. WOCKNER
Date : 08:23:99 15:26




Max. Depth: 35.27 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

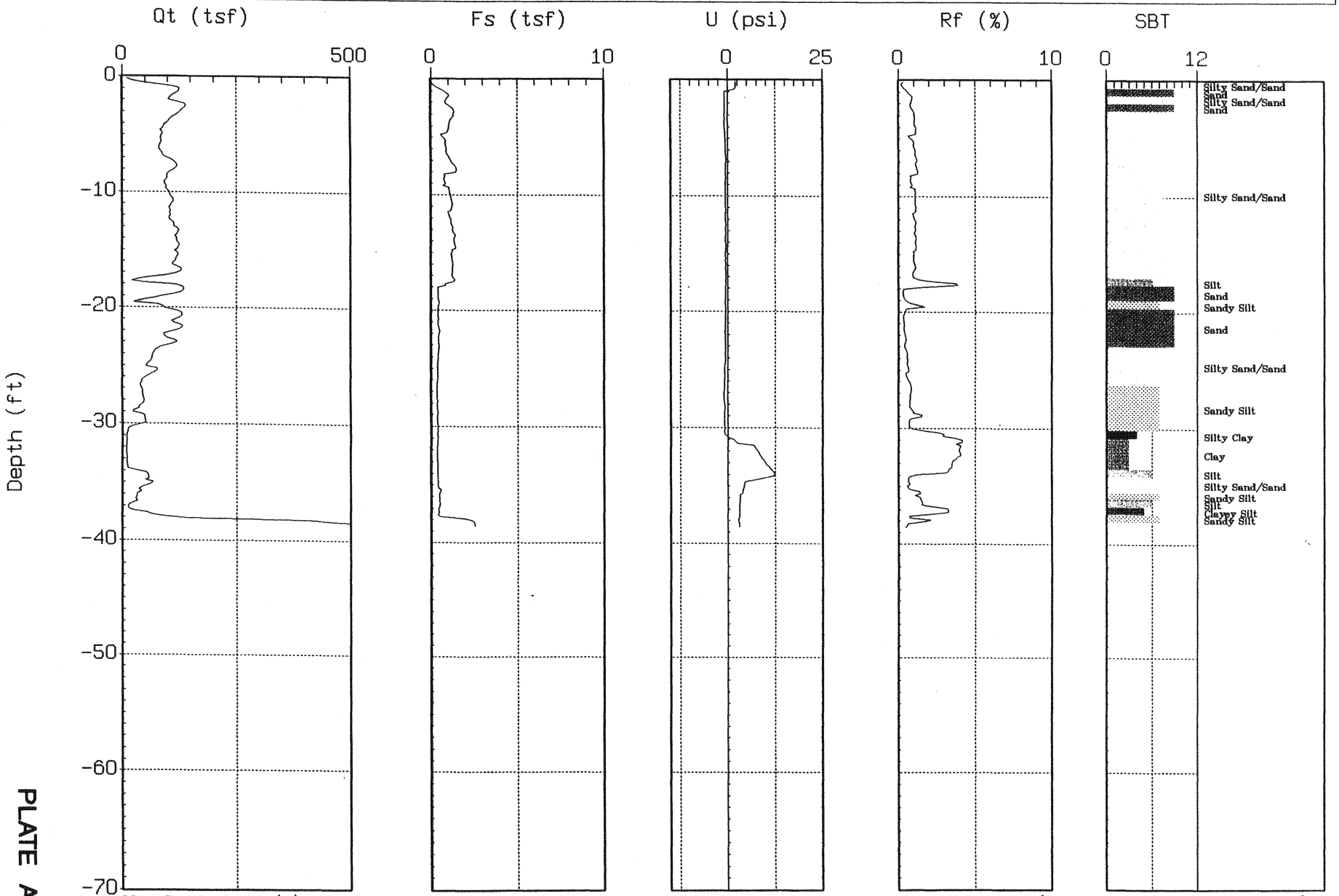
PLATE A.14

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-17

Prj. Manager : C. WOCKNER
Date : 08:23:99 07:58




Max. Depth: 38.55 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

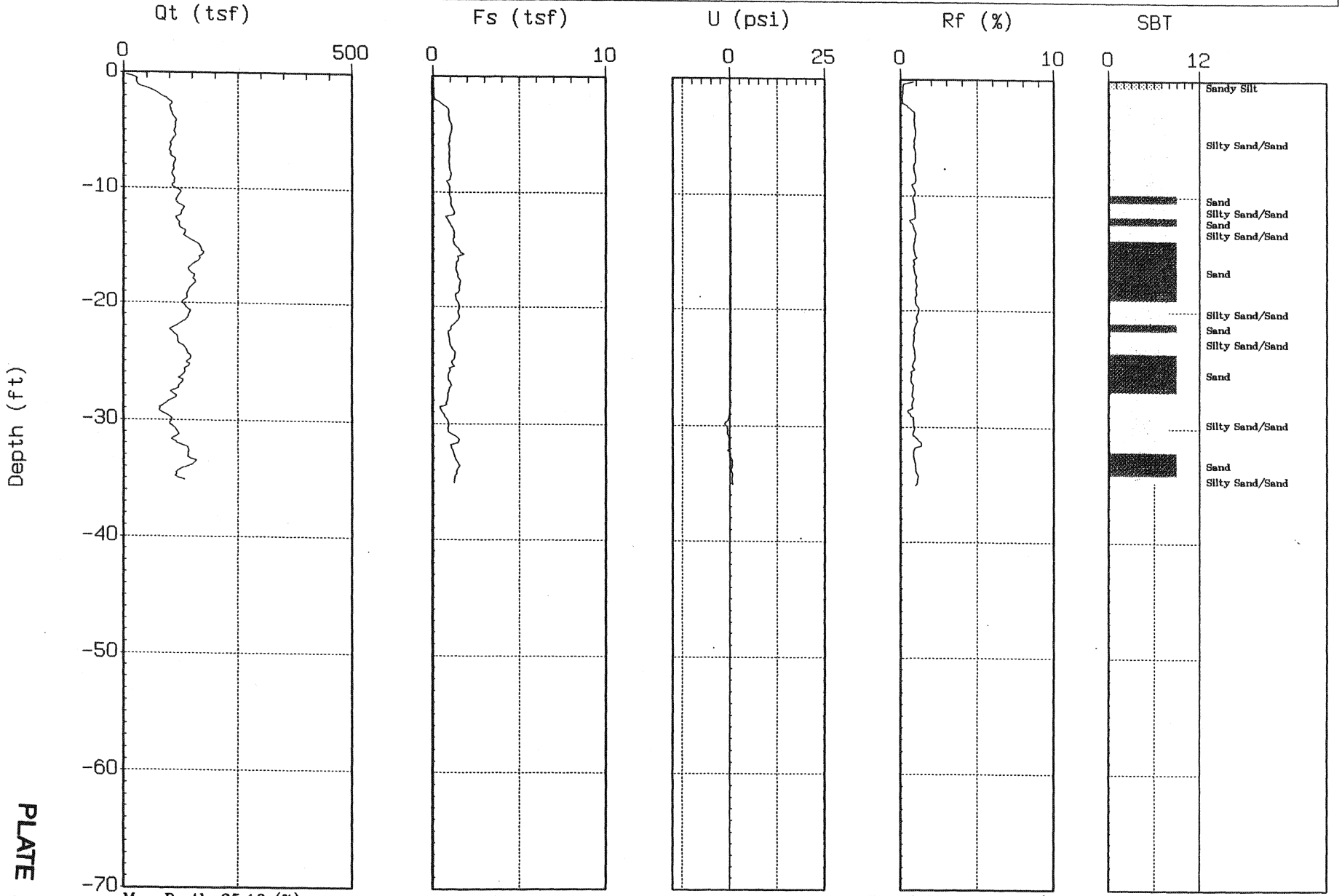
PLATE A.15

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-18

Prj. Manager : C. WOCKNER
Date : 08:24:99 09:21




Max. Depth: 35.10 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

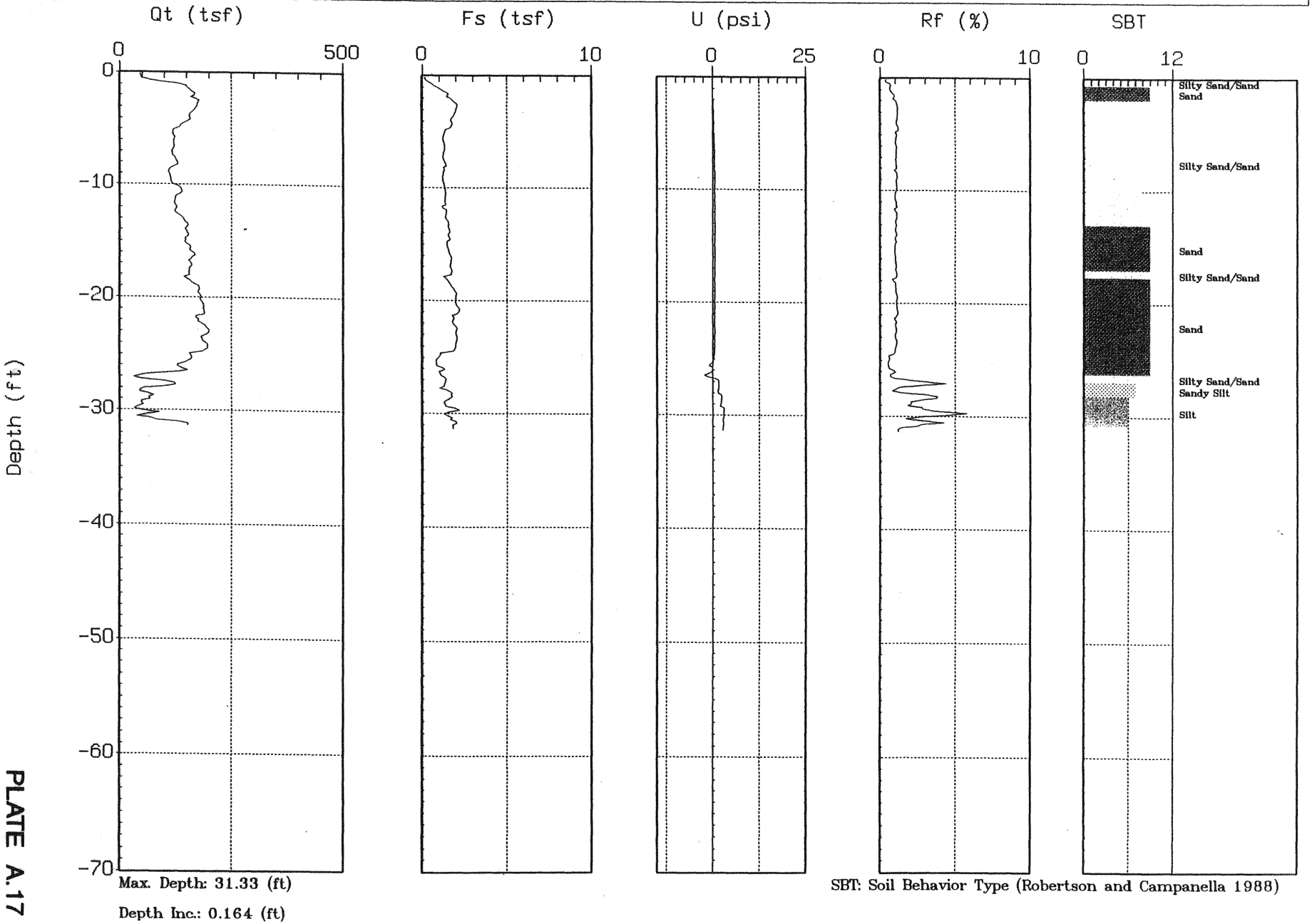
PLATE A.16

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-19

Prj. Manager : C. WOCKNER
Date : 08:24:99 06:53




Max. Depth: 31.33 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

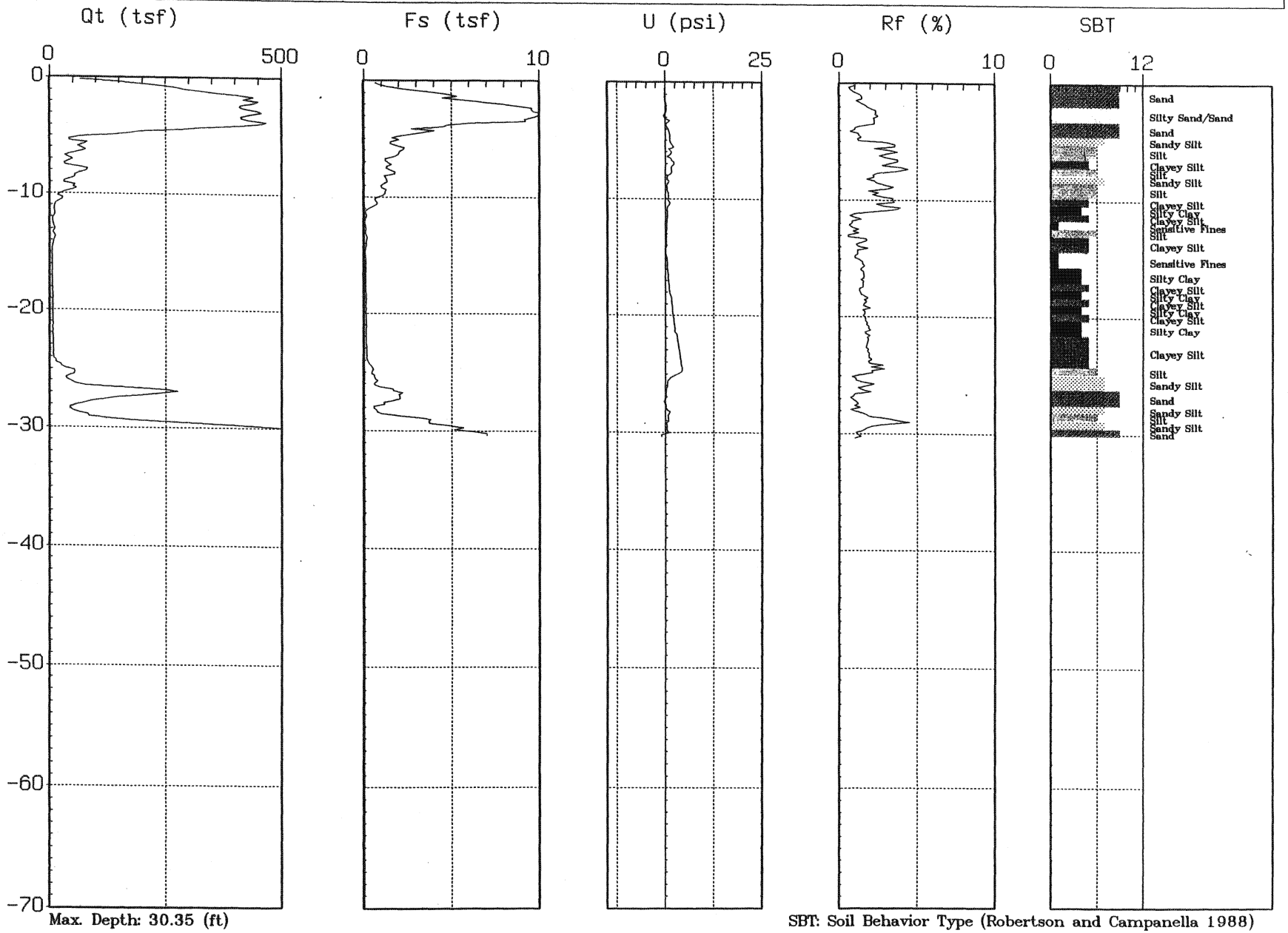
PLATE A.17

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-20

Prj. Manager : C. WOCKNER
Date : 08:24:99 09:43




Max. Depth: 30.35 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

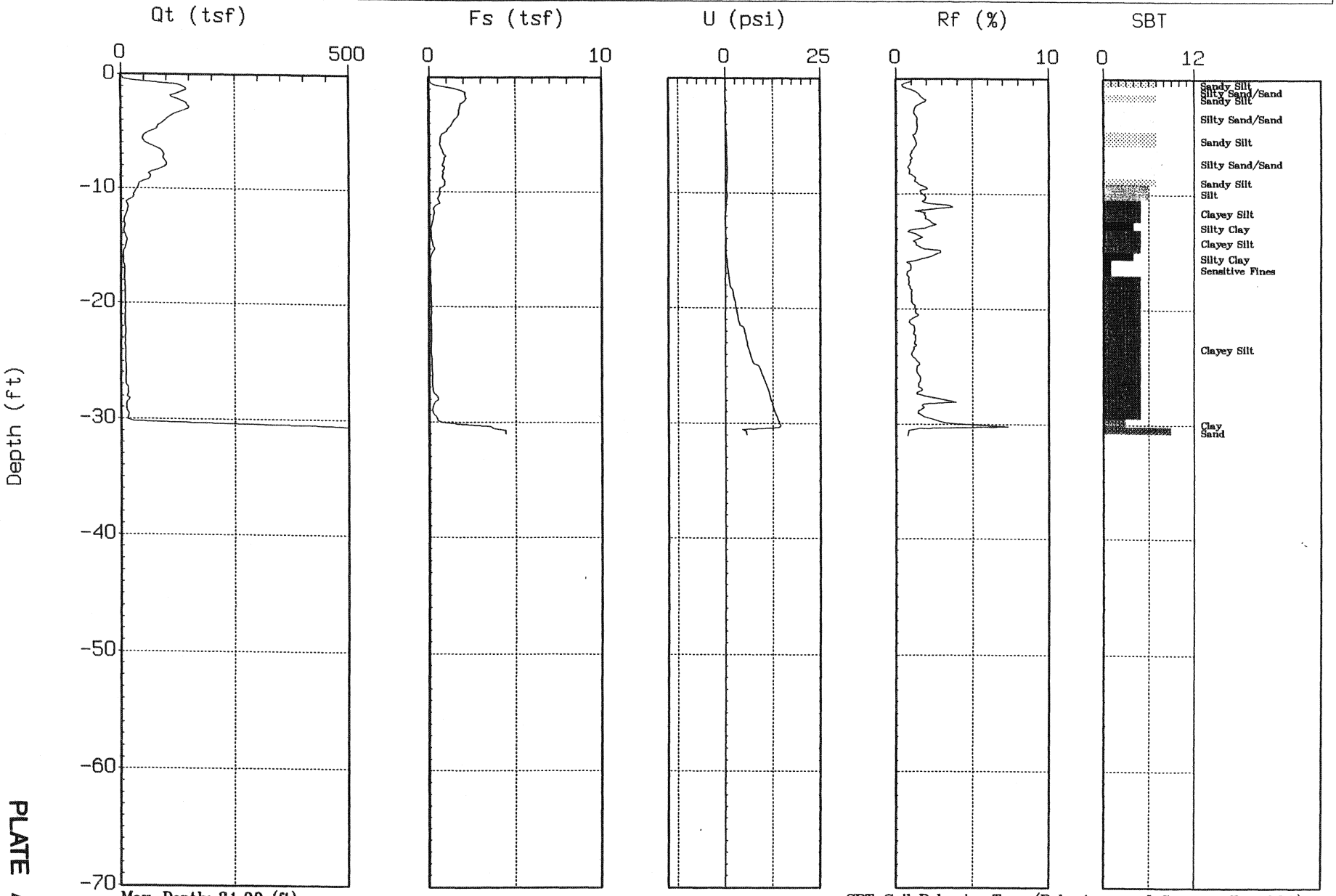
PLATE A.18

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-21

Prj. Manager : C. WOCKNER
Date : 08:24:99 10:15




Max. Depth: 31.00 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

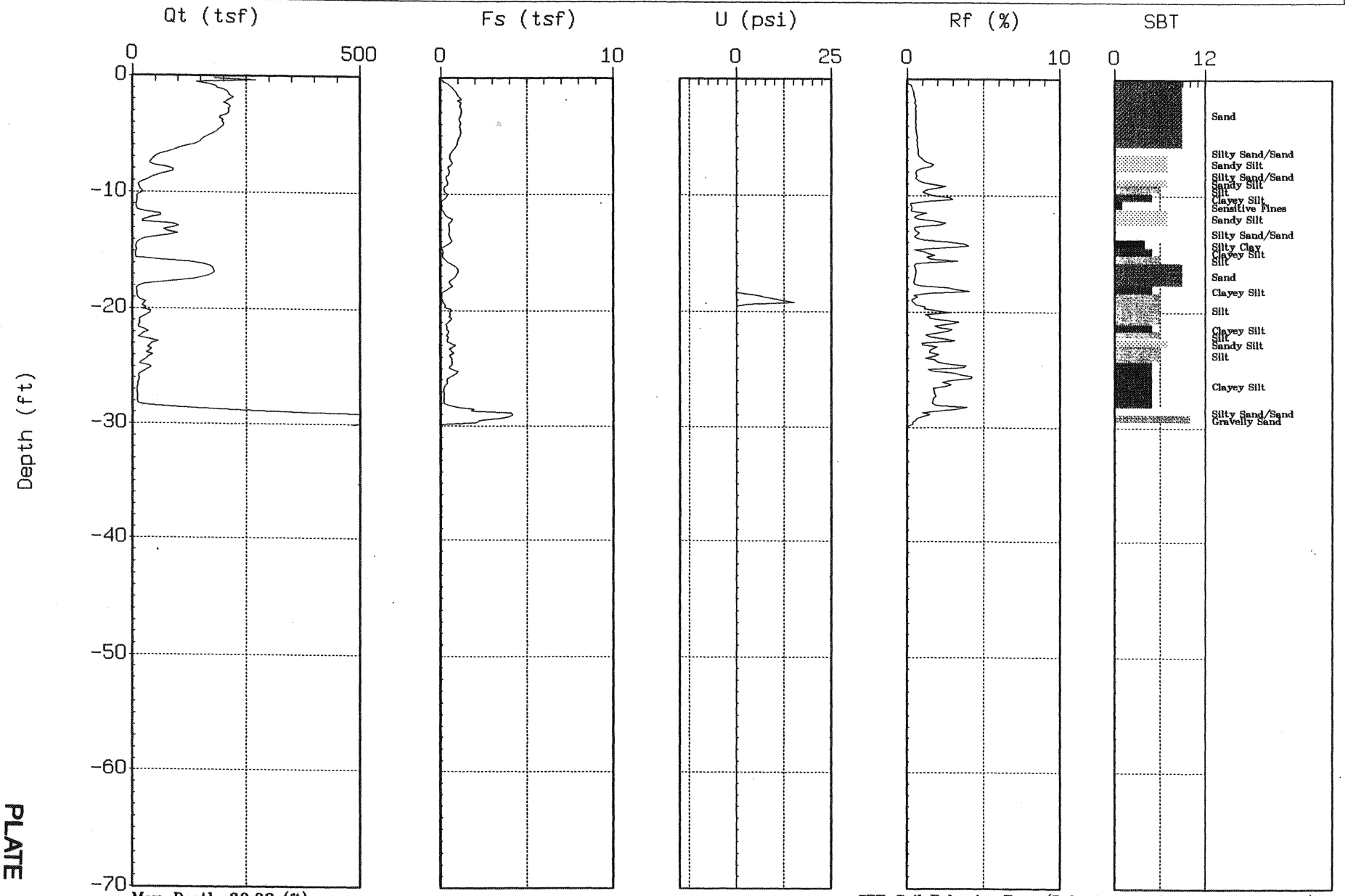
PLATE A.19

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-22

Prj. Manager : C. WOCKNER
Date : 08:23:99 07:29




Max. Depth: 30.02 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

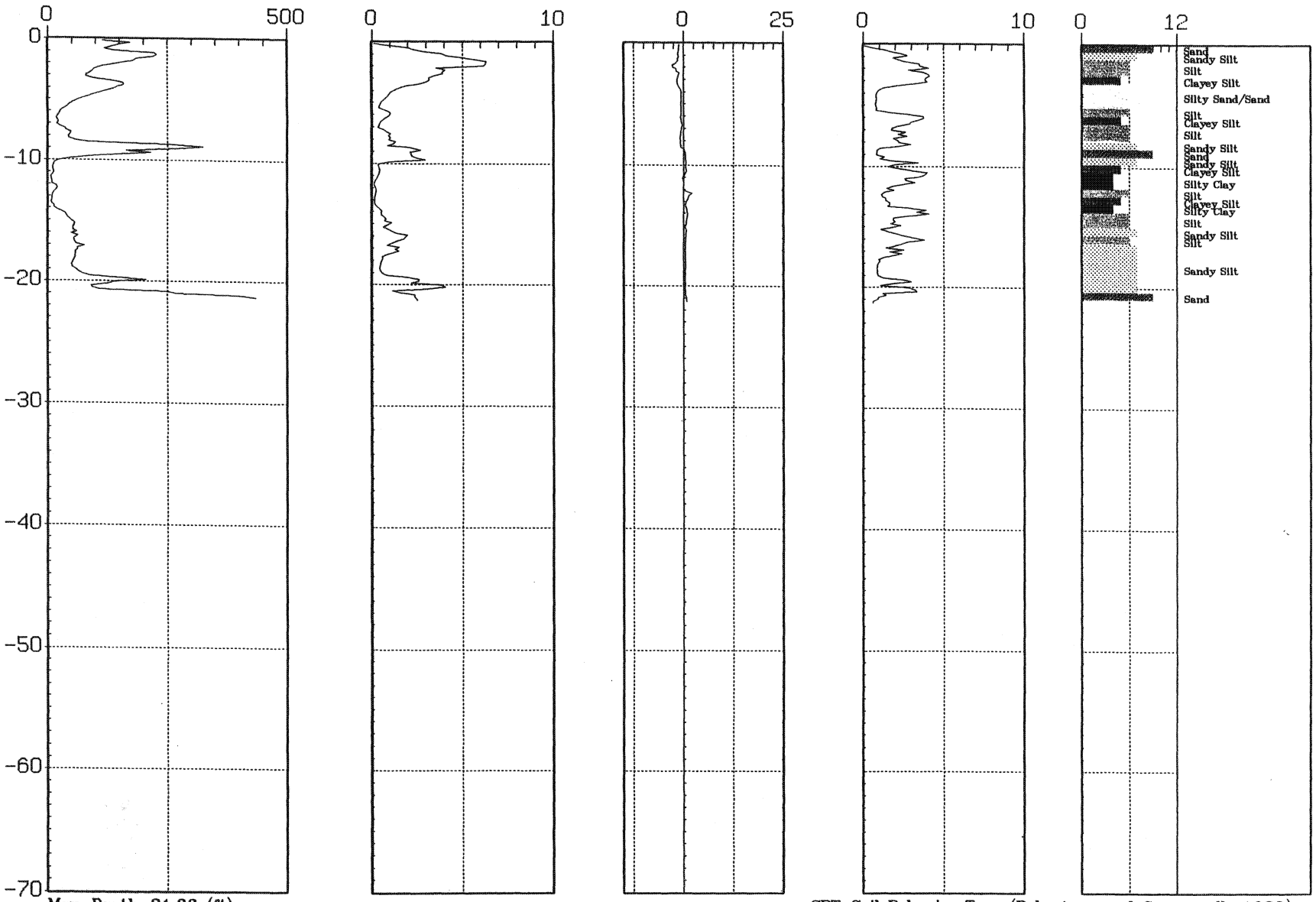
PLATE A.20

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-23

Prj. Manager : C. WOCKNER
Date : 08:24:99 11:27




Max. Depth: 21.33 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

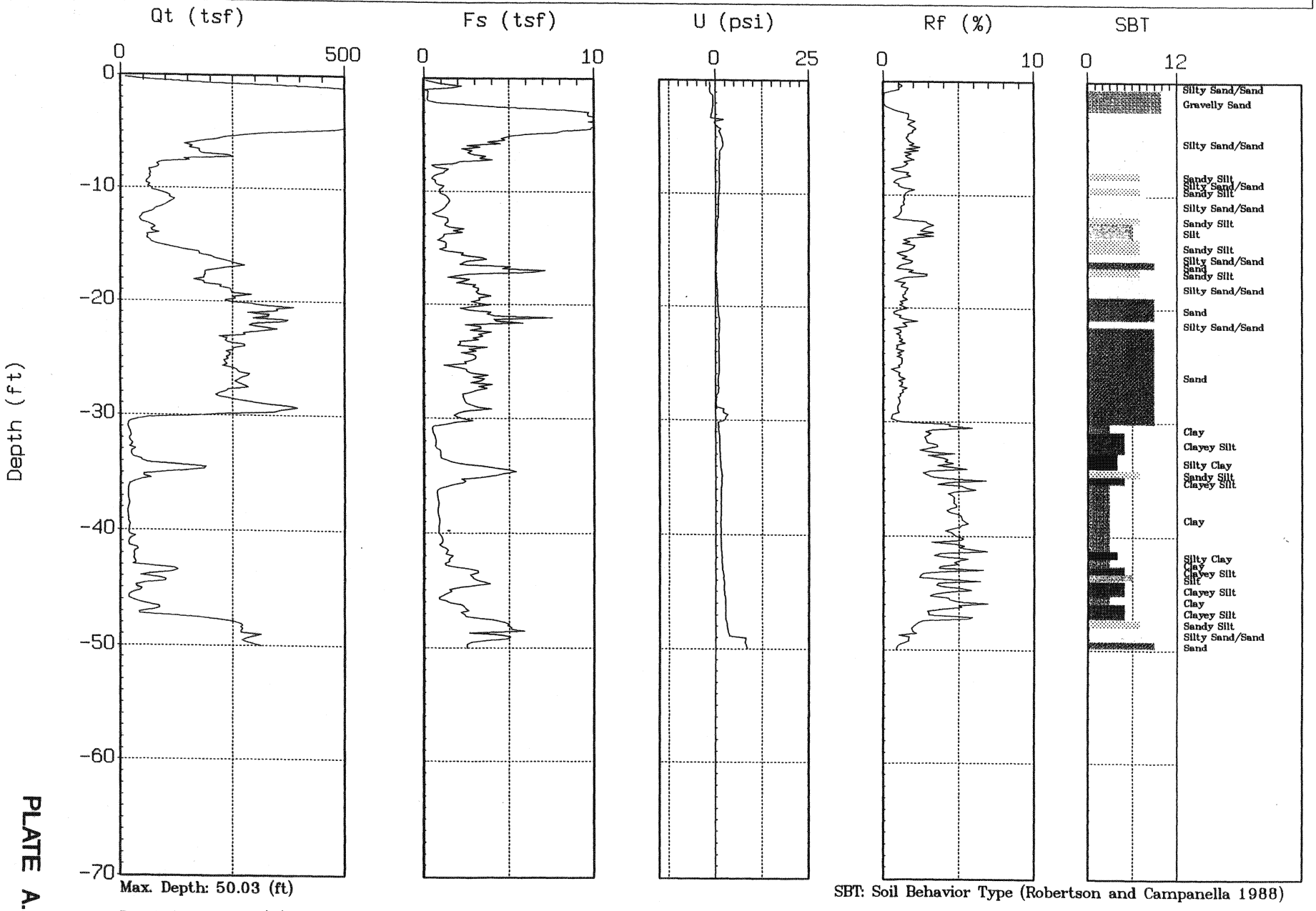
PLATE A.21

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-24

Prj. Manager : C. WOCKNER
Date : 08:24:99 11:59




Max. Depth: 50.03 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

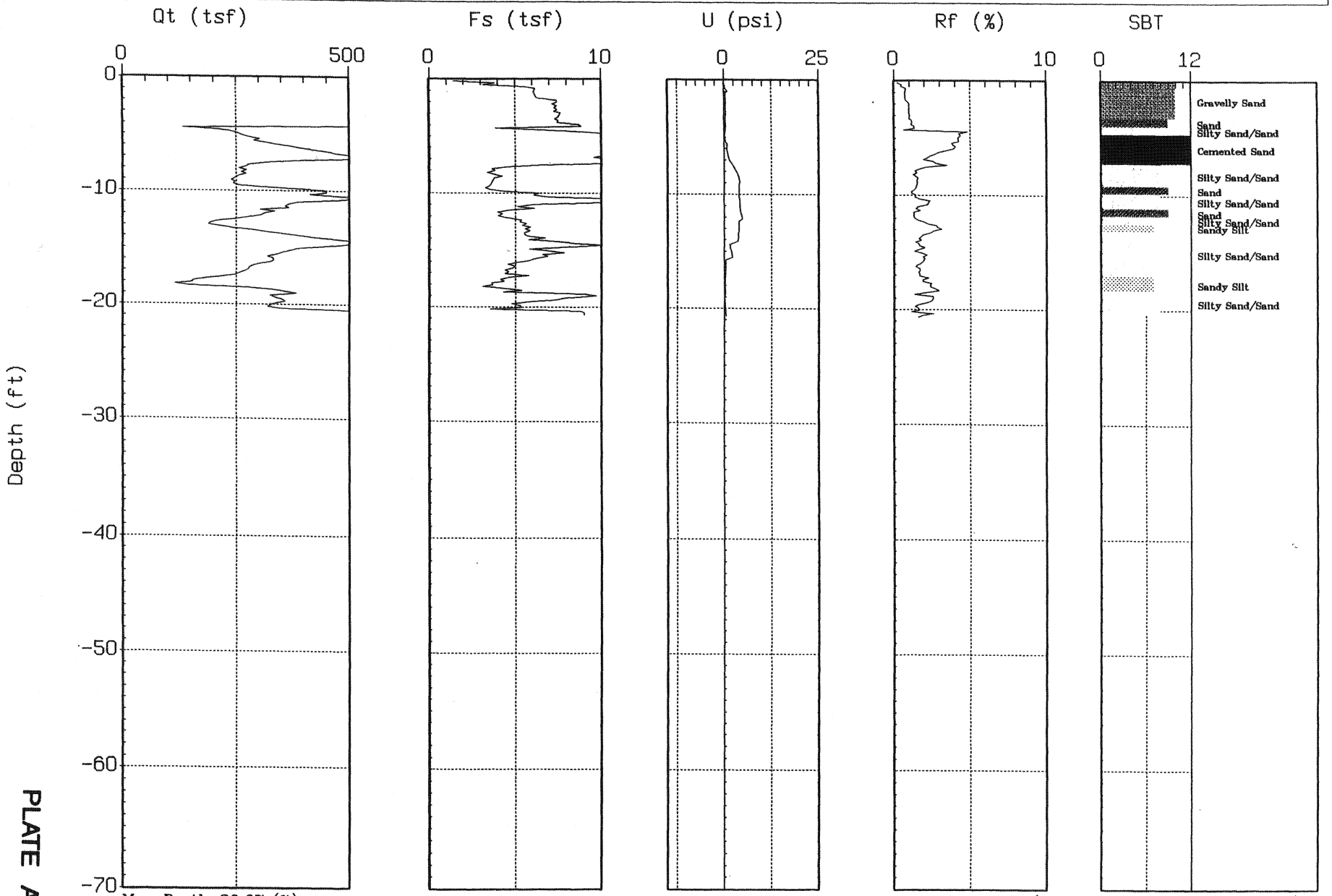
PLATE A.22

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-25

Prj. Manager : C. WOCKNER
Date : 08:24:99 14:56




Max. Depth: 20.67 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

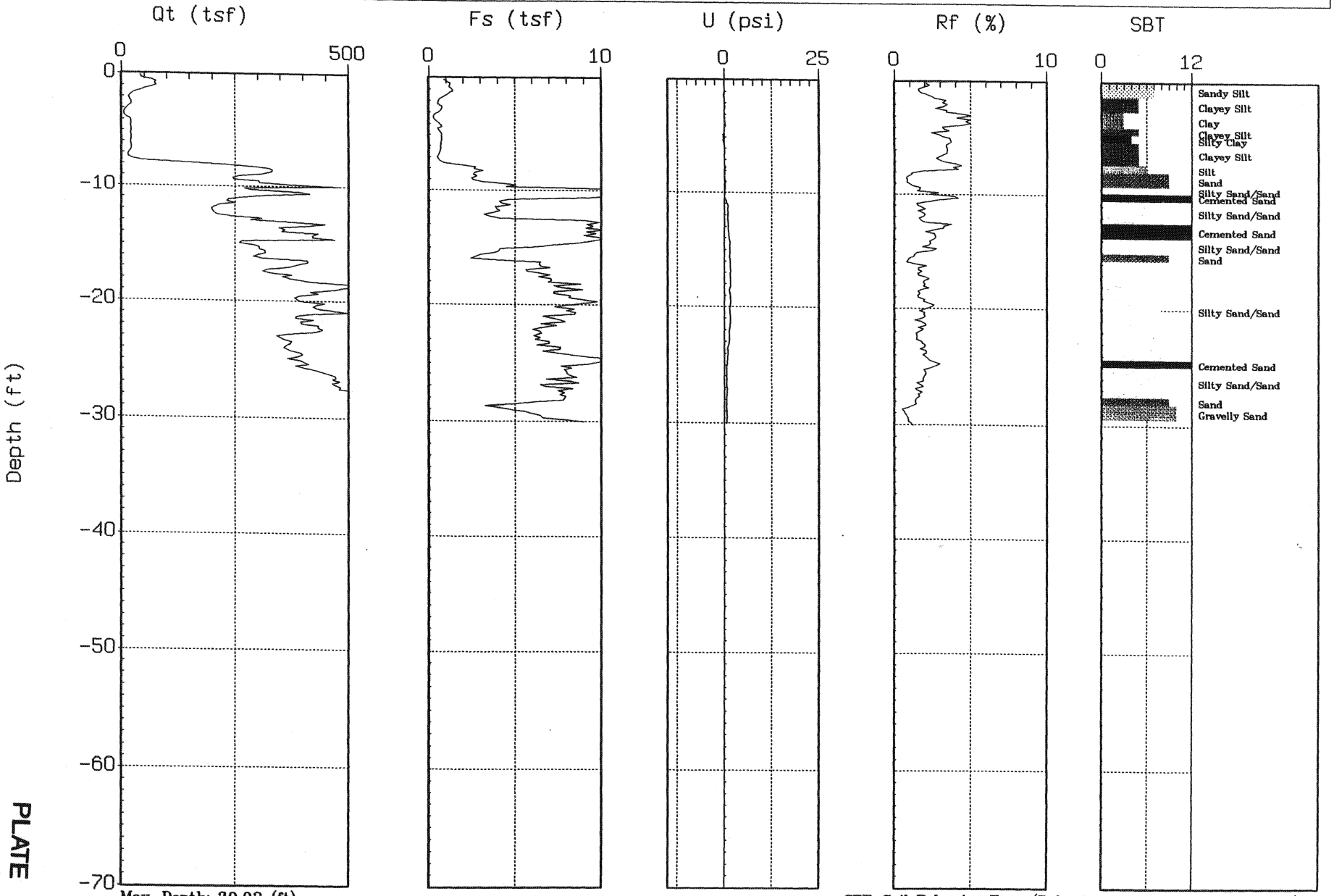
PLATE A.23

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-26

Prj. Manager : C. WOCKNER
Date : 08:24:99 17:36




Max. Depth: 30.02 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

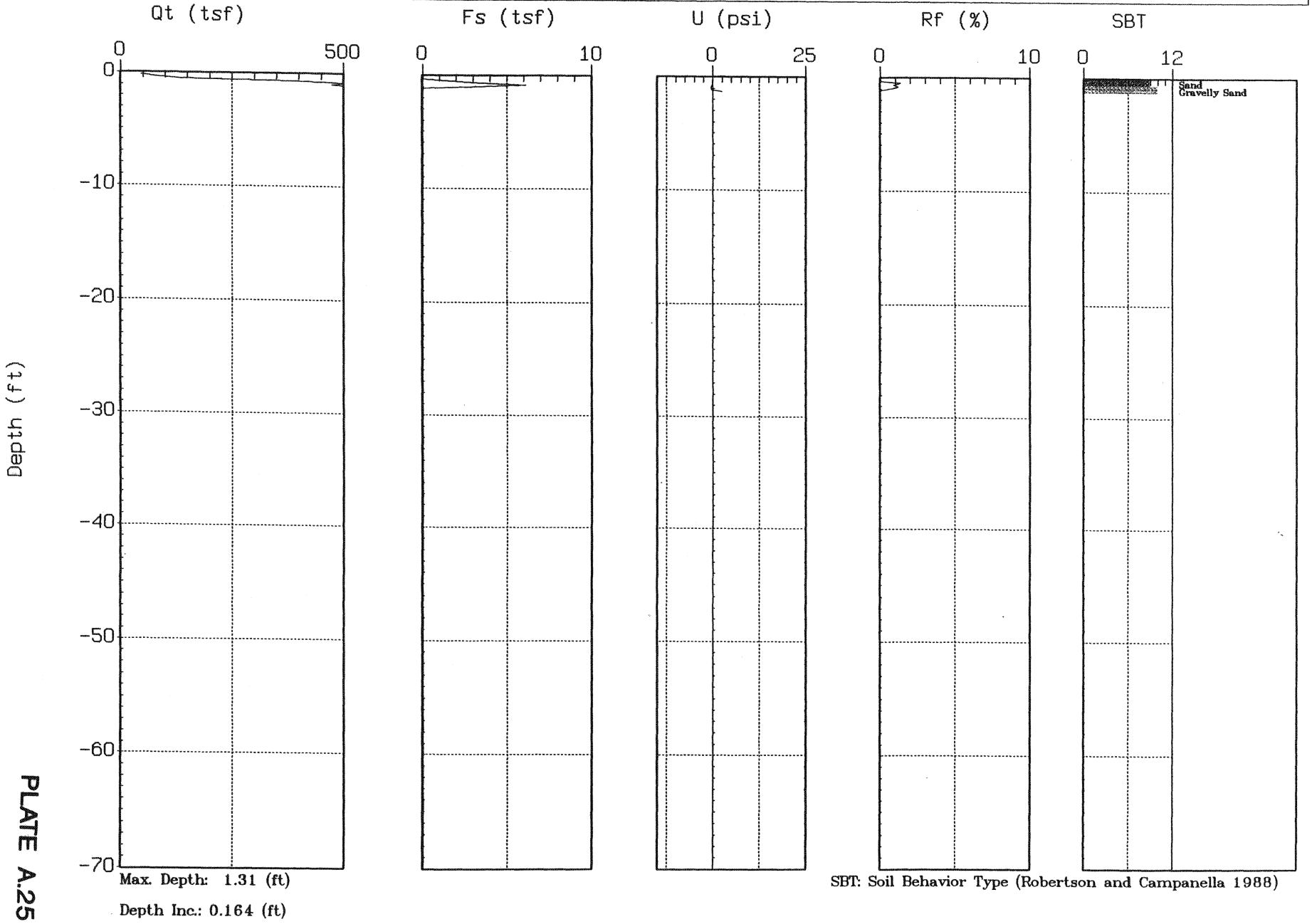
PLATE A.24

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-27

Prj. Manager : C. WOCKNER
Date : 08:24:99 16:08




Max. Depth: 1.31 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

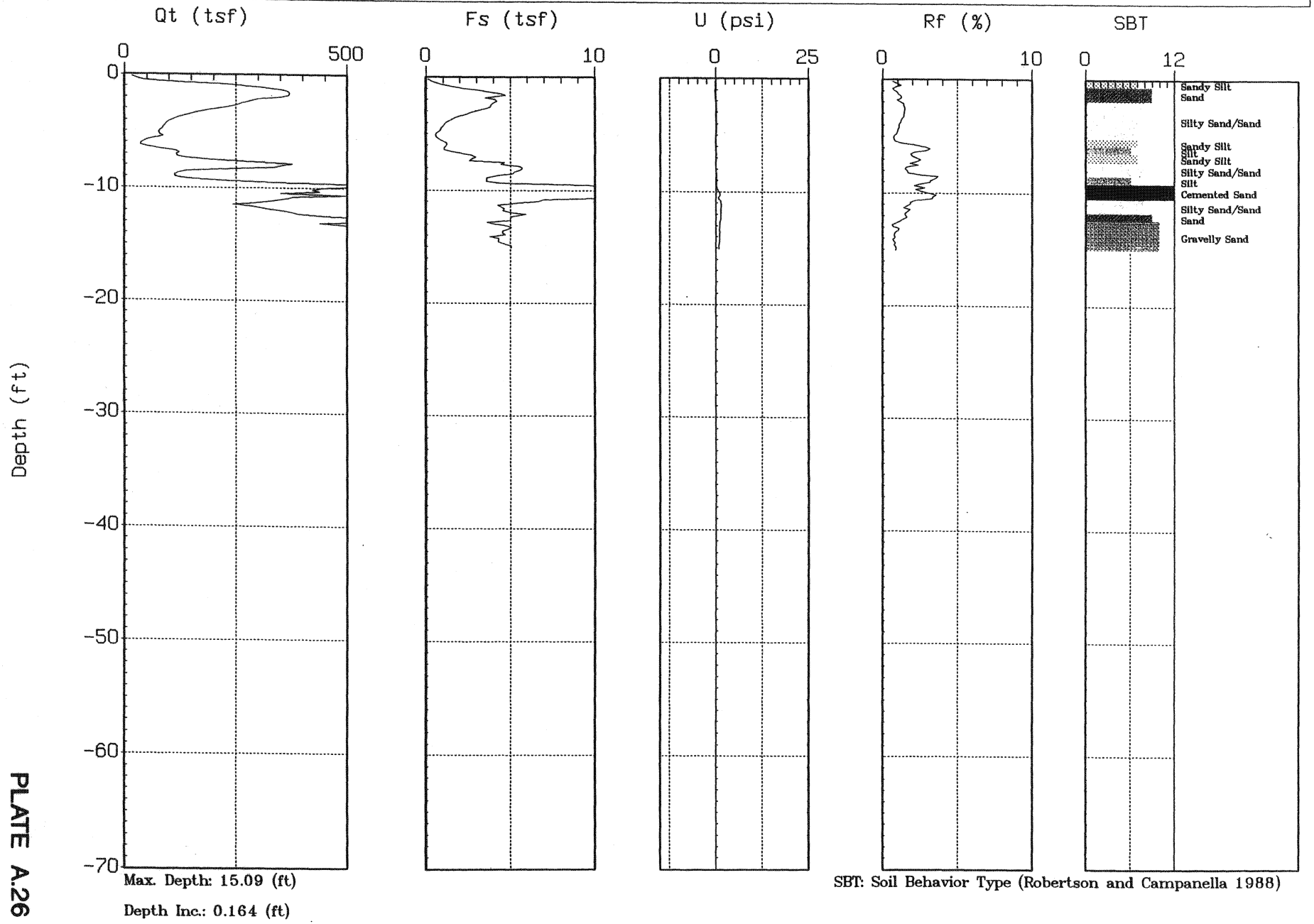
PLATE A.25

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-28

Prj. Manager : C. WOCKNER
Date : 08:24:99 15:44




Max. Depth: 15.09 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

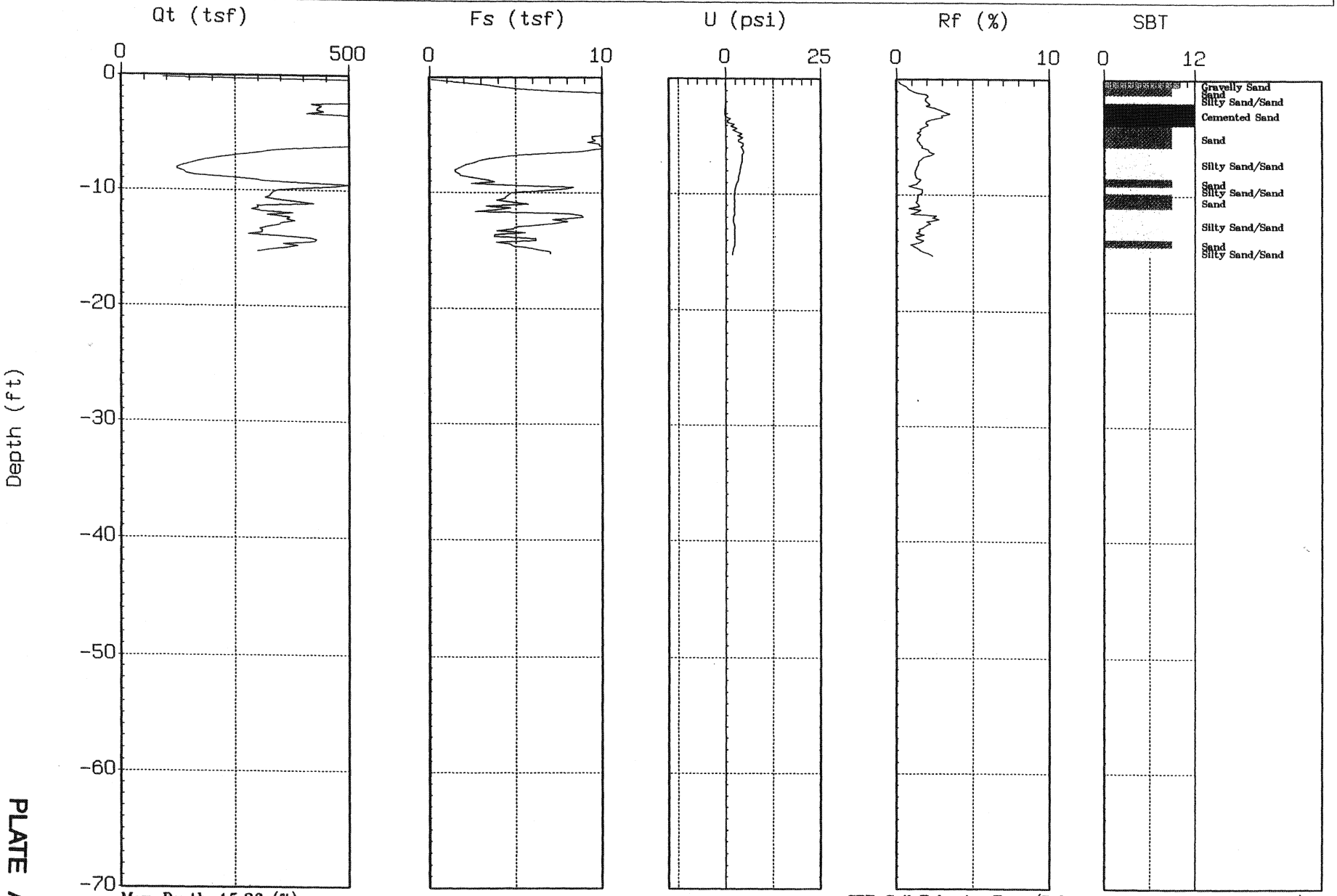
PLATE A.26

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-29

Prj. Manager : C. WOCKNER
Date : 08:24:99 14:06




Max. Depth: 15.26 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

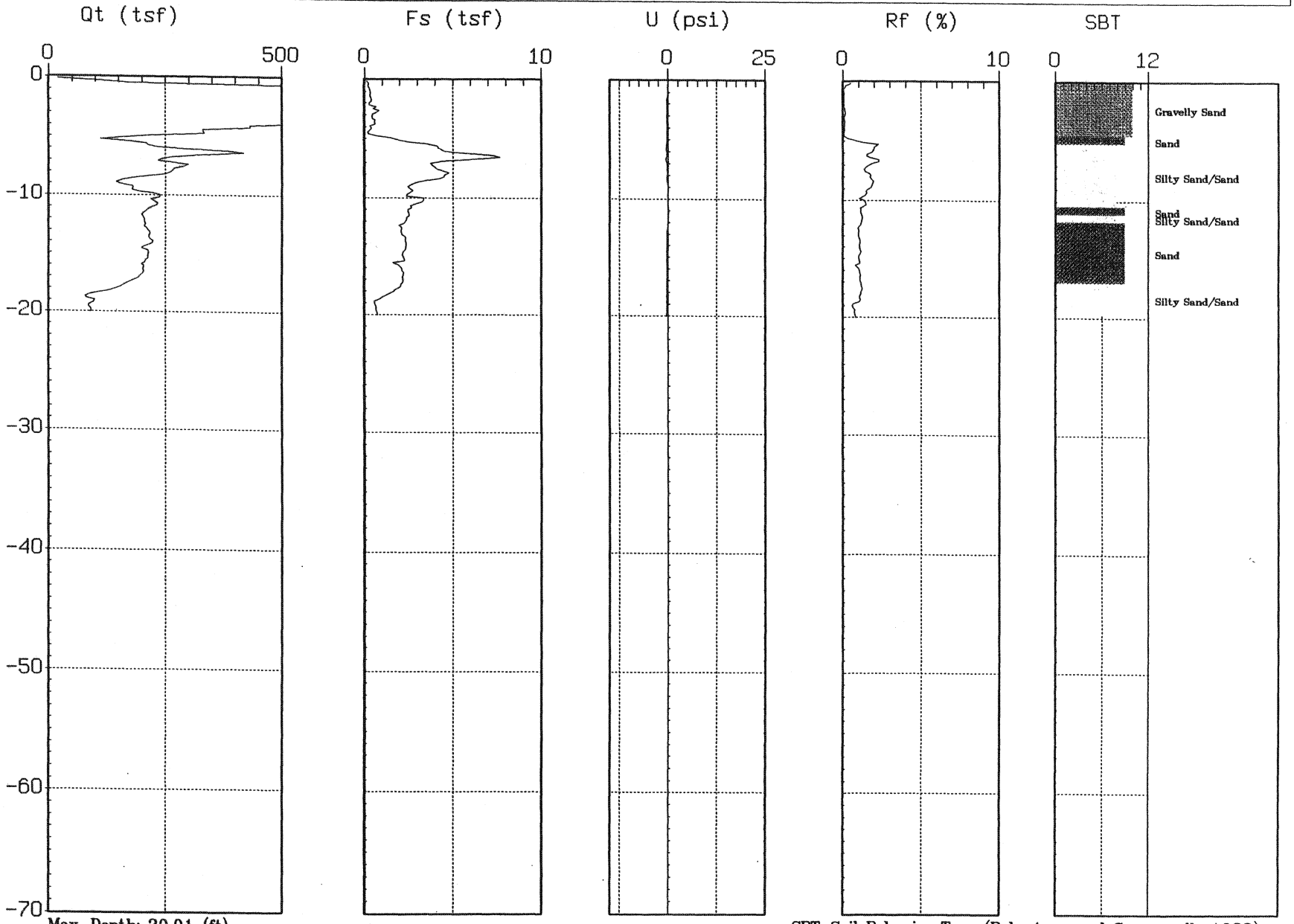
PLATE A.27

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-30

Prj. Manager : C. WOCKNER
Date : 08:24:99 13:30




Max. Depth: 20.01 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

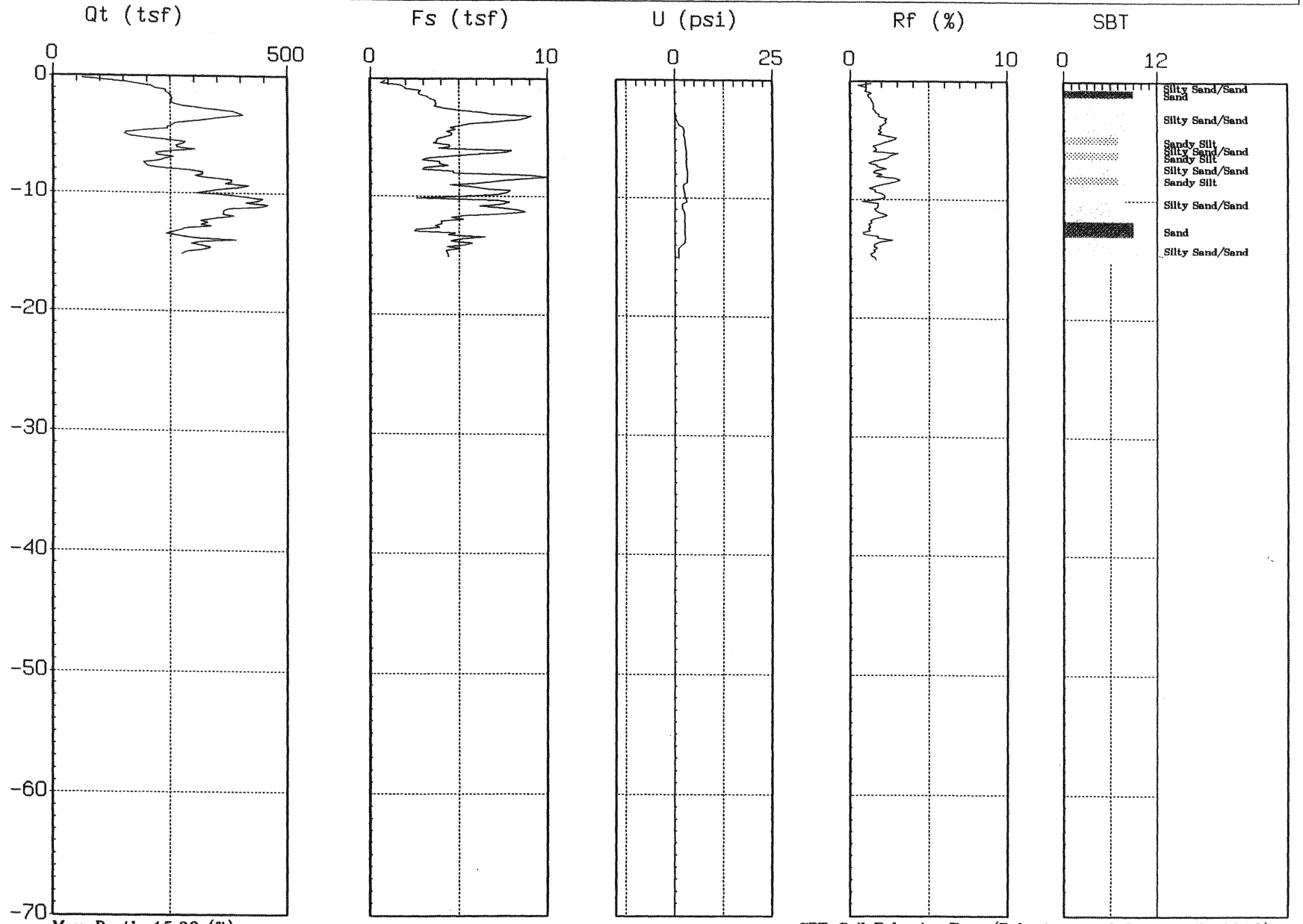
PLATE A.28

GREGG

# FUGRO GEOSCIENCES

Site : RIVER PARK
Location : CPT-31

Prj. Manager : C. WOCKNER
Date : 08:24:99 13:01



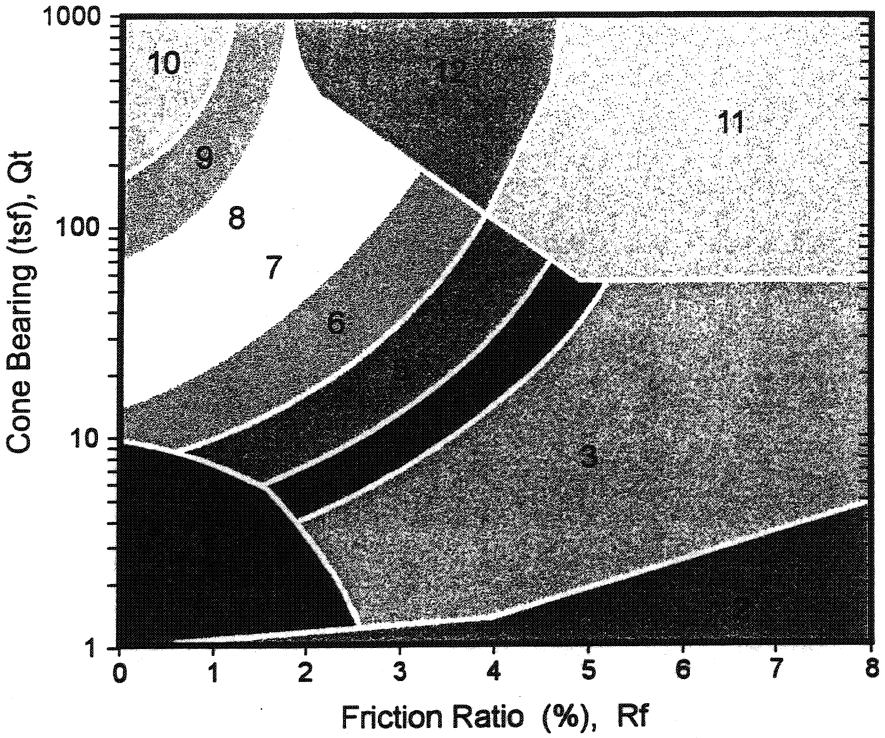

Max. Depth: 15.09 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)

PLATE A.29

# CPT Classification Chart
(after Robertson and Campanella, 1988)




| Zone | $Q_t$ / N | Soil Behaviour Type |
|---|---|---|
| 1 | 2 | sensitive fine grained |
| 2 | 1 | organic material |
| 3 | 1 | clay |
| 4 | 1.5 | silty clay to clay |
| 5 | 2 | clayey silt to silty clay |
| 6 | 2.5 | sandy silt to clayey silt |
| 7 | 3 | silty sand to sandy silt |
| 8 | 4 | sand to silty sand |
| 9 | 5 | sand |
| 10 | 6 | gravelly sand to sand |
| 11 | 1 | very stiff fine grained * |
| 12 | 2 | sand to clayey sand * |

* overconsolidated or cemented

GREGG

Gregg In Situ, Inc.

PLATE A.30

LOCATION: per Plate 3

SURFACE EL: 90 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88 | 2 | F | | | **ARTIFICIAL FILL (af)**<br>- Asphalt concrete pavement over base materials<br>Silty fine SAND (SM): medium dense, brown, moist, with pieces of asphalt concrete pavement to approx. 1-1/2" | | | | | | | |
| 86 | 4 | 1 | | (22) | **ALLUVIUM (Qal)**<br>SAND (SP): medium dense to very loose, light gray, moist | 104 | 101 | 3 | | | | |
| 84 | 6 | G<br>2 | | (24) | - with layers of light brown silt, from 6' to 8' | 109 | 106 | 3 | | | | |
| 82 | 8 | | | | | | | | | | | |
| 80 | 10 | 3 | | (53) | - with abundant gravel layers, below 10'<br>- recovery in sample shoe only, at 10' | | | | | | | |
| 78 | 12 | | | | - gravel noted during drilling, at 12' | | | | | | | |
| 76 | 14 | | | | | | | | | | | |
| 74 | 16 | 4 | | (59) | - gravel to 2-1/2" in sampler shoe, at 15'<br>- gravel noted during drilling, from 16' to 20' | 114 | 110 | 4 | | | | |
| 72 | 18 | | | | | | | | | | | |
| 70 | 20 | 5 | | (66) | | 113 | 109 | 4 | 8 | | | |
| 68 | 22 | | | | | | | | | | | |
| 66 | 24 | | | | | | | | | | | |
| 64 | 26 | 6 | | 46 | | | | | | | | |
| 62 | 28 | | | | | | | | | | | |
| 60 | 30 | 7 | | 63 | - sampled through a piece of gravel/cobbles, at 30' | | | 4 | | | | |
| 58 | 32 | | | | Note: Hole caved in below 23' after auger was withdrawn | | | | | | | |
| 56 | 34 | | | | | | | | | | | |
| 54 | 36 | | | | | | | | | | | |
| 52 | 38 | | | | | | | | | | | |

COMPLETION DEPTH: 31.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Cuttings
DRILLING DATE: August 26, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-1

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.1

LOCATION: per Plate 3

SURFACE EL: 93 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 92 | | | | | **ARTIFICIAL FILL (af)** | | | | | | | |
| | 2 | | | | Silty SAND (SM): medium dense, reddish brown, moist, with pea size gravel and asphalt concrete to approx 1" | | | | | | | |
| 90 | | 1 | | (16) | | 95 | 91 | 4 | | | | |
| | 4 | | | | Interlayered Silty SAND (SM); SILT (ML); and SAND (SP): loose, grayish brown, moist | | | | | | | |
| 88 | | B | | | | | | | | | | |
| | 6 | 2 | | (13) | | 106 | 103 | 3 | | | | |
| 86 | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | |
| 84 | | | | | **ALLUVIUM (Qal)** | | | | | | | |
| | 10 | | | | Silty SAND (SM) and SAND (SP): loose, gray brown, moist | | | | | | | |
| 82 | | 3 | | (9) | - olive brown, with gray mottles, and $FeO_2$ stains, at 10' | 107 | 92 | 16 | | | | |
| | 12 | | | | - gravel noted during drilling, at 11' | | | | | | | |
| 80 | | | | | | | | | | | | |
| | 14 | | | | | | | | | | | |
| 78 | | | | | | | | | | | | |
| | 16 | 4 | | 28 | SAND with gravel (SP): dense, yellowish brown, moist, gravel to approx. 3/4" | | | | | | | |
| 76 | | | | | - gravel noted during drilling, at 17' to 20' | | | | | | | |
| | 18 | | | | | | | | | | | |
| 74 | | | | | | | | | | | | |
| | 20 | 5 | | (69) | - very dense, light grayish brown, few gravel, below 20' | 108 | 102 | 6 | | | | |
| 72 | | | | | | | | | | | | |
| | 22 | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |
| | 24 | | | | | | | | | | | |
| 68 | | | | | | | | | | | | |
| | 26 | 6 | | 46 | | | | | | | | |
| 66 | | | | | | | | | | | | |
| | 28 | | | | | | | | | | | |
| 64 | | | | | | | | | | | | |
| | 30 | | | | - gravel noted during drilling, at 29' | | | | | | | |
| 62 | | 7 | | (66: 6") | - sampler bouncing on a rock, at 30' | 107 | 103 | 4 | | | | |
| | 32 | | | | - gravel noted during drilling, at 32 ' to 33' | | | | | | | |
| 60 | | | | | | | | | | | | |
| | 34 | | | | | | | | | | | |
| 58 | | | | | | | | | | | | |
| | 36 | 8 | | 45 | Silty SAND (SM): very dense, grayish brown, moist, with gravel layers | | | | 15 | | | |
| 56 | | | | | | | | | | | | |
| | 38 | | | | - gravel noted during drilling, at 38' | | | | | | | |
| 54 | | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 34 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 25, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-2

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.2a

| ELEVATION, ft | DEPTH, ft | MATERIAL SYMBOL | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | LOCATION: per Plate 3<br>SURFACE EL: 93 ft +/- (rel. MSL datum) | | | | | | | |
| 52 | | | 9 | | (90: 6") | - with gravel to approx. 2-1/2", innaccurate blow counts, at 40' | | | | | | | |
| 50 | 42 | | | | | | | | | | | | |
| | 44 | | | | | | | | | | | | |
| 48 | | | 10 | | 58 | - very dense, without gravel, at 45' | | | | | | | |
| 46 | 46 | | | | | | | | | | | | |
| 44 | 48 | | | | | | | | | | | | |
| 42 | 50 | | 11 | | (50: 5") | - with abundant gravel, at 45' | | | | | | | |
| 40 | 52 | | | | | Note: Hole caved in below 21' upon auger withdrawl | | | | | | | |
| 38 | 54 | | | | | | | | | | | | |
| 36 | 56 | | | | | | | | | | | | |
| 34 | 58 | | | | | | | | | | | | |
| 32 | 60 | | | | | | | | | | | | |
| 30 | 62 | | | | | | | | | | | | |
| 28 | 64 | | | | | | | | | | | | |
| 26 | 66 | | | | | | | | | | | | |
| 24 | 68 | | | | | | | | | | | | |
| 22 | 70 | | | | | | | | | | | | |
| 20 | 72 | | | | | | | | | | | | |
| 18 | 74 | | | | | | | | | | | | |
| 16 | 76 | | | | | | | | | | | | |
| 14 | 78 | | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 34 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 25, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

# LOG OF BORING NO. B-2

RiverPark B
El Rio Area, Ventura County, California

PLATE A-2.2b

LOCATION: per Plate 3

SURFACE EL: 92 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90 | 2 | C | | | **ARTIFICIAL FILL (af)** Silty SAND (SM): medium dense to dense, brown, dry to 2-1/2' then moist, with some gravel, | | | | | | | |
| | | 1 | | (62: 6") | (sampler bouncing on rock) | 118 | 113 | 4 | | | | |
| 88 | 4 | | | | | | | | | | | |
| 86 | 6 | 2 | | (26) | - with gravel to approx. 2-1/2", inaccurate blow counts, at 5' | 116 | 110 | 5 | | | | |
| 84 | 8 | D | | | - brown, below 7' | | | | | | | |
| 82 | 10 | 3 | | (19) | | 109 | 102 | 7 | | | | |
| 80 | 12 | | | | | | | | | | | |
| 78 | 14 | | | | - gravel noted during drilling, at 14' | | | | | | | |
| 76 | 16 | 4 | | (13) | **ALLUVIUM (Qal)** SAND (SP): loose, yellowish brown, moist, with few gravel | 106 | 102 | 4 | | | | |
| 74 | 18 | | | | | | | | | | | |
| 72 | 20 | 5 | | 46 | - very dense to dense, with abundant gravel, below 20' | | | | | | | |
| 70 | 22 | | | | | | | | | | | |
| 68 | 24 | | | | | | | | | | | |
| 66 | 26 | 6 | | (59) | | 104 | 99 | 5 | | | | |
| 64 | 28 | | | | | | | | | | | |
| 62 | 30 | 7 | | 37 | | | | 6 | | | | |
| 60 | 32 | | | | | | | | | | | |
| 58 | 34 | | | | | | | | | | | |
| 56 | 36 | 8 | | (57) | | | | | | | | |
| 54 | 38 | | | | | | | | | | | |
| 52 | | | | | | | | | | | | |

COMPLETION DEPTH: 41.5 ft
DEPTH TO WATER: 37 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 25, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-3

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.3a

FUGRO

| ELEVATION, ft | DEPTH, ft | MATERIAL SYMBOL | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | LOCATION: per Plate 3<br>SURFACE EL: 92 ft +/- (rel. MSL datum)<br>MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 42 | | 9 | X | 36 | - without gravel, at 40' | | | 22 | | | | |
| 48 | 44 | | | | | | | | | | | | |
| 46 | 46 | | | | | | | | | | | | |
| 44 | 48 | | | | | | | | | | | | |
| 42 | 50 | | | | | | | | | | | | |
| 40 | 52 | | | | | | | | | | | | |
| 38 | 54 | | | | | | | | | | | | |
| 36 | 56 | | | | | | | | | | | | |
| 34 | 58 | | | | | | | | | | | | |
| 32 | 60 | | | | | | | | | | | | |
| 30 | 62 | | | | | | | | | | | | |
| 28 | 64 | | | | | | | | | | | | |
| 26 | 66 | | | | | | | | | | | | |
| 24 | 68 | | | | | | | | | | | | |
| 22 | 70 | | | | | | | | | | | | |
| 20 | 72 | | | | | | | | | | | | |
| 18 | 74 | | | | | | | | | | | | |
| 16 | 76 | | | | | | | | | | | | |
| 14 | 78 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | |

COMPLETION DEPTH: 41.5 ft
DEPTH TO WATER: 37 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 25, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-3

RiverPark B
El Rio Area, Ventura County, California

PLATE A-2.3b

FUGRO

LOCATION: per Plate 3

SURFACE EL: 90 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88 | 2 | 1 | | (51) | **ARTIFICIAL FILL (af)**<br>Silty SAND (SM): reddish brown to brown, moist, with few gravel | | | | | | | |
| 86 | 4 | A | | | SAND with gravel (SP): dense, yellowish brown, moist, gravel to approx. 2" | 110 | 105 | 5 | | | | |
| 84 | 6 | 2 | | (31) | Silty SAND with gravel (SM): dense, yellowish brown, moist | 113 | 106 | 7 | | | | |
| 82 | 8 | | | | | | | | | | | |
| 80 | 10 | 3 | | (10) | - loose, with pea size gravel, at 10' | 110 | 106 | 4 | | | | |
| 78 | 12 | | | | | | | | | | | |
| 76 | 14 | | | | | | | | | | | |
| 74 | 16 | 4 | | (19) | - medium dense, with silt, at 15' | 112 | 105 | 7 | | | | |
| 72 | 18 | | | | | | | | | | | |
| 70 | 20 | 5 | | 32 | **ALLUVIUM (Qal)**<br>SAND (SP): dense, yellow brown, wet<br>- with gravel to approx. 1", at 20'<br>- with gravel to approx. 2-1/2" expelled in cutting, from 20' to 25' | | | | | | | |
| 68 | 22 | | | | | | | | | | | |
| 66 | 24 | | | | | | | | | | | |
| 64 | 26 | 6 | | (56) | - with gravel to 3/4", inaccurate blow counts, at 25' | 113 | 108 | 5 | | | | |
| 62 | 28 | | | | | | | | | | | |
| 60 | 30 | 7 | | 16 | medium dense, at 30' | | | | 10 | | | |
| 58 | 32 | | | | Interlayered SILT (ML) and Lean CLAY (CL): medium dense to very stiff, olive brown, with light gray mottles, wet | | | | | | | |
| 56 | 34 | | | | | | | | | | | |
| 54 | 36 | 8 | | (32) | | 124 | 103 | 20 | | | | PP 1.6 |
| 52 | 38 | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 26 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 25, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-4

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.4a

FUGRO

LOCATION: per Plate 3

SURFACE EL: 90 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | MATERIAL SYMBOL | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 9 | | 16 | Interlayered SILT (ML) and Lean CLAY (CL): medium dense to very stiff, olive brown, with light gray mottles, wet | | | 27 | | | | PP 1.8 |
| -48 | 42 | | | | | | | | | | | | |
| -46 | 44 | | | | | | | | | | | | |
| | | | 10 | | (26) | | | | | | | | PP 2.2 |
| -44 | 46 | | | | | | | | | | | | |
| -42 | 48 | | | | | | | | | | | | |
| -40 | 50 | | 11 | | 17 | | | | | | | | |
| -38 | 52 | | | | | | | | | | | | |
| -36 | 54 | | | | | | | | | | | | |
| -34 | 56 | | | | | | | | | | | | |
| -32 | 58 | | | | | | | | | | | | |
| -30 | 60 | | | | | | | | | | | | |
| -28 | 62 | | | | | | | | | | | | |
| -26 | 64 | | | | | | | | | | | | |
| -24 | 66 | | | | | | | | | | | | |
| -22 | 68 | | | | | | | | | | | | |
| -20 | 70 | | | | | | | | | | | | |
| -18 | 72 | | | | | | | | | | | | |
| -16 | 74 | | | | | | | | | | | | |
| -14 | 76 | | | | | | | | | | | | |
| -12 | 78 | | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 26 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 25, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

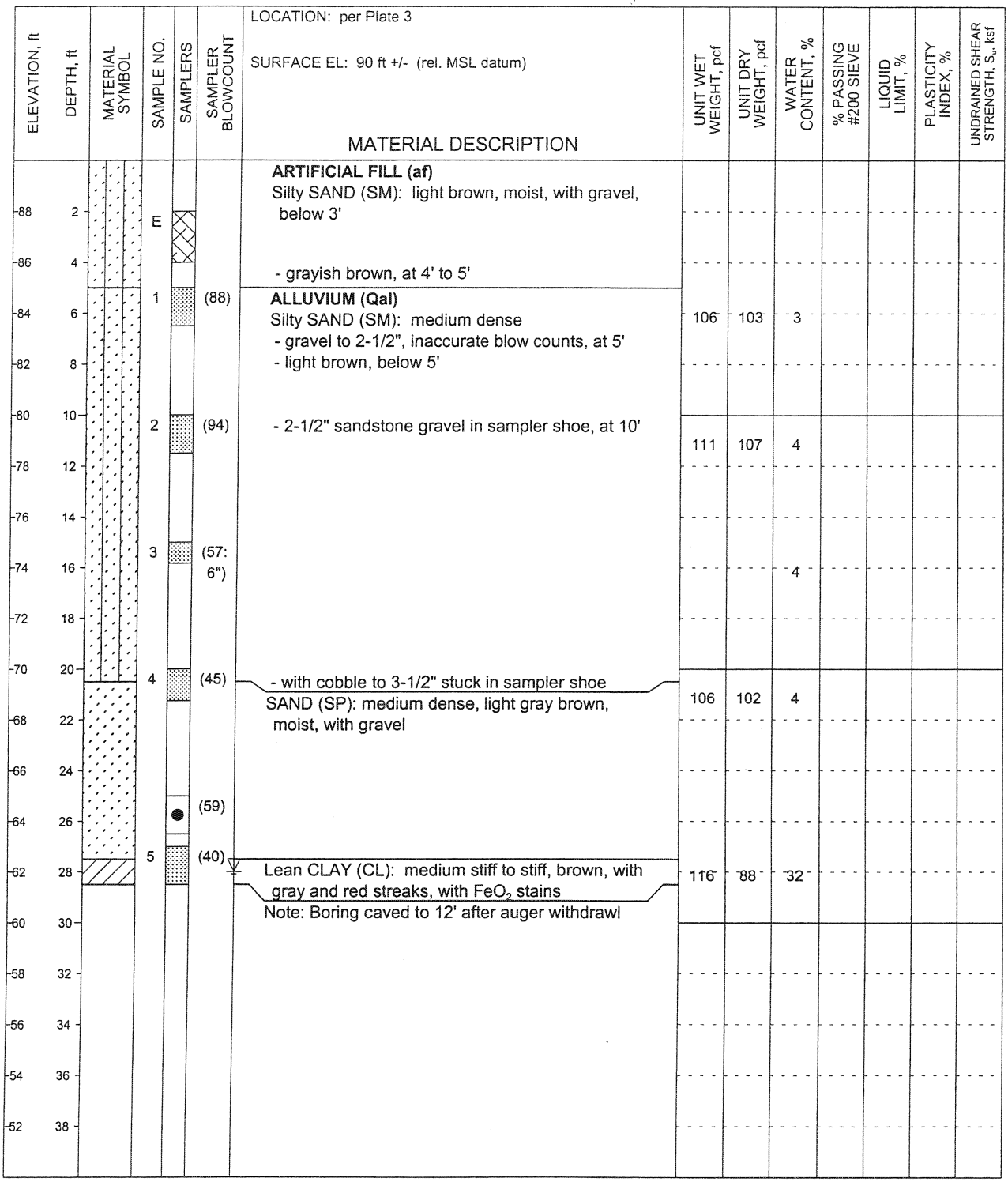
The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-4

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.4b




COMPLETION DEPTH: 28.5 ft
DEPTH TO WATER: 28-1/2 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 25, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-5

RiverPark B
El Rio Area, Ventura County, California

PLATE A-2.5

LOCATION: per Plate 3

SURFACE EL: 79 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | MATERIAL SYMBOL | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 78 | 2 | | H | | | **ARTIFICIAL FILL (af)**<br>SAND (SP): loose, light gray, brown, moist, fine to medium | | | | | | | |
| 76 | 4 | | | | | | | | | | | | |
| 74 | 6 | | 1 | | (16) | - medium dense, at 5' | | | | | | | |
| 72 | 8 | | | | | | | | | | | | |
| 70 | 10 | | 2 | | (2) | - very loose, at 10' | | | | | | | |
| 68 | 12 | | | | | - layer of clay, at 11' to 12' | | | | | | | |
| 66 | 14 | | 3 | | | - fine sand, from 12' to 21' | | | | | | | |
| 64 | 16 | | 4 | | 4 | | | | | 9 | | | |
| 62 | 18 | | | | | | | | | | | | |
| 60 | 20 | | 5 | | 7 | **ALLUVIUM (Qal)**<br>Silty SAND with gravel (SM): loose, light gray<br>- with layers of gravel, below 20'<br>- medium sand, at 21' | | | | | | | |
| 58 | 22 | | | | | | | | | | | | |
| 56 | 24 | | | | | | | | | | | | |
| 54 | 26 | | 6 | | 41 | - sampled through a pieces of gravel/cobble, at 25' | | | | | | | |
| 52 | 28 | | | | | | | | | | | | |
| 50 | 30 | | 7 | | 13 | Lean CLAY (CL): stiff, dark olive brown, wet | | | 29 | 85 | 43 | 22 | |
| 48 | 32 | | | | | | | | | | | | |
| 46 | 34 | | | | | | | | | | | | |
| 44 | 36 | | 8 | | (37) | - very stiff, at 35' | | | | | | | |
| 42 | 38 | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 18-1/2 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 26, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-CPT-1

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.6a

LOCATION: per Plate 3

SURFACE EL: 79 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | MATERIAL SYMBOL | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | 42 | | 9 | | 31 | - interlayered with stilt and silty sand, below 40' | | | | | | | |
| 36 | 44 | | | | | | | | | | | | |
| 34 | 46 | | 10 | | 16 | | | | | 81 | | | |
| 32 | 48 | | | | | | | | | | | | |
| 30 | 50 | | 11 | | 16 | | | | | | | | |
| 28 | 52 | | | | | | | | | | | | |
| 26 | 54 | | | | | | | | | | | | |
| 24 | 56 | | | | | | | | | | | | |
| 22 | 58 | | | | | | | | | | | | |
| 20 | 60 | | | | | | | | | | | | |
| 18 | 62 | | | | | | | | | | | | |
| 16 | 64 | | | | | | | | | | | | |
| 14 | 66 | | | | | | | | | | | | |
| 12 | 68 | | | | | | | | | | | | |
| 10 | 70 | | | | | | | | | | | | |
| 8 | 72 | | | | | | | | | | | | |
| 6 | 74 | | | | | | | | | | | | |
| 4 | 76 | | | | | | | | | | | | |
| 2 | 78 | | | | | | | | | | | | |
| 0 | | | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 18-1/2 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 26, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-CPT-1

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.6b

LOCATION: per Plate 3

SURFACE EL: 78 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 76 | 2 | 1 | | | **ARTIFICIAL FILL (af)**<br>Fine to medium SAND (SP): loose to medium dense, light grayish brown, dry to approx. 1' then moist | | | | | | | |
| 74 | 4 | | | | | | | | | | | |
| 72 | 6 | 1 | | 14 | | | | | | | | |
| 70 | 8 | | | | | | | | | | | |
| 68 | 10 | 2 | | 10 | | | | | | | | |
| 66 | 12 | | | | | | | | | | | |
| 64 | 14 | | | | | | | | | | | |
| 62 | 16 | 3 | | 11 | | | | | | | | |
| 60 | 18 | | | | - gravel noted during drilling, at 17' | | | | | | | |
| 58 | 20 | 4 | | 36 | - with medium sand, wet, driller adds drilling mud to prevent sand from flowing up into augers, at 20' | | | 25 | | | | |
| 56 | 22 | | | | | | | | | | | |
| 54 | 24 | | | | - gravel noted during drilling, at 24' | | | | | | | |
| 52 | 26 | 5 | | PUSH | **ALLUVIUM (Qal)**<br>Fat CLAY (CH): stiff, dark olive gray, wet, with gray mottles | 126 | 103 | 23 | | 50 | 28 | PP 1.3 |
| 50 | 28 | | | | | | | | | | | |
| 48 | 30 | 6 | | (16) | | | | | | | | PP 2.0 |
| 46 | 32 | | | | | | | | | | | |
| 44 | 34 | | | | | | | | | | | |
| 42 | 36 | 7 | | PUSH | - very stiff, brown with gray mottles, leaner, at 35' | | | | | | | PP 3.5 |
| 40 | 38 | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 19 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 26, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-CPT-11

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.7a

FUGRO

| ELEVATION, ft | DEPTH, ft | MATERIAL SYMBOL | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | LOCATION: per Plate 3<br>SURFACE EL: 78 ft +/- (rel. MSL datum)<br>MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 8 | | (22) | Fine SILT with sand (ML): medium dense to very dense, gray brown, wet | | | | 94 | | | |
| -36 | 42 | | | | | | | | | | | | |
| -34 | 44 | | | | | | | | | | | | |
| -32 | 46 | | 9 | | 41 | | | | | | | | |
| -30 | 48 | | | | | | | | | | | | |
| -28 | 50 | | 10 | | 56 | - with few pieces of gravel to approx. 1", at 50' | | | | | | | |
| -26 | 52 | | | | | | | | | | | | |
| -24 | 54 | | | | | | | | | | | | |
| -22 | 56 | | | | | | | | | | | | |
| -20 | 58 | | | | | | | | | | | | |
| -18 | 60 | | | | | | | | | | | | |
| -16 | 62 | | | | | | | | | | | | |
| -14 | 64 | | | | | | | | | | | | |
| -12 | 66 | | | | | | | | | | | | |
| -10 | 68 | | | | | | | | | | | | |
| -8 | 70 | | | | | | | | | | | | |
| -6 | 72 | | | | | | | | | | | | |
| -4 | 74 | | | | | | | | | | | | |
| -2 | 76 | | | | | | | | | | | | |
| -0 | 78 | | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 19 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 26, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-CPT-11

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.7b

LOCATION: per Plate 3

SURFACE EL: 82 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | MATERIAL SYMBOL | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | 2 | | K | | | **ARTIFICIAL FILL (af)**<br>Silty SAND (SM): loose to medium dense, light brown, dry to 1" then moist | | | | | | | |
| 78 | 4 | | | | | SAND (SP): loose to medium dense, light brown, moist, fine | | | | | | | |
| 76 | 6 | | 1 | | (9) | layer of lean clay with silty sand parting, from 5-1/2' to 7' | | | | | | | |
| 74 | 8 | | | | | | | | | | | | |
| 72 | 10 | | 2 | | (10) | - fine, loose, at 10' | | | | 8 | | | |
| 70 | 12 | | | | | | | | | | | | |
| 68 | 14 | | | | | | | | | | | | |
| 66 | 16 | | 3 | | (9) | - layer of medium stiff lean clay with silty sand partings, from 15-1/2' to 17'? | | | | | | | PP 0.6 |
| 64 | 18 | | | | | | | | | | | | |
| 62 | 20 | | 4 | | 7 | Silty fine SAND (SM): loose. gray, moist | | | | 41 | | | |
| 60 | 22 | | | | | | | | | | | | |
| 58 | 24 | | | | | | | | | | | | |
| 56 | 26 | | 5 | | (2) | - wet, at 25'<br>Note: water level measured and driller adds drilling mud to prevent sand from flowing up into augers | | | | 28 | | | |
| 54 | 28 | | | | | | | | | | | | |
| 52 | 30 | | 6 | | 12 | | | | | | | | |
| 50 | 32 | | | | | | | | | | | | |
| 48 | 34 | | | | | | | | | | | | |
| 46 | 36 | | 7 | | PUSH | - tube encountered a cobble, at 35'<br>- with interlayered lean clay, and silt, below 35' | | | | | | | |
| 44 | 38 | | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 25 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 27, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-CPT-13

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.8a

FUGRO

LOCATION: per Plate 3

SURFACE EL: 82 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 42 | 8 | | 27 | **ALLUVIUM (Qal)**<br>Sandy SILT (ML): medium dense, with light brown mottles and $FeO_2$ stains | | | | 52 | | | |
| 38 | 44 | | | | SAND (SP): dense, light gray brown, wet, medium, sampler is bouncing on a cobble | | | | | | | |
| 36 | 46 | 9 | | 50: 5" | | | | | | | | |
| 34 | 48 | | | | | | | | | | | |
| 32 | 50 | 10 | | 63 | - sampled through a piece of gravel, at 50' | | | | | | | |
| 30 | 52 | | | | | | | | | | | |
| 28 | 54 | | | | | | | | | | | |
| 26 | 56 | | | | | | | | | | | |
| 24 | 58 | | | | | | | | | | | |
| 22 | 60 | | | | | | | | | | | |
| 20 | 62 | | | | | | | | | | | |
| 18 | 64 | | | | | | | | | | | |
| 16 | 66 | | | | | | | | | | | |
| 14 | 68 | | | | | | | | | | | |
| 12 | 70 | | | | | | | | | | | |
| 10 | 72 | | | | | | | | | | | |
| 8 | 74 | | | | | | | | | | | |
| 6 | 76 | | | | | | | | | | | |
| 4 | 78 | | | | | | | | | | | |

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 25 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 27, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-CPT-13

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.8b

LOCATION: per Plate 3

SURFACE EL: 81 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | 2 | J | | | **ALLUVIUM (Qal)**<br>Silty SAND (SM) to SAND (SP): medium dense, light brown, moist | | | | | | | |
| 78 | 4 | | | | | | | | | | | |
| 76 | 6 | 1 | | 12 | | | | | | | | |
| 74 | 8 | | | | | | | | | | | |
| 72 | 10 | 2 | | (5) | - very loose below 10' | | | | | | | |
| 70 | 12 | | | | - dark gray silty sand layer, from 11' to 12' | | | | | | | |
| 68 | 14 | | | | | | | | | | | |
| 66 | 16 | 3 | | 4 | - with layer of silty sand grading to silt grading to lean clay, at 15' to 15-1/2' | | | | | | | |
| 64 | 18 | | | | | | | | | | | |
| 62 | 20 | 4 | | 5 | - wet, with dark gray silt pockets<br>Note: water level measured and drilling mud added to prevent sand from flowing up into the augers | | | | 32 | | | |
| 60 | 22 | | | | | | | | | | | |
| 58 | 24 | | | | | | | | | | | |
| 56 | 26 | 5 | | PUSH | | | | | | | | |
| 54 | 28 | | | | **ALLUVIUM (Qal)**<br>Lean CLAY (CL): medium stiff, olive gray, with $FeO_2$ staining, brown mottling and pockets of gray silty sand | | | | | | | |
| 52 | 30 | | | | | | | | | | | |
| 50 | 32 | 6 | | 29 | Sandy SILT (ML): dense, mottled light brown and light gray, wet, with $FeO_2$ stains | | | | 56 | | | |
| 48 | 34 | | | | | | | | | | | |
| 46 | 36 | 7 | | 48 | Medium SAND (SP): dense, light gray brown, wet, with few pea size gravel | | | | | | | |
| 44 | 38 | | | | | | | | | | | |
| 42 | | | | | | | | | | | | |

COMPLETION DEPTH: 47.5 ft
DEPTH TO WATER: 19-1/2 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 27, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-CPT-22

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.9a

LOCATION: per Plate 3

SURFACE EL: 81 ft +/- (rel. MSL datum)

| ELEVATION, ft | DEPTH, ft | MATERIAL SYMBOL | SAMPLE NO. | SAMPLERS | SAMPLER BLOWCOUNT | MATERIAL DESCRIPTION | UNIT WET WEIGHT, pcf | UNIT DRY WEIGHT, pcf | WATER CONTENT, % | % PASSING #200 SIEVE | LIQUID LIMIT, % | PLASTICITY INDEX, % | UNDRAINED SHEAR STRENGTH, $S_u$, ksf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 42 | | 8 | | 37 | Medium SAND (SP): dense, light gray brown, wet, with few pea size gravel | | | | | | | |
| 38 | 44 | | | | | | | | | | | | |
| 36 | 46 | | 9 | | 32 | | | | | 8 | | | |
| 34 | 48 | | | | | | | | | | | | |
| 32 | 50 | | | | | | | | | | | | |
| 30 | 52 | | | | | | | | | | | | |
| 28 | 54 | | | | | | | | | | | | |
| 26 | 56 | | | | | | | | | | | | |
| 24 | 58 | | | | | | | | | | | | |
| 22 | 60 | | | | | | | | | | | | |
| 20 | 62 | | | | | | | | | | | | |
| 18 | 64 | | | | | | | | | | | | |
| 16 | 66 | | | | | | | | | | | | |
| 14 | 68 | | | | | | | | | | | | |
| 12 | 70 | | | | | | | | | | | | |
| 10 | 72 | | | | | | | | | | | | |
| 8 | 74 | | | | | | | | | | | | |
| 6 | 76 | | | | | | | | | | | | |
| 4 | 78 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |

COMPLETION DEPTH: 47.5 ft
DEPTH TO WATER: 19-1/2 ft
BACKFILLED WITH: Cuttings
DRILLING DATE: August 27, 1999

DRILLING METHOD: 8-in. diameter Hollow Stem Auger
DRILLED BY: A+R Drilling, Inc.
LOGGED BY: NDerbidge
CHECKED BY: CWockner

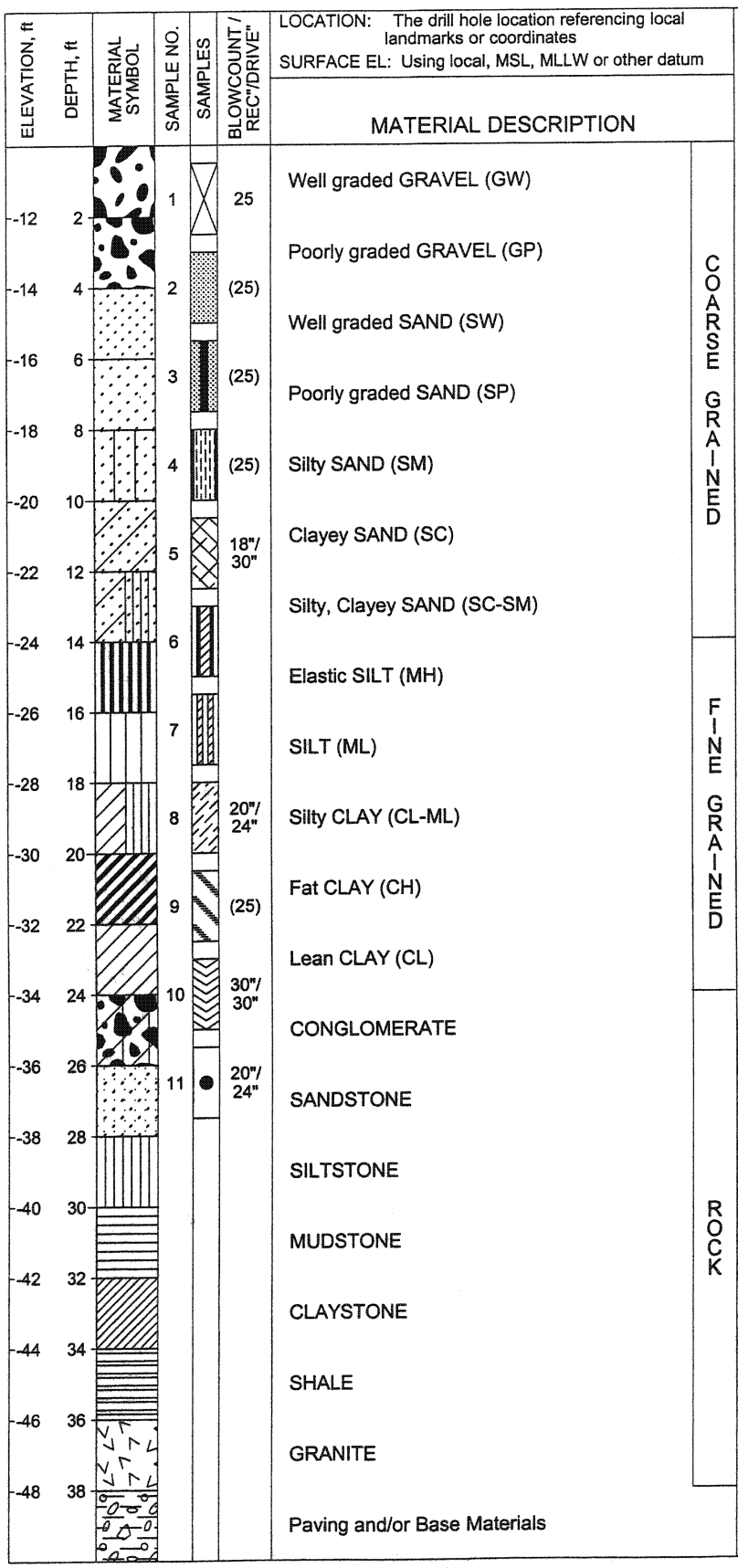
The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

## LOG OF BORING NO. B-CPT-22

RiverPark B

El Rio Area, Ventura County, California

PLATE A-2.9b




## General Notes

Soil Texture Symbol

Sloped line in symbol column indicates transitional boundary

Samplers and sampler dimensions (unless otherwise noted in report text) are as follows:

Symbol for:

| | |
|---|---|
| 1 | SPT Sampler, driven 1 3/8" ID, 2" OD |
| 2 | CA Liner Sampler, driven 2 3/8" ID, 3" OD |
| 3 | CA Liner Sampler, disturbed 2 3/8" ID, 3" OD |
| 4 | Thin-walled Tube, pushed 2 7/8" ID, 3" OD |
| 5 | Bulk Bag Sample (from cuttings) |
| 6 | Hand Auger Sample |
| 7 | CME Core Sample |
| 8 | Lexan Sample |
| 9 | Pitcher Sample |
| 10 | Vibracore Sample |
| 11 | No Sample Recovered |

Sampler Driving Resistance

Number of blows with 140 lb. hammer, falling 30-in. to drive sampler 1-ft. after seating sampler 6-in.; for example,

| Blows/ft | Description |
|---|---|
| 25 | 25 blows drove sampler 12" after initial 6" of seating |
| 86/11" | After driving sampler the initial 6" of seating, 36 blows drove sampler through the second 6" interval, and 50 blows drove the sampler 5" into the third interval |
| 50/6" | 50 blows drove sampler 6" after initial 6" of seating |
| Ref/3" | 50 blows drove sampler 3" during initial 6" seating interval |

Blow counts for California Liner Sampler shown in ( )

Length of sample symbol approximates recovery length

Classification of Soils per ASTM D2487 or D2488

Geologic Formation noted in bold font at the top of interpreted interval

Strength Legend

Q = Unconfined Compression
u = Unconsolidated Undrained Triaxial
t = Torvane
p = Pocket Penetrometer
m = Miniature Vane

Water Level Symbols

- Initial or perched water level
- Final ground water level
- Seepages encountered

Rock Quality Designation (RQD) is the sum of recovered core pieces greater than 4 inches divided by the length of the cored interval.

# KEY TO TERMS & SYMBOLS USED ON LOGS

PLATE A-2.10

# APPENDIX B
# LABORATORY TESTING

# APPENDIX B
# LABORATORY TESTING

Laboratory tests were performed on selected undisturbed and bulk soil samples to estimate engineering characteristics of the various earth materials encountered. Testing was performed in accordance with ASTM Standards for Soil Testing, latest revision on as noted otherwise. The results of the laboratory analyses are summarized on Plate B-1 - Summary of Laboratory Test Results.

## Laboratory Moisture and Density Determinations

Moisture content and dry density determinations were performed on selected undisturbed samples collected to evaluate the natural water content and dry density of the various soils encountered. The results are presented on Plates A-2.1 through A-2.9.

## Grain-Size Distribution

Grain size distribution with hydrometer were determined for two soil samples in accordance with standard test method ASTM D422. In addition, we performed tests to determine the amount of material in soils finer than the No. 200 Sieve in accordance with ASTM test method D1140. The grain-size curves are presented on Plate B-2 Grain Size Curves, and the results of percent passing the No. 200 sieve (or fines content) are presented on Plates A-2.1 through A-2.9.

## Atterberg Limits Tests

Atterberg limits tests were performed a two selected samples of fine-grained materials. Liquid and plastic limits were determined in accordance with standard test methods ASTM D423 and D424. The test results are shown on Plate B-3 - Plasticity Chart.

## Consolidation Tests

Two consolidation tests were performed on selected samples of the clayey soils. Samples were incrementally loaded to the approximate overburden pressure and then inundated, followed by incremental loading to the maximum consolidation pressure. One test was unloaded and reloaded during the cycle. The tests were conducted in accordance with ASTM D2435, Standard Test Method for One-Dimensional Consolidation Properties of Soils.

Additionally, modified one-dimensional consolidation tests were performed to estimate the hydroconsolidation (collapse) potential of the topsoil. Two samples were loaded to the approximate overburden pressure and then inundated with water. The collapse potential was

measured after each sample had come to equilibrium after inundation. The results of the consolidation and hydroconsolidation tests are presented on Plates B-4a through B-4d - Consolidation Test Results.

| LOCATION / SAMPLE NUMBER / DEPTH, ft | SAMPLE CLASSIFICATION | | | | | | COMPACTION TEST | | DIRECT SHEAR TEST | | COMPRESSIVE STRENGTH TESTS | | CORROSIVITY TESTS | | | | R-VALUE | SAND EQUIVALENT (SE) | TEST LISTING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UWW pcf | UDW pcf | MC % | FINES % | LL % | PI % | MAX DD pcf | OPT MC % | C ksf | PHI deg | $Q_u$ ksf | $S_u$ Cell Prs. ksf | R | pH | Cl | $SO_4$ | | | |
| B-1 1 4.5 | SAND (SP) 104 | 101 | 3 | | | | | | | | | | | | | | | | T,M |
| B-1 2 6.5 | SAND (SP) 109 | 106 | 3 | | | | | | | | | | | | | | | | T,M,C |
| B-1 4 15.8 | SAND (SP) 114 | 110 | 4 | | | | | | | | | | | | | | | | T,M |
| B-1 5 20.8 | SAND (SP) 113 | 109 | 4 | 8 | | | | | | | | | | | | | | | T,M,F |
| B-1 7 30.8 | SAND (SP) | | 4 | | | | | | | | | | | | | | | | M |
| B-2 1 2.8 | SAND with gravel (SP) 95 | 91 | 4 | | | | | | | | | | | | | | | | T,M |
| B-2 2 5.8 | Silty SAND with gravel (SM) 106 | 103 | 3 | | | | | | | | | | | | | | | | T,M |
| B-2 3 10.8 | Silty SAND (SM) 107 | 92 | 16 | | | | | | | | | | | | | | | | T,M,C |
| B-2 5 20.8 | Silty SAND with gravel (SM) 108 | 102 | 6 | | | | | | | | | | | | | | | | T,M |
| B-2 7 30.8 | Silty SAND with gravel (SM) 107 | 103 | 4 | | | | | | | | | | | | | | | | T,M |

**Classification Tests**
UWW = Unit Wet Weight
UDW = Unit Dry Weight
MC = Moisture Content
Fines = % passing #200 Sieve
LL = Liquid Limit
PI = Plasticity Index

**Compaction Test**
MAX DD = Maximum Dry Density
OPT MC = Optimum Moisture Content

**Direct Shear Test**
C = Assigned Cohesion, ksf
PHI = Assigned Friction Angle, degrees

**Compressive Strength Tests**
Qu = Unconfined Compression
Su = Undrained Shear Strength
u = Unconsolidated Undrained
p = Pocket Penetrometer
t = Torvane
m = Miniature Vane

**Corrosivity Tests**
R = Resistivity, ohm-cm, satur.
pH = pH
Cl = Chloride, ppm
$SO_4$ = Sulfate, ppm

**Test Listing Abbreviations**
M = Moisture Content
T = Total & Dry Density
S = Sieve Analysis
F = % Passing #200 Sieve
H = Hydrometer Analysis
A = Atterberg Limits
P = Compaction Test
D = Direct Shear Test
C = Consolidation Test
Co = Corrosivity Tests
CU = CU Triaxial
U = UU Triaxial
R = R-value (saturated)
E = Expansion Index

# SUMMARY OF LABORATORY TEST RESULTS

RiverPark B, El Rio Area, Ventura County, California

PLATE B-1a

LAB SUMMARY(12/16/99)05:12 PM)

October 1999
Project No. 99-42-0021

| LOCATION / SAMPLE NUMBER / DEPTH, ft | SAMPLE CLASSIFICATION | UWW pcf | UDW pcf | MC % | FINES % | LL % | PI % | COMPACTION TEST: MAX DD pcf | COMPACTION TEST: OPT MC % | DIRECT SHEAR TEST: C ksf | DIRECT SHEAR TEST: PHI deg | COMPRESSIVE STRENGTH TESTS: $Q_u$ ksf | COMPRESSIVE STRENGTH TESTS: $S_u$ Cell Prs. ksf | CORROSIVITY TESTS: R | CORROSIVITY TESTS: pH | CORROSIVITY TESTS: Cl | CORROSIVITY TESTS: $SO_4$ | R-VALUE | SAND EQUIVALENT (SE) | TEST LISTING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-2 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 35.8 | | | | | 15 | | | | | | | | | | | | | | | F |
| B-3 1 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 2.8 | | 118 | 113 | 4 | | | | | | | | | | | | | | | | T,M |
| B-3 2 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 5.8 | | 116 | 110 | 5 | | | | | | | | | | | | | | | | T,M |
| B-3 3 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 10.8 | | 109 | 102 | 7 | | | | | | | | | | | | | | | | T,M |
| B-3 4 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 15.8 | | 106 | 102 | 4 | | | | | | | | | | | | | | | | T,M |
| B-3 6 | SAND (SP) | | | | | | | | | | | | | | | | | | | |
| 25.8 | | 104 | 99 | 5 | | | | | | | | | | | | | | | | T,M |
| B-3 7 | SAND (SP) | | | | | | | | | | | | | | | | | | | |
| 30.8 | | | | 6 | | | | | | | | | | | | | | | | M |
| B-3 8 | SAND (SP) | | | | | | | | | | | | | | | | | | | |
| 40.8 | | | | 22 | | | | | | | | | | | | | | | | M |
| B-4 1 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 2.8 | | 110 | 105 | 5 | | | | | | | | | | | | | | | | T,M |
| B-4 2 | Silty SAND with gravel (SM) | | | | | | | | | | | | | | | | | | | |
| 5.8 | | 113 | 106 | 7 | | | | | | | | | | | | | | | | T,M |

**Classification Tests**
UWW = Unit Wet Weight
UDW = Unit Dry Weight
MC = Moisture Content
Fines = % passing #200 Sieve
LL = Liquid Limit
PI = Plasticity Index

**Compaction Test**
MAX DD = Maximum Dry Density
OPT MC = Optimum Moisture Content

**Direct Shear Test**
C = Assigned Cohesion, ksf
PHI = Assigned Friction Angle, degrees

**Compressive Strength Tests**
Qu = Unconfined Compression
Su = Undrained Shear Strength
u = Unconsolidated Undrained
p = Pocket Penetrometer
t = Torvane
m = Miniature Vane

**Corrosivity Tests**
R = Resistivity, ohm-cm, satur.
pH = pH
Cl = Chloride, ppm
$SO_4$ = Sulfate, ppm

**Test Listing Abbreviations**
M = Moisture Content
T = Total & Dry Density
S = Sieve Analysis
F = % Passing #200 Sieve
H = Hydrometer Analysis
A = Atterberg Limits
P = Compaction Test
D = Direct Shear Test
C = Consolidation Test
Co = Corrosivity Tests
CU = CU Triaxial
U = UU Triaxial
R = R-value (saturated)
E = Expansion Index

# SUMMARY OF LABORATORY TEST RESULTS

RiverPark B, El Rio Area, Ventura County, California

PLATE B-1b

_LAB SUMMARY(12/16/99)05:12 PM)

| LOCATION / SAMPLE NUMBER / DEPTH, ft | SAMPLE CLASSIFICATION | UWW pcf | UDW pcf | MC % | FINES % | LL % | PI % | COMPACTION TEST: MAX DD pcf | COMPACTION TEST: OPT MC % | DIRECT SHEAR TEST: C ksf | DIRECT SHEAR TEST: PHI deg | COMPRESSIVE STRENGTH TESTS: $Q_u$ ksf | COMPRESSIVE STRENGTH TESTS: $S_u$ Cell Prs. ksf | CORROSIVITY TESTS: R | CORROSIVITY TESTS: pH | CORROSIVITY TESTS: Cl | CORROSIVITY TESTS: $SO_4$ | R-VALUE | SAND EQUIVALENT (SE) | TEST LISTING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-4 3 | Silty SAND with gravel (SM) | | | | | | | | | | | | | | | | | | | |
| 10.8 | | 110 | 106 | 4 | | | | | | | | | | | | | | | | T,M |
| B-4 4 | Silty SAND with gravel (SM) | | | | | | | | | | | | | | | | | | | |
| 15.8 | | 112 | 105 | 7 | | | | | | | | | | | | | | | | T,M |
| B-4 6 | Silty SAND with gravel (SM) | | | | | | | | | | | | | | | | | | | |
| 25.8 | | 113 | 108 | 5 | | | | | | | | | | | | | | | | T,M |
| B-4 | Silty SAND with gravel (SM) | | | | | | | | | | | | | | | | | | | |
| 30.8 | | | | | 10 | | | | | | | | | | | | | | | F |
| B-4 | Lean CLAY (CL) | | | | | | | | | | | | | | | | | | | |
| 36.0 | | 124 | 103 | 20 | | | | | | | | | | | | | | | | T,M,C |
| B-4 9 | Interlayered SILT (ML) and Lean CLAY (CL) | | | | | | | | | | | | | | | | | | | |
| 40.8 | | | | 27 | | | | | | | | | | | | | | | | M |
| B-5 1 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 5.8 | | 106 | 103 | 3 | | | | | | | | | | | | | | | | T,M |
| B-5 2 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 10.8 | | 111 | 107 | 4 | | | | | | | | | | | | | | | | T,M |
| B-5 3 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 15.8 | | | | 4 | | | | | | | | | | | | | | | | M |
| B-5 4 | Silty SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 20.8 | | 106 | 102 | 4 | | | | | | | | | | | | | | | | T,M |

**Classification Tests**
UWW = Unit Wet Weight
UDW = Unit Dry Weight
MC = Moisture Content
Fines = % passing #200 Sieve
LL = Liquid Limit
PI = Plasticity Index

**Compaction Test**
MAX DD = Maximum Dry Density
OPT MC = Optimum Moisture Content

**Direct Shear Test**
C = Assigned Cohesion, ksf
PHI = Assigned Friction Angle, degrees

**Compressive Strength Tests**
Qu = Unconfined Compression
Su = Undrained Shear Strength
u = Unconsolidated Undrained
p = Pocket Penetrometer
t = Torvane
m = Miniature Vane

**Corrosivity Tests**
R = Resistivity, ohm-cm, satur.
pH = pH
Cl = Chloride, ppm
$SO_4$ = Sulfate, ppm

**Test Listing Abbreviations**
M = Moisture Content
T = Total & Dry Density
S = Sieve Analysis
F = % Passing #200 Sieve
H = Hydrometer Analysis
A = Atterberg Limits
P = Compaction Test
D = Direct Shear Test
C = Consolidation Test
Co = Corrosivity Tests
CU = CU Triaxial
U = UU Triaxial
R = R-value (saturated)
E = Expansion Index

## SUMMARY OF LABORATORY TEST RESULTS

RiverPark B, El Rio Area, Ventura County, California

PLATE B-1c

LAB SUMMARY(12/7/99)05:12 PM)

| LOCATION / SAMPLE NUMBER / DEPTH, ft | SAMPLE CLASSIFICATION | | | | | | COMPACTION TEST | | DIRECT SHEAR TEST | | COMPRESSIVE STRENGTH TESTS | | CORROSIVITY TESTS | | | | R-VALUE | SAND EQUIVALENT (SE) | TEST LISTING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UWW pcf | UDW pcf | MC % | FINES % | LL % | PI % | MAX DD pcf | OPT MC % | C ksf | PHI deg | $Q_u$ ksf | $S_u$ Cell Prs. ksf | R | pH | Cl | $SO_4$ | | | |
| B-5 | Lean CLAY (CL) | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | |
| 27.8 | 116 | 88 | 32 | | | | | | | | | | | | | | | | T,M |
| B-CPT-1 | SAND (SP) | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | |
| 15.8 | | | | 9 | | | | | | | | | | | | | | | F |
| B-CPT-1 | Lean CLAY (CL) | | | | | | | | | | | | | | | | | | |
| 30.8 | | | 29 | | 43 | 22 | | | | | | | | | | | | | M, A |
| B-CPT-1 | Lean CLAY (CL) | | | | | | | | | | | | | | | | | | |
| 31.0 | | | | 85 | | | | | | | | | | | | | | | H |
| B-CPT-1 | Lean CLAY (CL) | | | | | | | | | | | | | | | | | | |
| 45.8 | | | | 81 | | | | | | | | | | | | | | | F |
| B-CPT-11 | Fine to medium SAND (SP) | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | |
| 20.8 | | | 25 | | | | | | | | | | | | | | | | M |
| B-CPT-11 | Fat CLAY (CH) | | | | | | | | | | | | | | | | | | |
| 26.0 | 126 | 103 | 23 | | 50 | 28 | | | | | | | | | | | | | T,M,A |
| B-CPT-11 | Fine sandy SILT (ML) | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | |
| 40.8 | | | | 94 | | | | | | | | | | | | | | | F |
| B-CPT-13 | SAND (SP) | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | |
| 10.8 | | | | 8 | | | | | | | | | | | | | | | F |
| B-CPT-13 | Silty fine SAND (SM) | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | |
| 20.8 | | | | 41 | | | | | | | | | | | | | | | F |

**Classification Tests**
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C = Consolidation Test
Co = Corrosivity Tests
CU = CU Triaxial
U = UU Triaxial
R = R-value (saturated)
E = Expansion Index

# SUMMARY OF LABORATORY TEST RESULTS

RiverPark B, El Rio Area, Ventura County, California

PLATE B-1d

LAB SUMMARY(12/16/99)05:12 PM)

LAB SUMMARY(12/16/99)05:12 PM)

| LOCATION / SAMPLE NUMBER / DEPTH, ft | SAMPLE CLASSIFICATION | UWW pcf | UDW pcf | MC % | FINES % | LL % | PI % | COMPACTION TEST: MAX DD pcf | COMPACTION TEST: OPT MC % | DIRECT SHEAR TEST: C ksf | DIRECT SHEAR TEST: PHI deg | COMPRESSIVE STRENGTH TESTS: $Q_u$ ksf | COMPRESSIVE STRENGTH TESTS: $S_u$ Cell Prs. ksf | CORROSIVITY TESTS: R | CORROSIVITY TESTS: pH | CORROSIVITY TESTS: Cl | CORROSIVITY TESTS: $SO_4$ | R-VALUE | SAND EQUIVALENT (SE) | TEST LISTING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-CPT-13 | Silty fine SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 25.8 | | | | | 28 | | | | | | | | | | | | | | | F |
| B-CPT-13 | Sandy SILT (ML) | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | |
| 40.8 | | | | | 52 | | | | | | | | | | | | | | | F |
| B-CPT-22 | Silty Fine to Medium SAND (SM) | | | | | | | | | | | | | | | | | | | |
| 21.0 | | | | | 32 | | | | | | | | | | | | | | | F |
| B-CPT-22 | Sandy SILT (ML) | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | |
| 31.8 | | | | | 56 | | | | | | | | | | | | | | | F |
| B-CPT-22 | Medium SAND (SP) | | | | | | | | | | | | | | | | | | | |
| 46.8 | | | | | 8 | | | | | | | | | | | | | | | F |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

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UWW = Unit Wet Weight
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**Compressive Strength Tests**
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P = Compaction Test
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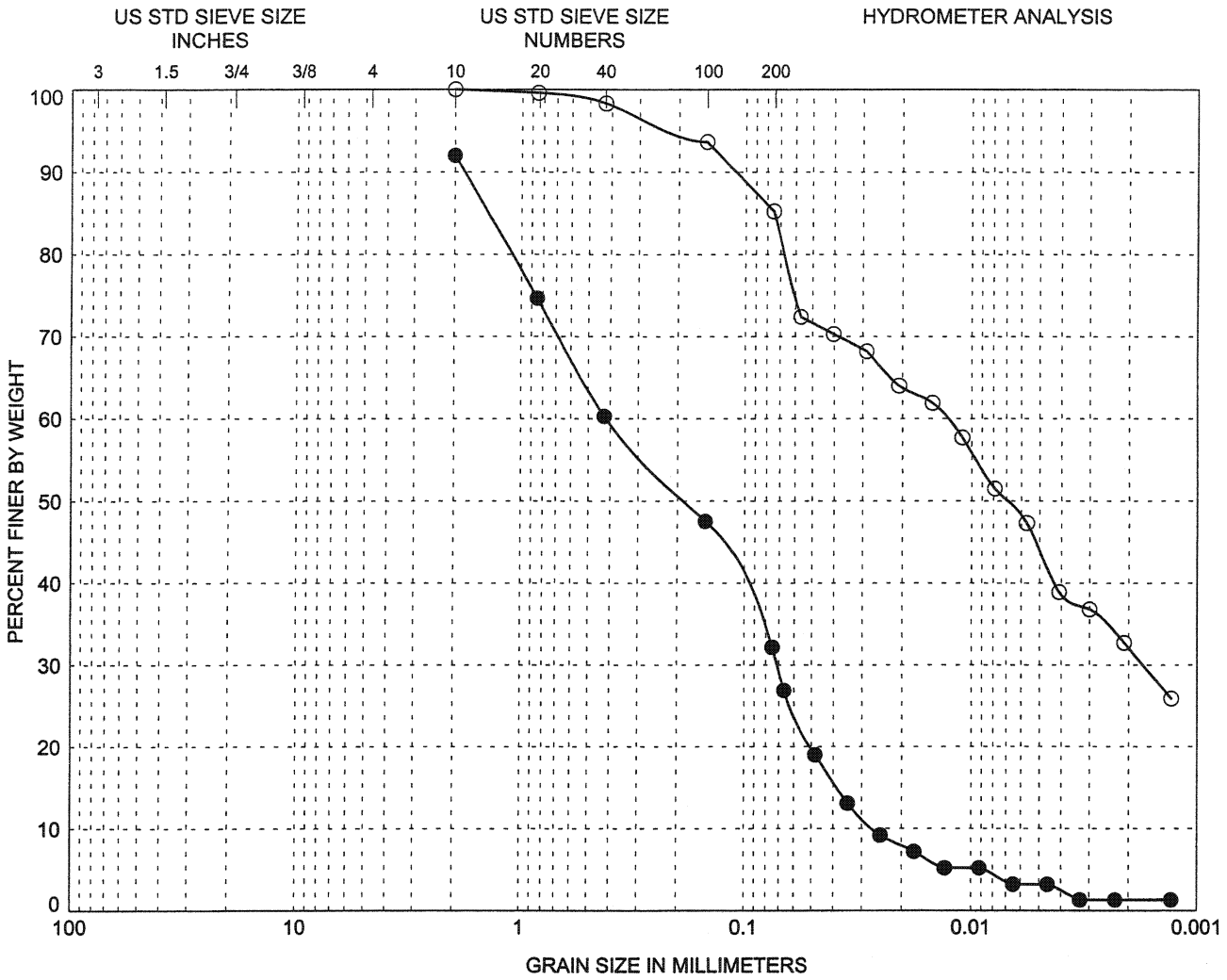
C = Consolidation Test
Co = Corrosivity Tests
CU = CU Triaxial
U = UU Triaxial
R = R-value (saturated)
E = Expansion Index

PLATE B-1e

# SUMMARY OF LABORATORY TEST RESULTS

RiverPark B, El Rio Area, Ventura County, California

TUGRO

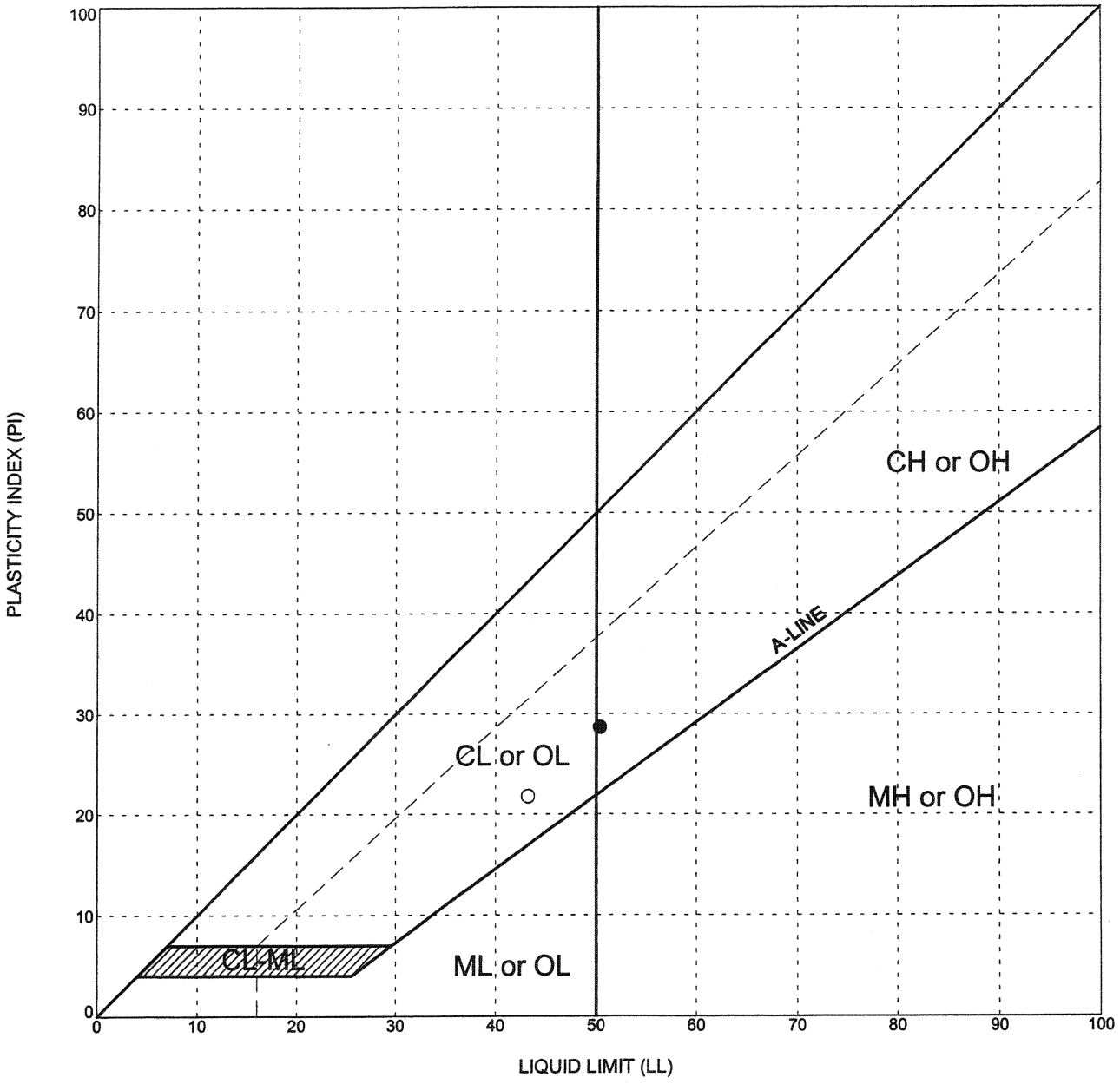



| LEGEND | (location) | (depth,ft) |
|---|---|---|
| ○ | B-CPT-1 | 31.0 |
| ● | B-CPT-22 | 21.0 |

| CLASSIFICATION |
|---|
| Lean CLAY (CL) |
| Silty Fine to Medium SAND (SM) |

**GRAIN SIZE CURVES**
RiverPark B
El Rio Area, Ventura County, California

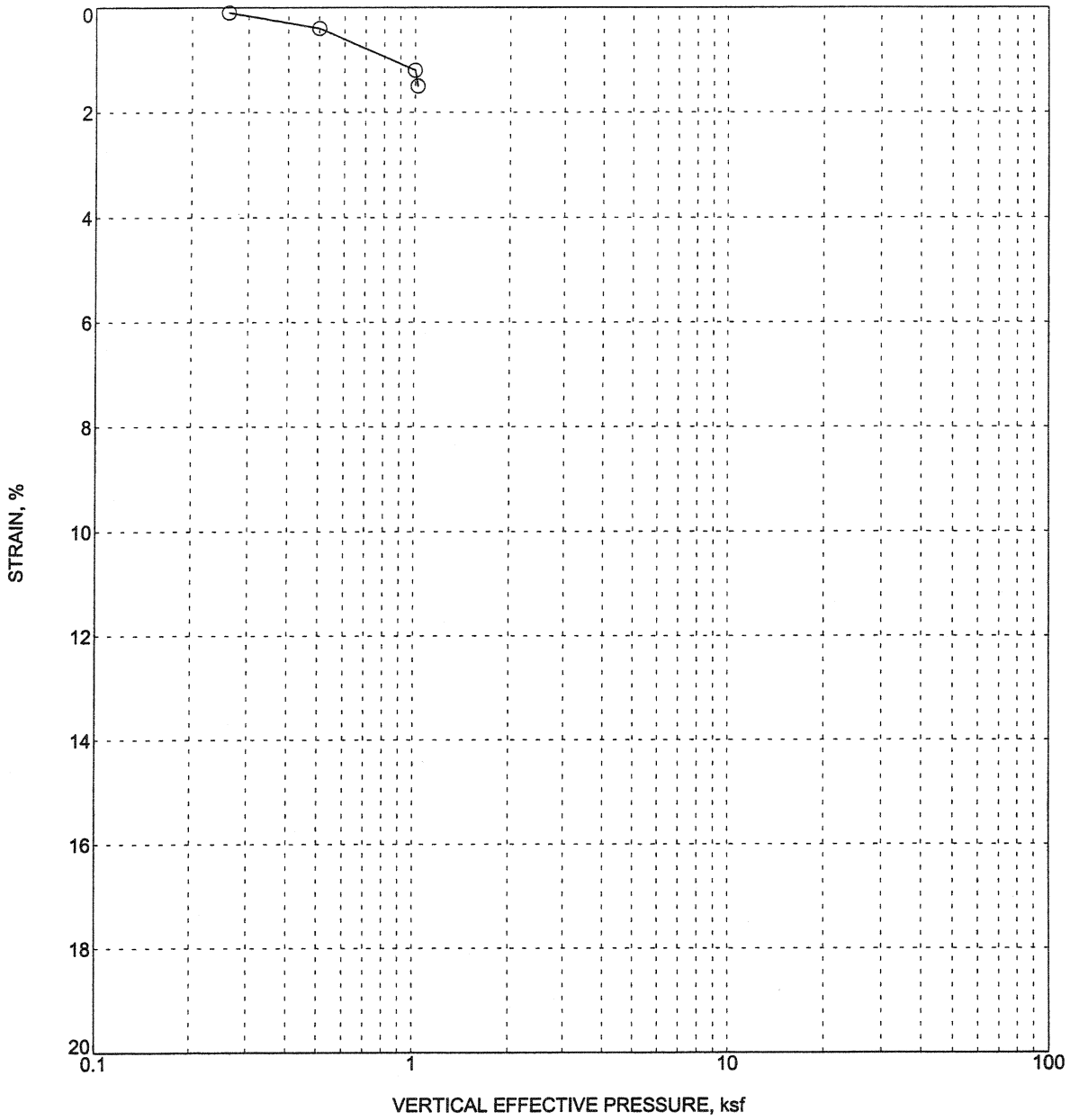
PLATE B-2




| LEGEND | | | CLASSIFICATION | ATTERBERG LIMITS TEST RESULTS | | |
|---|---|---|---|---|---|---|
| | (location) | (depth,ft) | | LIQUID LIMIT(LL) | PLASTIC LIMIT(PL) | PLASTICITY INDEX (PI) |
| ○ | B-CPT-1 | 30.8 | Lean CLAY (CL) | 43 | 21 | 22 |
| ● | B-CPT-11 | 26.0 | Fat CLAY (CH) | 50 | 22 | 28 |

**PLASTICITY CHART**
RiverPark B
El Rio Area, Ventura County, California

PLATE B-3



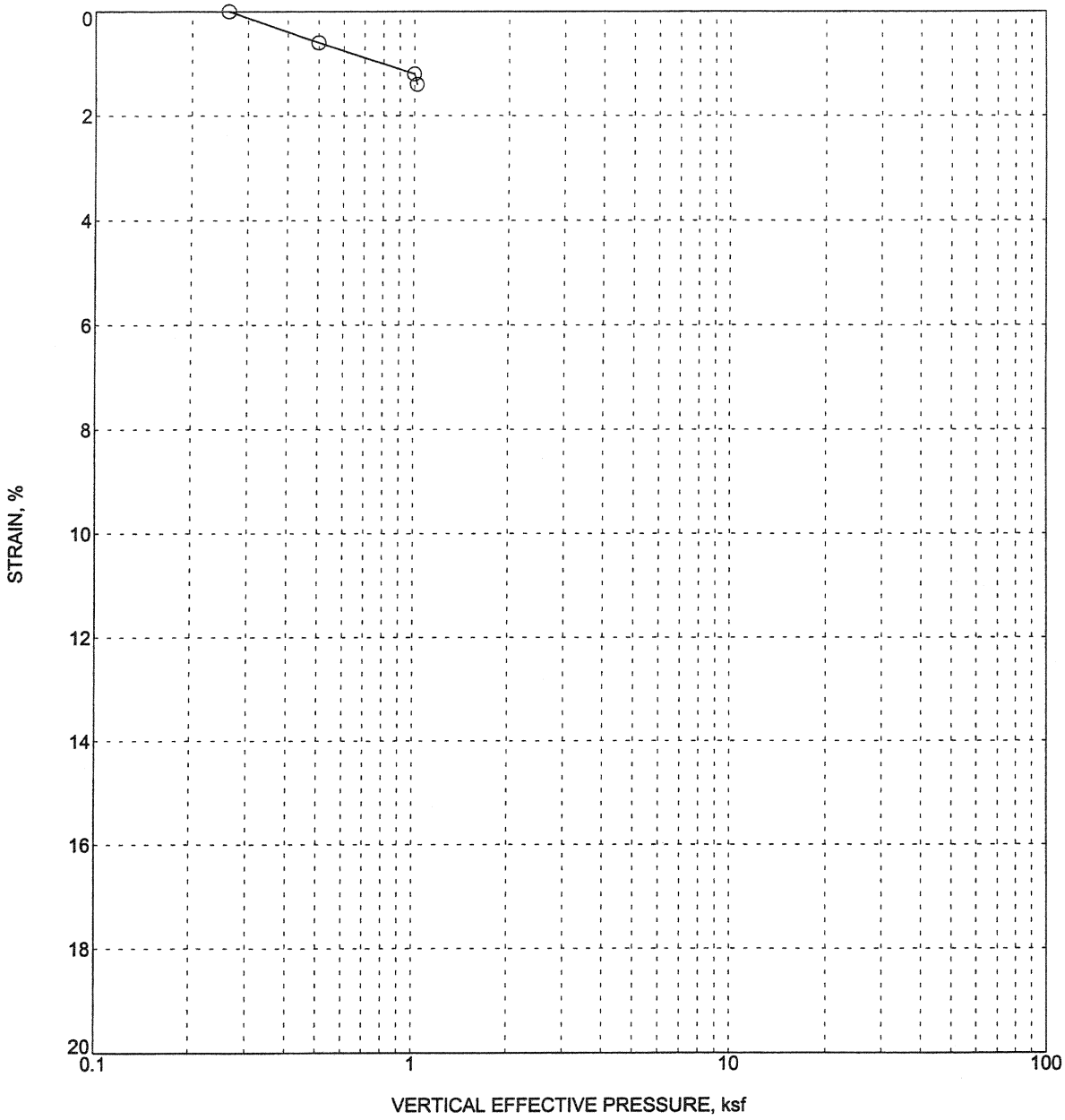

| | |
|---|---|
| LOCATION | B-1 |
| DEPTH, ft | 6.5 |
| INITIAL MOISTURE CONTENT, % | 3 |
| UNIT DRY WEIGHT, pcf | 106 |
| MATERIAL DESCRIPTION | SAND (SP) |
| SAMPLE CONDITION | Liner Sample |

## CONSOLIDATION TEST RESULTS

RiverPark B

El Rio Area, Ventura County, California

PLATE B-4a



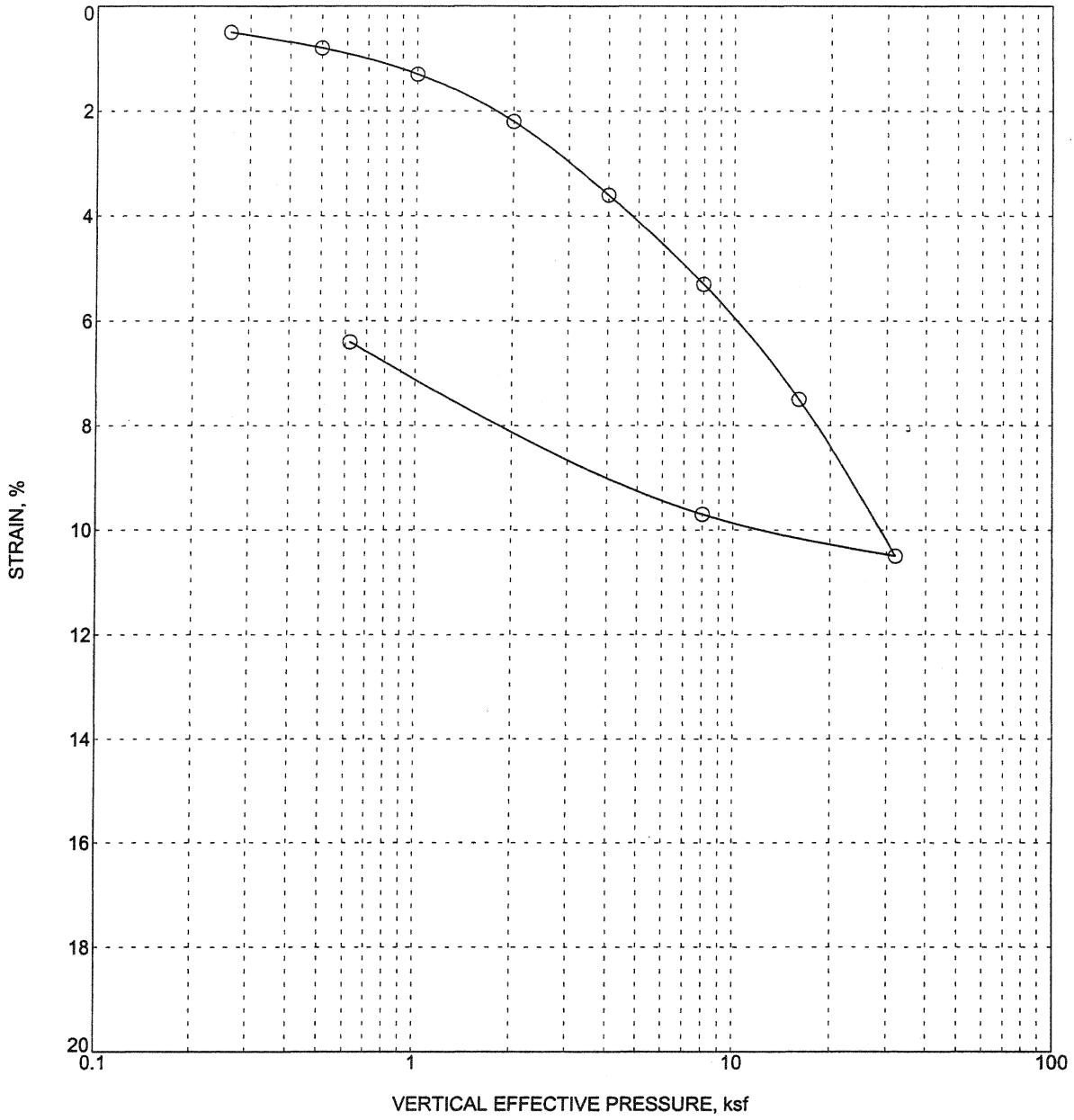

| | |
|---|---|
| LOCATION | B-2 |
| DEPTH, ft | 10.8 |
| INITIAL MOISTURE CONTENT, % | 16 |
| UNIT DRY WEIGHT, pcf | 92 |
| MATERIAL DESCRIPTION | Silty SAND (SM) |
| SAMPLE CONDITION | Liner Sample |

## CONSOLIDATION TEST RESULTS

RiverPark B

El Rio Area, Ventura County, California

PLATE B-4b



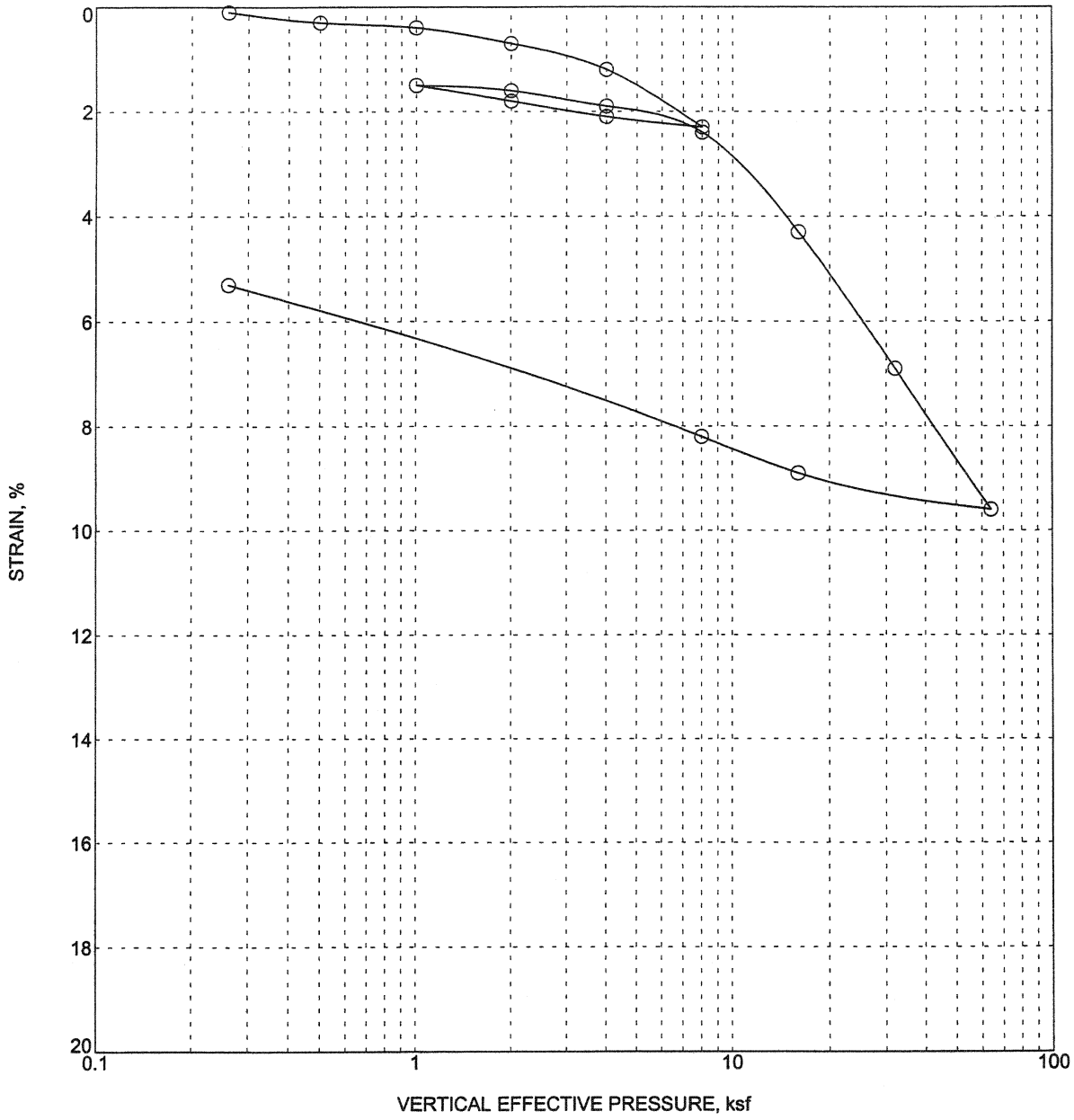

| | |
|---|---|
| LOCATION | B-4 |
| DEPTH, ft | 36.0 |
| INITIAL MOISTURE CONTENT, % | 20 |
| UNIT DRY WEIGHT, pcf | 103 |
| MATERIAL DESCRIPTION | Lean CLAY (CL) |
| SAMPLE CONDITION | Liner Sample |

## CONSOLIDATION TEST RESULTS

RiverPark B

El Rio Area, Ventura County, California

PLATE B-4c




| | |
|---|---|
| LOCATION | B-CPT-11 |
| DEPTH, ft | 26.0 |
| INITIAL MOISTURE CONTENT, % | 23 |
| UNIT DRY WEIGHT, pcf | 103 |
| MATERIAL DESCRIPTION | Fat CLAY (CH) |
| SAMPLE CONDITION | Shelby Tube Sample |

## CONSOLIDATION TEST RESULTS

RiverPark B

El Rio Area, Ventura County, California

PLATE B-4d

# APPENDIX 4.4
## Biological Data

# RARE PLANT AND VEGETATION SURVEYS

# RIVERPARK SPECIFIC PLAN SITE, OXNARD, VENTURA COUNTY, CA

*Submitted to:*

*IMPACT SCIENCES, INC.*
*30343 Canwood Street, Suite 210*
*Agoura Hills, CA 91301*
*ATTN: Dave Crawford*

Submitted by:

Anuja Parikh, Ph.D., PWS
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May 2001

## 1. INTRODUCTION

The RiverPark Specific Plan site in the City of Oxnard, Ventura County, California, was surveyed for rare plant species on May 2 and 3, 2001, by a team of two consultants from FL*x* (Dr. Anuja Parikh and Dr. Nathan Gale). The site occupies approximately 720 acres, and is bordered by the Santa Clara River to the northwest, Vineyard Avenue to the southeast, and Highway 101 to the southwest. Residential development surrounds most of the RiverPark project area; the site itself is occupied mostly by agricultural fields and mining operations.

All areas with some vegetation cover were surveyed on foot, and most of the roads present on the site were driven. Bare or cleared areas in the mining property and fields currently under planting were not examined, since there is no potential habitat for rare plants in such areas. Species nomenclature in this report follows Hickman (1993).

## 2. RARE PLANT SPECIES

Rare plant species previously reported in the region by the CNDDB include Coulter's goldfields (*Lasthenia glabrata* ssp. *coulteri*), Orcutt's pincushion (*Chaenactis glabriuscula* var. *orcuttiana*), and salt marsh bird's beak (*Cordylanthus maritimus* ssp. *maritimus*). The current rare plant surveys were carried out in May to accommodate the blooming periods of these species. Ventura marsh milk-vetch (*Astragalus pycnostachyus* var. *lanosissimus*) also has been reported in the vicinity, and although it blooms later in the summer, it can be recognized in vegetative form and therefore also was included in the targeted search. The habitats for these species include vernal pools, coastal salt marshes, coastal dunes, and coastal bluff scrub. None of these habitats occurs on the RiverPark site. Although all sensitive species that potentially could occur were searched for, none was found during the current surveys. It is very unlikely that any rare plants exist on the site due to the lack of appropriate habitats. The entire site has been disturbed previously by grading, disking, or vegetation clearing, and habitat quality of the surveyed areas generally is poor. Summer surveys for late-blooming plants are not considered necessary.

## 3. VEGETATION PRESENT IN THE SURVEY AREAS

Vegetation found on the RiverPark site includes mostly non-native grassland and ruderal species. Species elements of native plant communities such as coastal sage scrub, mule fat scrub, southern willow scrub, and marsh occur scattered in areas that are all disturbed or artificially modified. All native species occurrences also are degraded by weedy species and introduced annual grasses.

A description of vegetation found in the various survey areas labelled on the map is provided below. Areas that were in active use for agriculture or mining were not surveyed.

**Area A.** This area in the southern part of the site has been disked previously. It is dominated by annual grasses including hare barley (*Hordeum murinum*), ripgutgrass (*Bromus diandrus*), and wild oat (*Avena fatua*), and by herbaceous weedy species including radish (*Raphanus sativus*), sourclover (*Melilotus indicus*), California burclover (*Medicago polymorpha*), and mallows (*Malva* spp.). A pepper tree is present near the center of the area. The only native species noted were arroyo lupine (*Lupinus succulentus*) and western ragweed (*Ambrosia psilostachya*).

**Area B.** This area lies just north of Area A, and also has been disked previously. It is dominated by introduced grasses including hare barley (*Hordeum murinum*), wild oat (*Avena fatua*), and Bermuda grass (*Cynodon dactylon*). Weedy species include common plantain (*Plantago major*), pigweed (*Chenopodium album*), and mallows (*Malva* spp.). Landscape planting trees are present. Native plants include western ragweed (*Ambrosia psilostachya*) and a relatively large blue elderberry (*Sambucus mexicana*) tree.

**Area C.** This is a relatively long drainage ditch with culverts, running parallel to the frontage road along the freeway. There was no water flowing at the time of survey. The ditch is occupied by introduced species: annual grasses, rescue grass (*Bromus catharticus*), and curly dock (*Rumex crispus*).

**Area D.** This relatively large disked field north of the Ventura County facilities has a low grass cover, and is occupied mainly by the native common fiddleneck (*Amsinckia menziesii* var. *intermedia*), and the introduced nettle-leaved goosefoot (*Chenopodium murale*) and mallows (*Malva* spp.).

**Area E.** This triangular area between the freeway ramps is dominated by introduced annual grasses including bromegrasses (*Bromus diandrus, B. madritensis* ssp. *rubens*), oats (*Avena fatua, A. barbata*), rat-tail fescue (*Vulpia myuros* var. *hirsuta*), and hare barley (*Hordeum murinum*). Herbaceous ruderal species include shortpod mustard (*Hirschfeldia incana*), sourclover (*Melilotus indicus*), California burclover (*Medicago polymorpha*), and gazania (*Gazania linearis*). The native arroyo lupine (*Lupinus succulentus*) also is present.

**Area F.** This large disked field in the western corner of the RiverPark site is dominated by London rocket (*Sisymbrium irio*), nettle-leaved goosefoot (*Chenopodium murale*), ripgutgrass (*Bromus diandrus*), and hare barley (*Hordeum murinum*). Other less common herbaceous plants noted were the native annual bur-sage (*Ambrosia acanthicarpa*) and the non-native shepherd's purse (*Capsella bursa-pastoris*).

**Area G.** This area at the river's edge appears to have been scraped, and has disturbed gravelly soil. Native species of coastal sage scrub, mule fat scrub, and willow scrub are scattered in the area, and include California-aster (*Lessingia filaginifolia* var. *filaginifolia*), California sagebrush (*Artemisia californica*), California broom (*Lotus scoparius*), coyote brush (*Baccharis pilularis*), mule fat (*Baccharis salicifolia*), narrow-leaved willow (*Salix exigua*), Santa Barbara locoweed (*Astragalus trichopodus* var. *phoxus*), and telegraph weed (*Heterotheca grandiflora*). Non-native species also are dominant, and include clumps of giant reed (*Arundo donax*), grasses (*Bromus madritensis* ssp. *rubens, B. hordeaceus, Vulpia myuros* var. *hirsuta, Cynodon dactylon*), Italian thistle (*Carduus pycnocephalus*), sourclover (*Melilotus indicus*), white sweetclover (*Melilotus albus*), Australian saltbush (*Atriplex semibaccata*), scarlet pimpernel (*Anagallis arvensis*), and red-stemmed filaree (*Erodium cicutarium*).

**Area H.** This scraped disturbed area also near the river's edge has non-native grasses (*Bromus diandrus, B. madritensis* ssp. *rubens, Avena barbata, Vulpia myuros* var. *hirsuta*). Scattered uncommon shrubs include California-aster (*Lessingia filaginifolia* var. *filaginifolia*), coyote brush (*Baccharis pilularis*), mule fat (*Baccharis salicifolia*), and big saltbush (*Atriplex lentiformis*). Dominant herbs include tocalote (*Centaurea melitensis*), California burclover (*Medicago polymorpha*), shortpod mustard (*Hirschfeldia incana*), western ragweed (*Ambrosia psilostachya*), and telegraph weed (*Heterotheca grandiflora*).

**Area I.** This disked area is dominated by bromegrasses (*Bromus* spp.) and ruderal species including sourclover (*Melilotus indicus*) and shortpod mustard (*Hirschfeldia incana*). Nearby areas are being used for agriculture.

**Area J.** This Ventura County flood control detention basin also has been artificially dug or scraped. Scattered native and non-native wetland species occupy the basin, including brass-buttons (*Cotula coronopifolia*), Bermuda grass (*Cynodon dactylon*), dock (*Rumex* spp.), salt heliotrope (*Heliotropium curassavicum*), annual beard grass (*Polypogon monspeliensis*), weedy cudweed (*Gnaphalium luteo-album*), and horseweed (*Conyza canadensis*). Clumps of willows (*Salix lasiolepis, S. exigua, S. laevigata*), cattails (*Typha* spp.), mule fat (*Baccharis salicifolia*), bulrushes (*Scirpus* spp.), and tamarisk (*Tamarix* sp.) also are found in this area.

**Area K.** This area includes the mine pits and the slopes surrounding them. The level upland area of the basins have non-native grasses, and ruderal species dominated by sourclover (*Melilotus indicus*), tocalote (*Centaurea melitensis*), and shortpod mustard (*Hirschfeldia incana*). The slopes of the pits are relatively steep in places, and are occupied by grasses and scattered shrubs, including California-aster (*Lessingia filaginifolia* var. *filaginifolia*), coyote brush (*Baccharis pilularis*), mule fat (*Baccharis salicifolia*), arroyo willow (*Salix lasiolepis*), big saltbush (*Atriplex lentiformis*), tree tobacco (*Nicotiana glauca*), and nightshade (*Solanum douglasii*).

**Area L.** This peninsula of land extends into one of the mine pits, and has coarse to fine sandy soil that supports some smaller native herbaceous plants such as sun cup (*Camissonia* spp.), salt heliotrope (*Heliotropium curassavicum*), and cryptantha (*Cryptantha* spp.). Most of the area is dominated by tamarisk (*Tamarix* sp.), clovers (*Melilotus albus, M. indicus*), narrow-leaved willow (*Salix exigua*), California broom (*Lotus scoparius*), shortpod mustard (*Hirschfeldia incana*), and lupine (*Lupinus* sp.). Mule fat (*Baccharis salicifolia*) shrubs are scattered along the water's edge.

**Area M.** This mine pit occurs in the northeastern corner of the site. The level upland area of the pit has non-native foxtail chess (*Bromus madritensis* ssp. *rubens*), fennel (*Foeniculum vulgare*), white sweetclover (*Melilotus albus*), and shortpod mustard (*Hirschfeldia incana*). Natives include morning-glory (*Calystegia macrostegia*) and salt heliotrope (*Heliotropium curassavicum*). The slopes have scattered willows (*Salix lasiolepis, S. exigua*), mule fat (*Baccharis salicifolia*), California sagebrush (*Artemisia californica*), California-aster (*Lessingia filaginifolia* var. *filaginifolia*), coyote brush (*Baccharis pilularis*), and coast goldenbush (*Isocoma menziesii*); non-natives include tamarisk (*Tamarix* sp.), giant reed (*Arundo donax*), and castor bean (*Ricinus communis*).

**Area N.** This large area is part of the mining operations, and previously has been disturbed, dug, disked, or cleared of vegetation. Vegetation cover is variable depending on the amount of disturbance. Eucalyptus windrows are present bordering this area. A basin is present in the southern part of the area; the remainder of the area has two long ditches dug in it with level upland areas above. Dominant introduced species found in Area N are foxtail chess (*Bromus madritensis* ssp. *rubens*), clovers (*Melilotus albus, M. indicus*), and shortpod mustard (*Hirschfeldia incana*). Scattered willows (*Salix lasiolepis, S. exigua*), mule fat (*Baccharis salicifolia*), and branching phacelia (*Phacelia ramosissima*) are present on the slopes. California broom (*Lotus scoparius*), California-aster (*Lessingia filaginifolia* var. *filaginifolia*), California croton (*Croton californicus*), Santa Barbara locoweed (*Astragalus trichopodus* var. *phoxus*),

and telegraph weed (*Heterotheca grandiflora*) are native species present in more level areas. A few shrubs of blue elderberry (*Sambucus mexicana*) and black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) also were seen. Exotic species present include some giant reed (*Arundo donax*), castor bean (*Ricinus communis*), and poison hemlock (*Conium maculatum*). Coarse to fine sandy soils in Area N support some smaller native herbaceous plants such as sun cup (*Camissonia* spp.), buckwheat (*Eriogonum* spp.), and California filago (*Filago californica*).

## 4. REFERENCES

Hickman, J.C. (Editor). 1993. The Jepson Manual, Higher Plants of California. University of California Press, Berkeley, California.

The following constitutes report of my findings at Riverpark.

## SUMMARY

I made 8 surveys for Impact Sciences of the Riverpark Project ("Project") in 2001 to determine presence or absence of Least Bell's Vireo ("LBVI"), following guidelines in the USFWS's "Survey Protocol for Least Bell's Vireos", which calls for a minimum of 10 days between surveys, and up to 8 surveys during the LBVI breeding season (mid April to 31 July). Thus, dates of the surveys were: 02, 15, 22 May, 05, 22 June, 03, 18, 31 July. Weather during the 8 survey dates was relatively mild, and unseasonably cool and overcast during spring and summer of 2001. Six pairs of LBVI were found during the second survey: 1 pair was guarding a nest within 100 feet of the project on the south side of the river 150-200 meters east of US 101; 5 pairs of LBVI were found along the north side of the river, outside potential impacts of the Project (500+ feet). Only the south side pair was of potential concern to the Project. There were several vegetated areas within the Project where LBVI could have attempted to nest, all on Hanson Aggregates ("Hanson"), but LBVI were not found in any of them. Two adult Least Terns foraged over the east pond on 31 July. Other "species of concern" found on the Project were: Blue Grosbeaks and Great Blue Herons fledged young, the former at the northwest corner of the eastern pond on Hanson Aggregates, and the latter in a eucalyptus next to Hanson Aggregates' office; Red-tailed and Cooper's hawks flew overhead on several dates. A cumulative total of 92 species of birds were found during the surveys, of which 74 were confirmed, probable, or possible breeders; the remainder were migrants, winter and/or summer visitors from nearby or distant breeding sites.

## INTRODUCTION

The Project is in Oxnard in Ventura County, California, on the south side of the Santa Clara River ("SCR"), and extends from the river along US 101 south to Vineyard Avenue, then eastward along Vineyard and SCR to the east end of Hanson, upriver approximately 1.3 miles. The Project proposes to change the use of a large segment of the 720+ acres from its current industrial uses to a mix of commercial and other urban uses. While the proposed plan may change the use of the land from its intensive, often noisy and habitat-destructive activities to one more conducive to human amenities, intensity of use will likely increase as it is converted from open spaces to building and paved lots less conducive to the wildlife that have come to depend on the ponds and vegetated thickets that occupy the landscape at present.

The purpose of the Least Bell's Vireo protocol survey was to ascertain whether or not LBVI was present within the Riverpark Project, and if so, whether they used habitats within the project area for nesting or other reproductive activities. Immediately adjacent river bottom and/or upland habitats within 500 feet of the river side of the Project were investigated on 3 of the 8 surveys. Within the 720+ acres of the Project itself there were only 50-100 acres of potential LBVI habitat, all of which was on Hanson. This included riparian habitat on 3 ponds (3-East, 3-Central, and 3-West) and a large stockpile area at the northwest corner of Hanson (4-North). Other areas surveyed included several narrow strips of riparian vegetation just off site along the south edge of the river (north edge of the Project), and parallel thickets to the north part way to the main low-flow channel, within 300-500 feet of the Project; one survey was made along the north edge of the river before ascertaining that it was outside the potential impact zone of the Project.

Three areas were not surveyed: Riverpark Area A (including sections 1 and 2), an already developed office complex, and agricultural fields, comprising 250-300 acres; an agricultural field of 50+ acres (4-Southwest); and a small pit along Vineyard (4-South) of 10 or so acres just east of the Hanson entrance, which was inaccessible and unlikely to harbor LBVI. About 200 acres of Hanson was unlikely to be of use to LBVI, because it was the aggregate plant itself or open water. Thus, 100 acres of the Project constituted the study area, most of which was within Hanson, with a small portion along the south edge of the river, just outside the north boundary of the Project.

## METHODS

Surveys were conducted by Jim Greaves (Endangered Species Permit # TE-769931). This permits use of taped playback of the LBVI calls to elicit responses from otherwise quiet or resting birds that could be overlooked during simple walking surveys. In this way absence is best determined. Observations were made through 8-10 power binoculars, and bird identifications were made by sight and sound, and were recorded on bird lists prepared prior to entering the field. Locations of any significant sightings were to be marked on maps in the field.

## RESULTS

Least Bell's Vireos were not found within the confines of the Project. However, one pair was in a location that had 1-2 pairs in each of the 3 previous years near the northwest corner of the Project; the area was investigated on 3 visits, and the birds bred successfully at least once.

There were 5 LBVI pairs found nesting along the north edge of SCR on 15 May, one of which was fledging young that day, but since their territories were outside the 500 foot minimum distance required for construction activities by CDFG, they were not monitored further for this Project.

Ninety-two species of birds were found during the survey of the Project in 2001. Dozens of birds used thickets in the pond areas at Hanson; several water bird species were successful in producing young from both floating and upland nest sites (Table 1): American Coot and Pied-billed Grebe nests were seen on the ponds, as were their young. Mallards bred throughout the area (2 nests were found, 40 meters and 150 meters from water, on the edge of the east pond and in the western stockpile area, respectively). Flightless Spotted Sandpiper chicks were found along the edge of the central pond, and a large colony of Red-winged Blackbirds bred in the riparian thicket of the central pond at Hanson. There were 24 confirmed breeders (*, Table 1) on Hanson that could be potentially impacted by the Project. Another 50 species that were noted could breed on the Project site and could be adversely affected, because they were found immediately adjacent (along south edge of SCR), and/or are known to breed on SCR elsewhere (personal observations; USFWS, Ventura Field Office, unpublished data).

## DISCUSSION

CDFG does not distinguish between "naturally occurring" and artificially created wetlands and their adjacent "riparian" vegetations for mitigation purposes (Morgan Wehtje, CDFG, personal communication). Because riparian and riparian upland vegetation grows rapidly when untended, extensive thickets had grown up around the edges of and within the ponds on Hanson, as well as in the stockpile area. These consisted of Mulefat, Tamarisk and Sandbar Willow (Baccharis salicifolia, Tamarisk sp, and Salix exigua) and associated non-woody weeds of sufficient age and structure to support several pairs of LBVI. Proximity of successfully nesting LBVI (on the south and north sides of SCR) indicate a high probability that the species could use such nearby locations.

Despite the relative barrenness and apparent artificial appearance of habitats on Hanson, a relatively high number of the total species found either bred or had the potential to breed on site; 22 of 24 "confirmed breeders" were on Hanson (Table 1; LBVI and Hutton's vireo were along the river off site). Most of those listed as "probable breeders" (eg, Ruddy Duck, Anna's Hummingbird, Mourning and Rock doves, etc) for which nests and young were not confirmed, would be expected to breed in similar habitats nearby. Thus, even such places may constitute important refugia for wildlife in the ever-shrinking wild areas along the Santa Clara River.

RECOMMENDATION

In spite of the absence of LBVI (and other endangered riparian birds) on the Project itself, some mitigation should be considered for potential habitat losses and increasing adverse urbanization due to the Project. One mitigation might be to widen the area of habitat adjacent to and just north of the flood control berm, which is higher than the main river "channel", and which at present serves as a 20 meter wide right of way for aggregate company vehicles (either Hanson or some other), but which will not be needed once aggregate processing ceases in that section of the SCR. Such an area may support upland riparian vegetation which, if not merely serving as buffer between "wild" and urban zones, could function as nesting substrate for LBVI (and other birds and wildlife) just as the open spaces adjacent to and actually on the grounds of the Fillmore FishHatchery do for LBVI and other species, including SW Willow Flycatcher, another Federal and State endangered species (personal observations; USFWS, Ventura Field Office, unpublished data).

If you have questions or require clarification, please do not hesitate to contact me. I remain,

Sincerely

Jim Greaves

The following is a response by Jim Greaves regarding a request for information regarding presence/absence of southwestern willow flycatcher in the project area covered during the LBVI surveys:

If I had been targeting them, and if they had been present, I would have found them. However, during previous several summers we had not found any in that section of the river, nor did we determine that habitat in the vicinity of RiverPark looked suitable for Willow Flycatcher breeding (1991 and 2000 Zev Labinger and I, jointly for FWS; and Zev for Caltrans in 2000).

Presence or absence during migration would also have been noted, but I have not seen any in that section of the river, and do not think the habitat in the ponds at Hanson would have been a likely spot (though I could have been absent myself during a day when one or more migrants were present). The high water table in the ponds that was inundating shrubbery (tamarisk and willows, as well as mustard and some other weeds) in the earlier part of the breeding season (through June), could have provided conditions suitable to their breeding. However, the low likelihood of the species on the Santa Clara River in general, and specifically downstream of where they have been found in recent years (Saticoy upstream to Fillmore Fish Hatchery), make me satisfied that they should not have been present during my surveys as anything other than migrants.

I did not find any SW Willow Flycatcher during protocol survey for Least Bell's Vireo, which overlapped sufficiently the survey protocol period for SW Willow Flycatcher to satisfy me that none were there.

## Table 1
## Avian Species Observed or Detected on the RiverPark Project Site[1]

| Scientific Name[2] | Common Name[2] | Status[3] State/Federal and Comments |
|---|---|---|
| **Podicipedidae** | **Grebes** | |
| *Podilymbus podiceps* | Pied-billed grebe | Nests and young observed |
| *Podiceps nigricollis* | Eared grebe | |
| *Aechmophorus clarkii* | Clark's grebe | * /---<br>Migrant |
| **Phalacrocoracidae** | **Cormorants** | |
| *Phalacrocorax auritus* | Double-crested cormorant | CSC/---(rookery) |
| **Ardeidae** | **Herons** | |
| *Ardea herodias* | Great blue heron | * /--- (rookery)<br>Nests and young observed |
| *Ardea alba* | Great egret | * /--- (rookery) |
| *Egretta thula* | Snowy egret | * /--- (rookery) |
| *Nycticorax nycticorax* | Black-crowned night-heron | * /--- (rookery) |
| **Anatidae** | **Waterfowl** | |
| **Anatinae** | | |
| *Anas platyrhynchos* | Mallard | Nests and young observed |
| *Anas cyanoptera* | Cinnamon teal | |
| *Anas strepera* | Gadwall | Young observed |
| *Aythya americana* | Redhead | (possibly common porchard) |
| *Aythya collaris* | Ring-necked duck | |
| *Oxyura jamaicensis* | Ruddy duck | |
| **Cathartidae** | **New World Vultures** | |
| *Cathartes aura* | Turkey vulture | |
| **Accipitridae** | **Hawks** | |
| **Accipitrinae** | | |
| *Accipiter cooperii* | Cooper's hawk | CSC/--- (nesting) |
| *Buteo jamaicensis* | Red-tailed hawk | |
| **Odontophoridae** | **New World Quails** | |
| *Callipepla californica* | California quail | |
| **Rallidae** | **Rails & Gallinules** | |
| *Fulica americana* | American coot | Nests and young observed |
| **Charadriidae** | **Plovers** | |
| *Charadrius vociferus* | Killdeer | |
| **Recurvirostridae** | **Stilts & Avocets** | |
| *Himantopus mexicanus* | Black-necked stilt | |
| **Scolopacidae** | **Sandpipers** | |
| **Scolopacinae** | | |
| *Tringa melanoleuca* | Greater yellowlegs | |
| *Actitis macularia* | Spotted sandpiper | Young observed |
| **Laridae** | **Gulls & Terns** | |
| **Larinae** | | |
| *Larus philadelphia* | Bonaparte's gull | |
| *Larus delawarensis* | Ring-billed gull | |
| *Larus californicus* | California gull | CSC/--- (nesting colony) |
| *Larus occidentalis* | Western gull | |

## Table 1
## Avian Species Observed or Detected on the RiverPark Project Site[1]

| Scientific Name[2] | Common Name[2] | Status[3] State/Federal and Comments |
|---|---|---|
| **Sterninae** | | |
| *Sterna forsteri* | Forster's tern | CSC/--- (nesting colony)<br>Recent fledgling observed |
| **Columbidae** | **Pigeons & Doves** | |
| *Columba livia*** | Rock dove | |
| *Zenaida macroura* | Mourning dove | |
| **Cuculidae** | **Cuckoos & Roadrunners** | |
| *Geococcyx californianus* | Greater roadrunner | |
| **Caprimulgidae** | **Goatsuckers** | |
| *Chordeiles acutipennis* | Lesser nighthawk | Nest with egg observed |
| **Trochilidae** | **Hummingbirds** | |
| *Archilochus alexandri* | Black-chinned hummingbird | |
| *Calypte anna* | Anna's hummingbird | |
| *Selasphorus sasin* | Allen's hummingbird | |
| **Alcedinidae** | **Kingfishers** | |
| *Ceryle alcyon* | Belted kingfisher | |
| **Picidae** | **Woodpeckers** | |
| *Picoides nuttallii* | Nuttall's woodpecker | |
| *Picoides pubescens* | Downy woodpecker | |
| *Picoides villosus* | Hairy woodpecker | |
| **Tyrannidae** | **Tyrant Flycatchers** | |
| *Empidonax difficilis* | Pacific-slope flycatcher | |
| *Sayornis nigricans* | Black phoebe | |
| *Sayornis saya* | Say's phoebe | |
| *Myiarchus cinerascens* | Ash-throated flycatcher | |
| *Tyrannus vociferans* | Cassin's kingbird | Young observed |
| *Tyrannus verticalis* | Western kingbird | |
| **Alaudidae** | **Larks** | |
| *Eremophila alpestris actia* | California horned lark | CSC/---<br>Adult seen carrying food |
| **Hirundinidae** | **Swallows** | |
| *Tachycineta bicolor* | Tree swallow | |
| *Tachycineta thalassina* | Violet-green swallow | |
| *Stelgidopteryx serripennis* | Northern rough-winged swallow | |
| *Petrochelidon pyrrhonota* | Cliff swallow | |
| *Hirundo rustica* | Barn swallow | |
| **Corvidae** | **Jays & Crows** | |
| *Corvus brachyrhynchos* | American crow | |
| *Corvus corax* | Common raven | |
| **Paridae** | **Titmice** | |
| *Baeolophus inornatus* | Oak titmouse | |
| **Aegithalidae** | **Bushtits** | |
| *Psaltriparus minimus* | Bushtit | Nests and young observed |

## Table 1
## Avian Species Observed or Detected on the RiverPark Project Site[1]

| Scientific Name[2] | Common Name[2] | Status[3] State/Federal and Comments |
|---|---|---|
| **Troglodytidae** | **Wrens** | |
| *Thryomanes bewickii* | Bewick's wren | Young observed |
| **Turdidae** | **Thrushes** | |
| *Catharus ustulatus* | Swainson's thrush | |
| *Turdus migratorius* | American robin | |
| **Timaliidae** | **Babblers** | |
| *Chamaea fasciata* | Wrentit | |
| **Mimidae** | **Thrashers** | |
| *Mimus polyglottos* | Northern mockingbird | |
| *Toxostoma redivivum* | California thrasher | |
| **Bombycillidae** | **Waxwings** | |
| *Bombycilla cedrorum* | Cedar waxwing | Migrant |
| **Sturnidae** | **Starlings** | |
| *Sturnus vulgaris*** | European starling | Young observed |
| **Vireonidae** | **Vireos** | |
| *Vireo bellii pusillus* | Least Bell's vireo | **CE/FE** (nesting)<br>Young observed along Santa Clara River adjacent to project site |
| *Vireo huttoni* | Hutton's vireo | Young observed |
| *Vireo gilvus* | Warbling vireo | |
| **Parulidae** | **Wood Warblers** | |
| *Vermivora celata* | Orange-crowned warbler | |
| *Dendroica petechia* | Yellow warbler | **CSC**/--- (nesting) |
| *Dendroica coronata* | Yellow-rumped warbler | Migrant |
| *Dendroica nigrescens* | Black-throated gray warbler | Migrant |
| *Geothlypis trichas* | Common yellowthroat | Young observed |
| *Wilsonia pusilla* | Wilson's warbler | |
| *Icteria virens* | Yellow-breasted chat | **CSC**/--- (nesting) |
| **Cardinalidae** | **Cardinals** | |
| *Pheucticus melanocephalus* | Black-headed grosbeak | |
| *Guiraca caerulea* | Blue grosbeak | Nests and young observed |
| *Passerina amoena* | Lazuli bunting | |
| **Emberizidae** | **Emberizids** | |
| *Pipilo maculatus* | Spotted towhee | |
| *Pipilo crissalis* | California towhee | Young observed |
| *Passerculus sandwichensis* | Savannah sparrow | |
| *Melospiza melodia* | Song sparrow | Young observed |

## Table 1
## Avian Species Observed or Detected on the RiverPark Project Site[1]

| Scientific Name[2] | Common Name[2] | Status[3] State/Federal and Comments |
|---|---|---|
| **Icteridae** | **Blackbirds** | |
| *Agelaius phoeniceus* | Red-winged blackbird | Nests and young observed |
| *Xanthocephalus xanthocephalus* | Yellow-headed blackbird | Migrant |
| *Euphagus cyanocephalus* | Brewer's blackbird | |
| *Quiscalus mexicanus* | Great-tailed grackle | |
| *Molothrus ater* | Brown-headed cowbird | Young fed by Blue grossbeak |
| *Icterus cucullatus* | Hooded oriole | Young observed |
| *Icterus bullockii* | Bullock's oriole | Young observed |
| **Fringillidae** | **Finches** | |
| *Carpodacus mexicanus* | House finch | Young observed |
| *Carduelis psaltria* | Lesser goldfinch | Young observed |
| *Carduelis lawrencei* | Lawrence's goldfinch | |
| *Carduelis tristis* | American goldfinch | |
| **Passeridae** | **Old World Sparrows** | |
| *Passer domesticus*** | House (English) sparrow | |

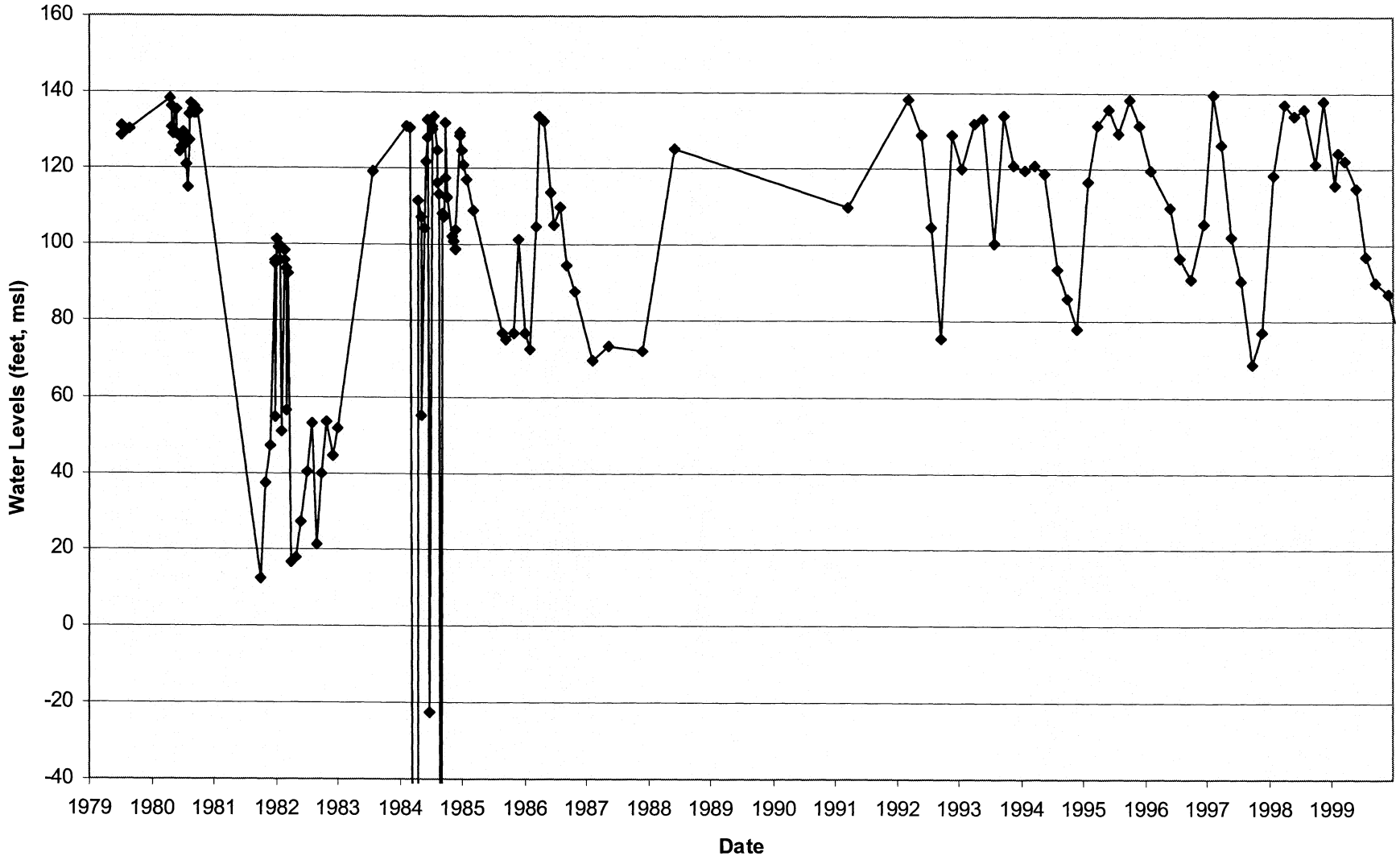
KEY:
Scientific and common names are from American Ornithologist's Union (2000).
Status: CSC = State Species of Special Concern
CE = California Endangered Species
FE = Federal Endangered Species
* = California Special Animal
(nesting, nesting colony, rookery) = this indicates that the status afforded the species is directed toward active nests and nest sites.

** Non-native or introduced species

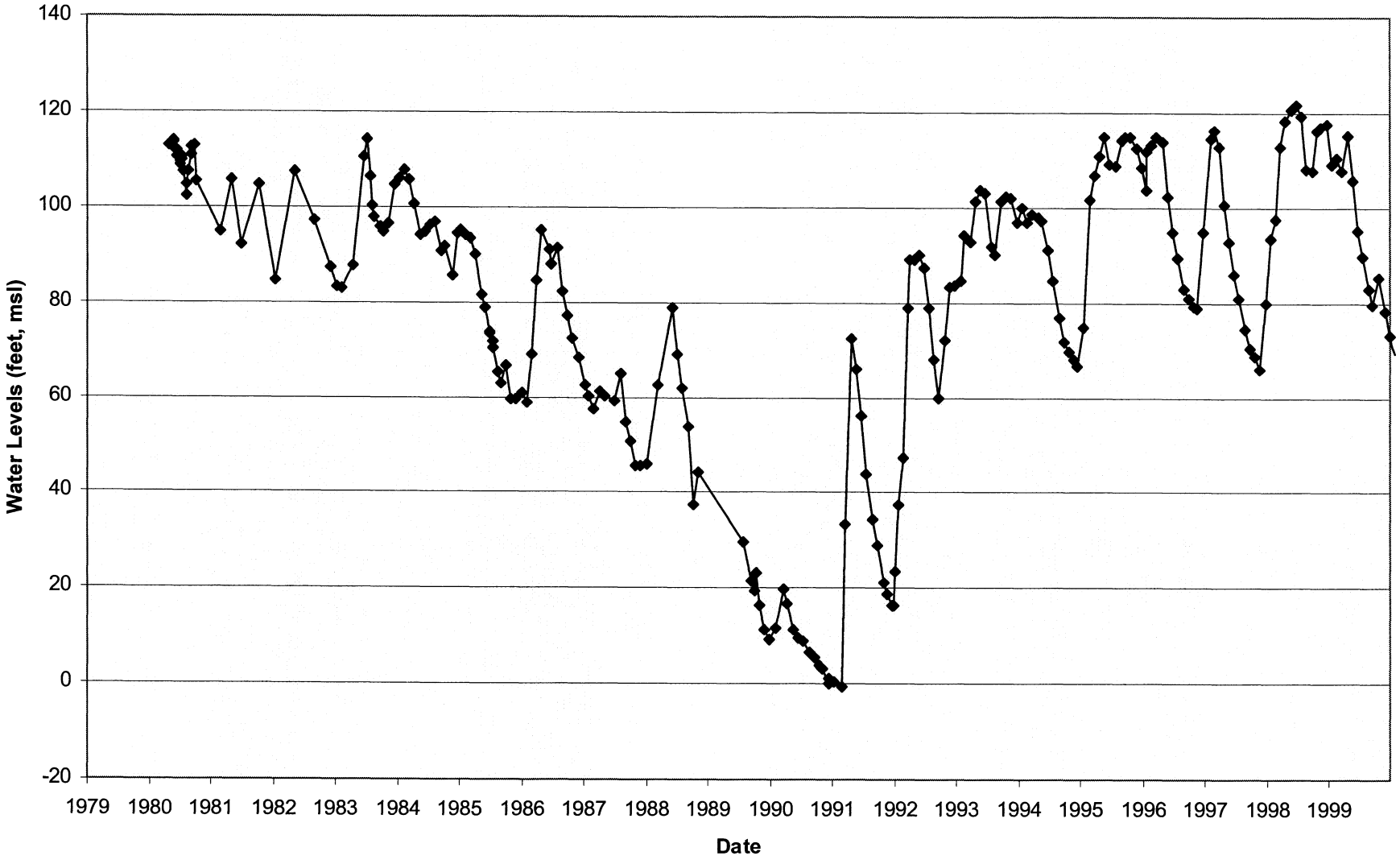
# APPENDIX 4.5
## Water Quality Data

# APPENDIX 4.5-1
# Key Well Hydrographs

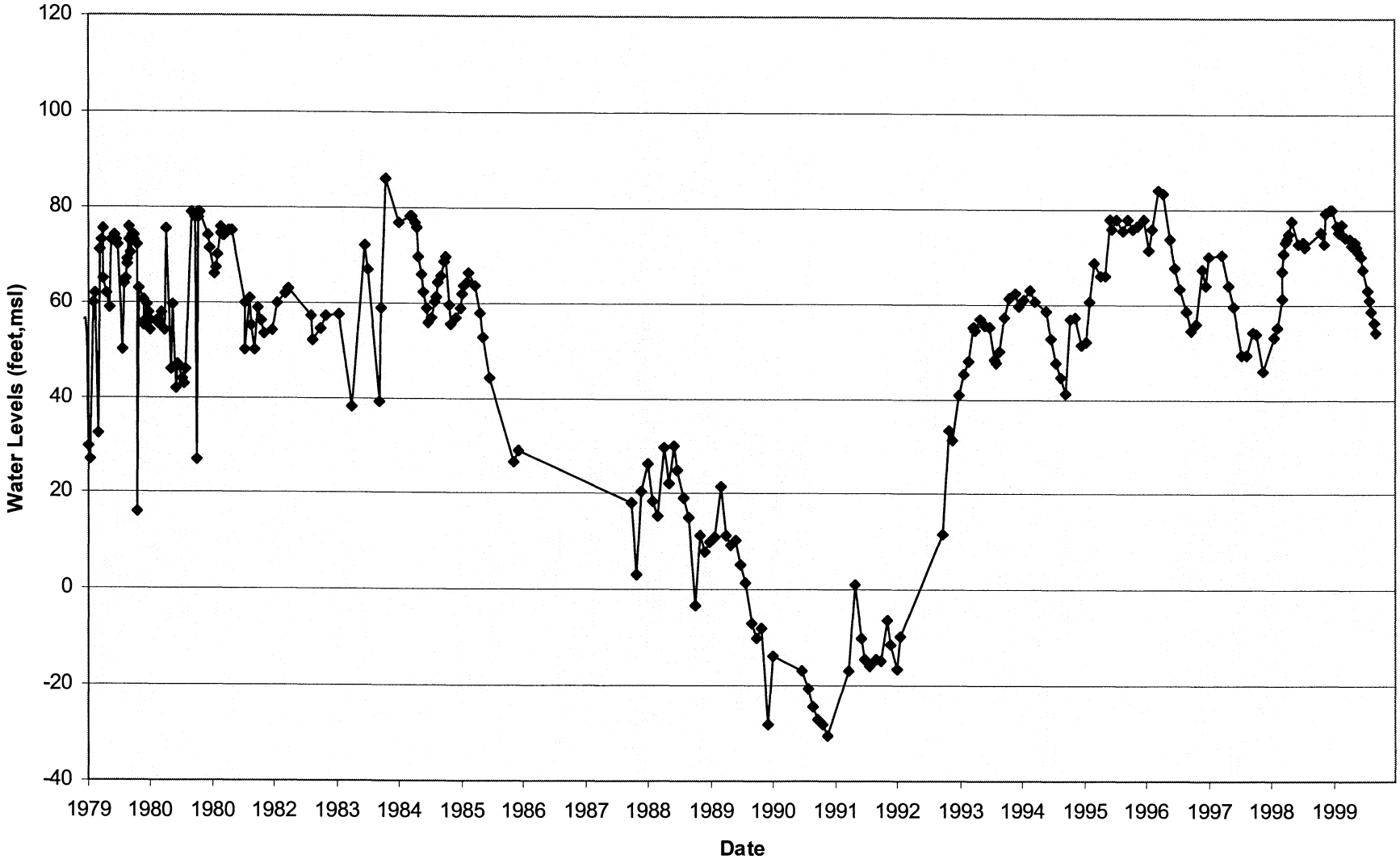
## Hydrograph - State Well No. 2N/22W-12A1



## Hydrograph - State Well No. 2N22W-12R1



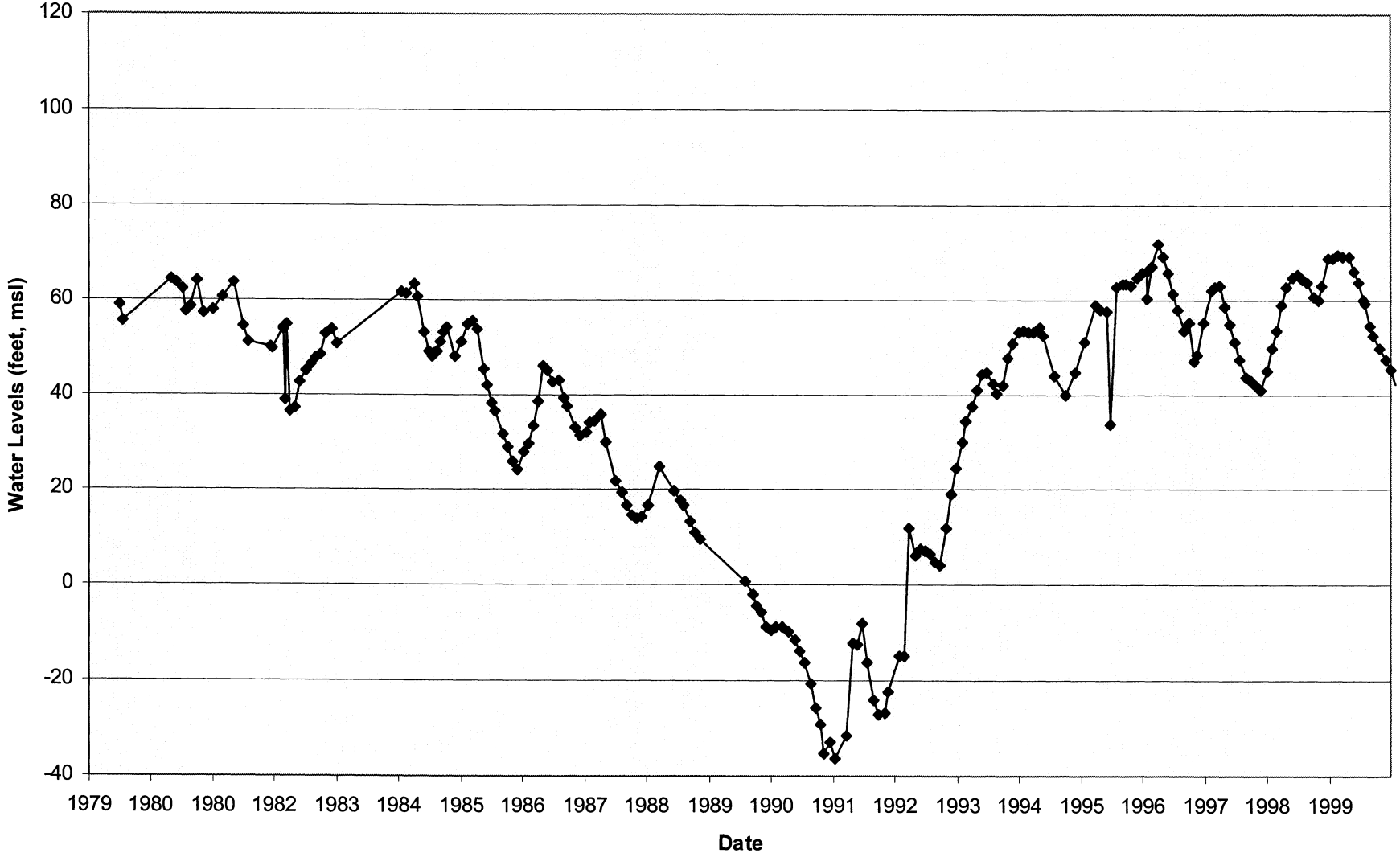
## Hydrograph - State Well No. 2N22W-14P2



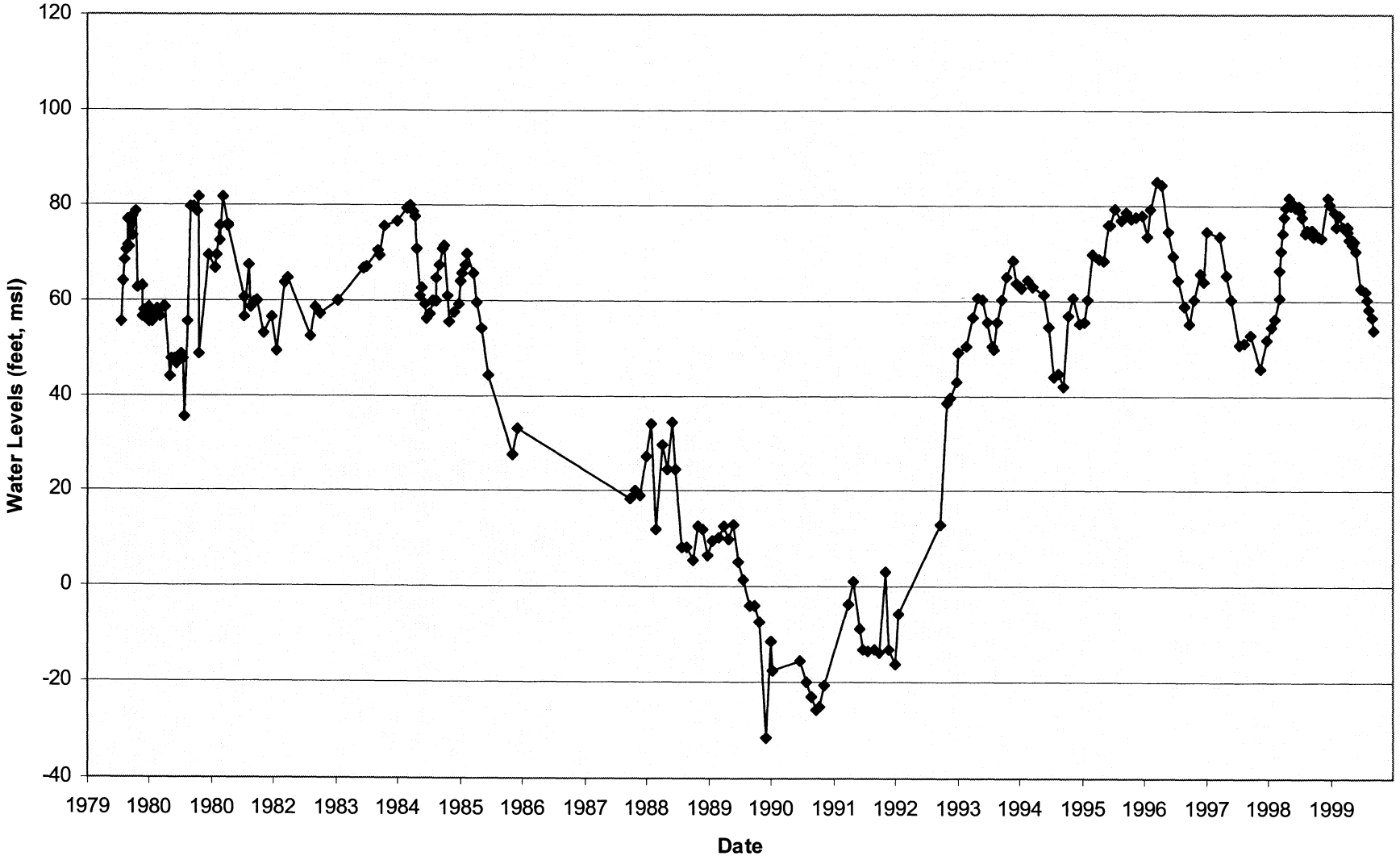
## Hydrograph - State Well No. 2N22W-22H1

## Hydrograph - State Well No. 2N22W-22M4

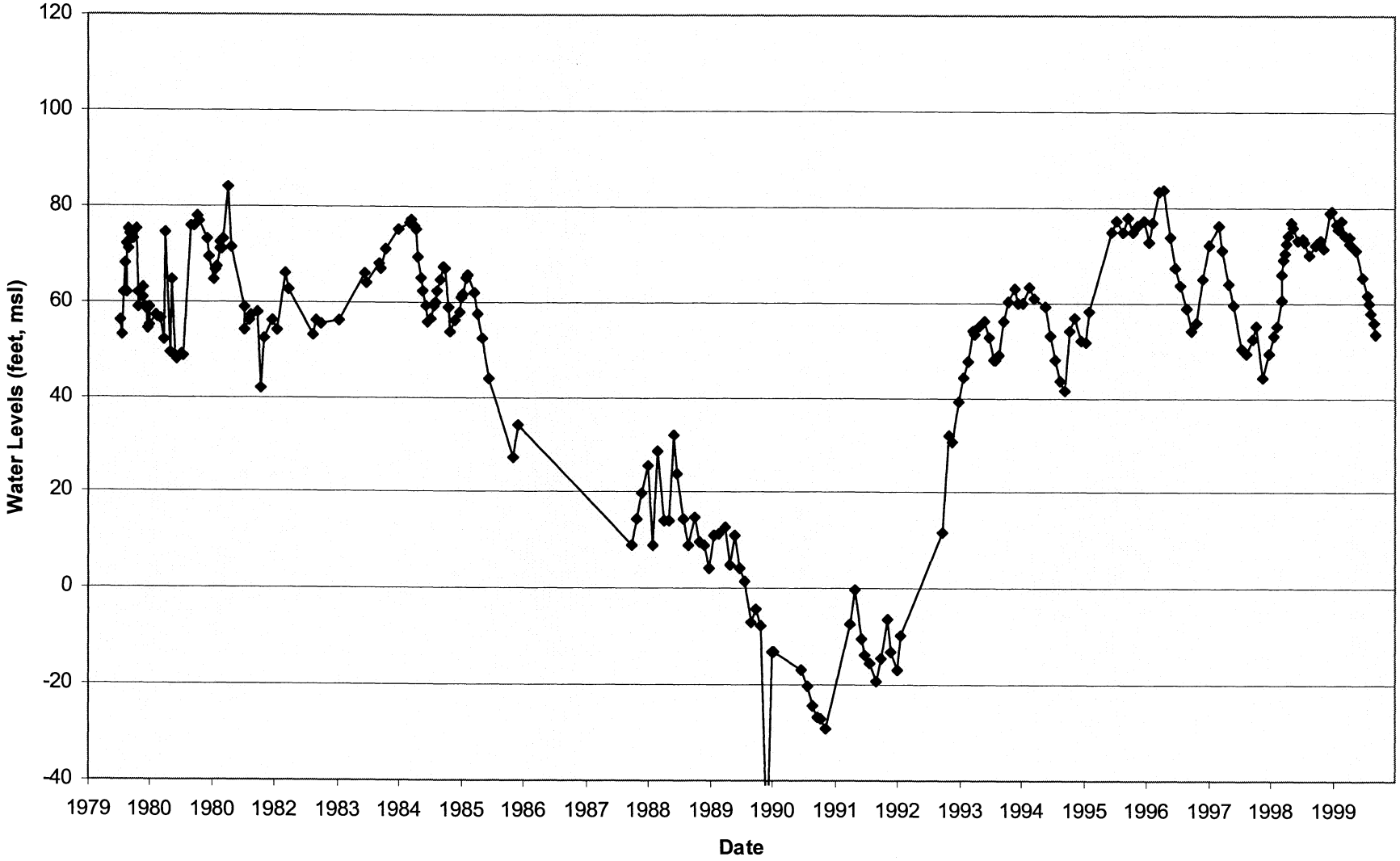
## Hydrograph - State Well No. 2N/22W-22R1



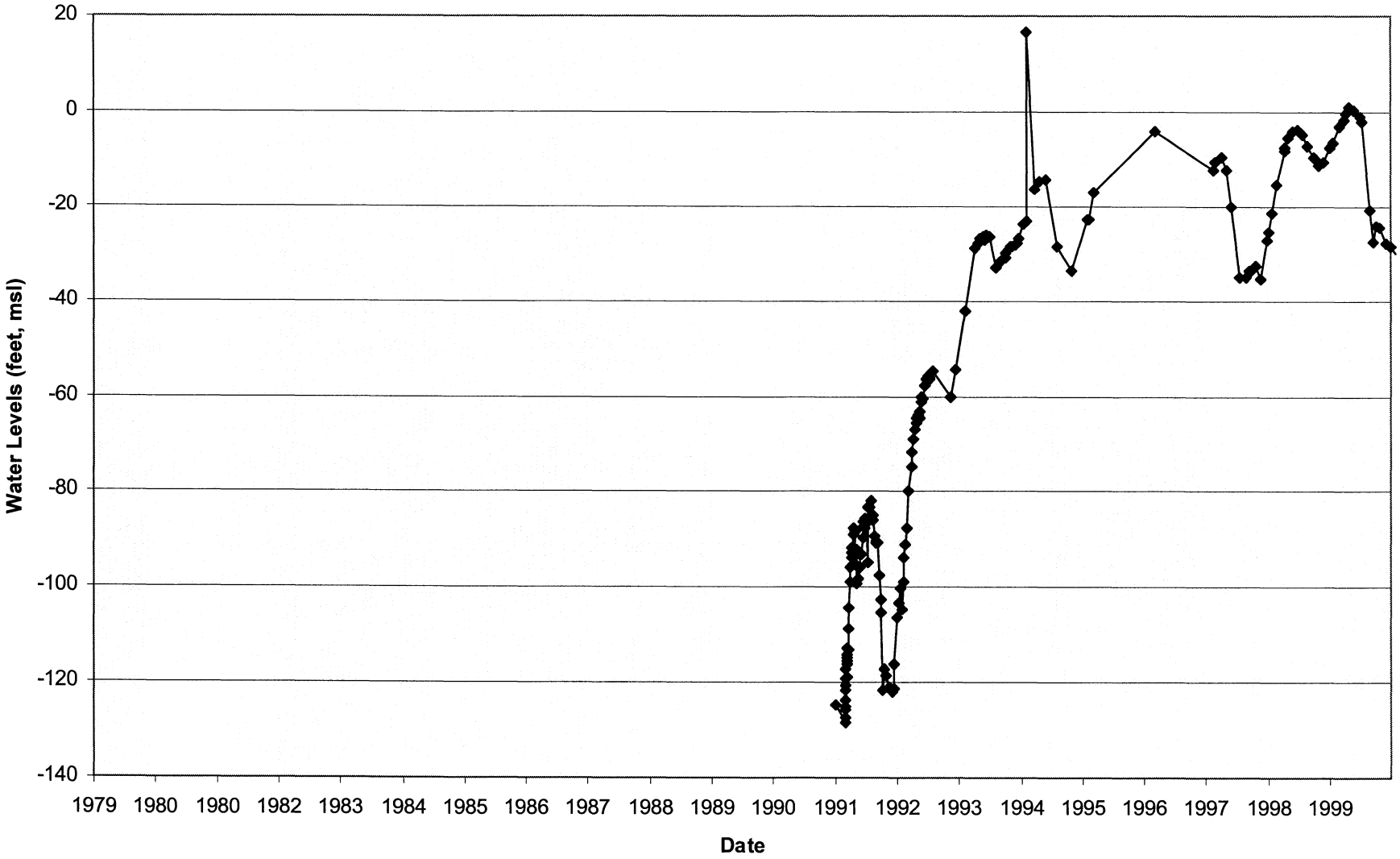
## Hydrograph - State Well No. 2N22W-23B1



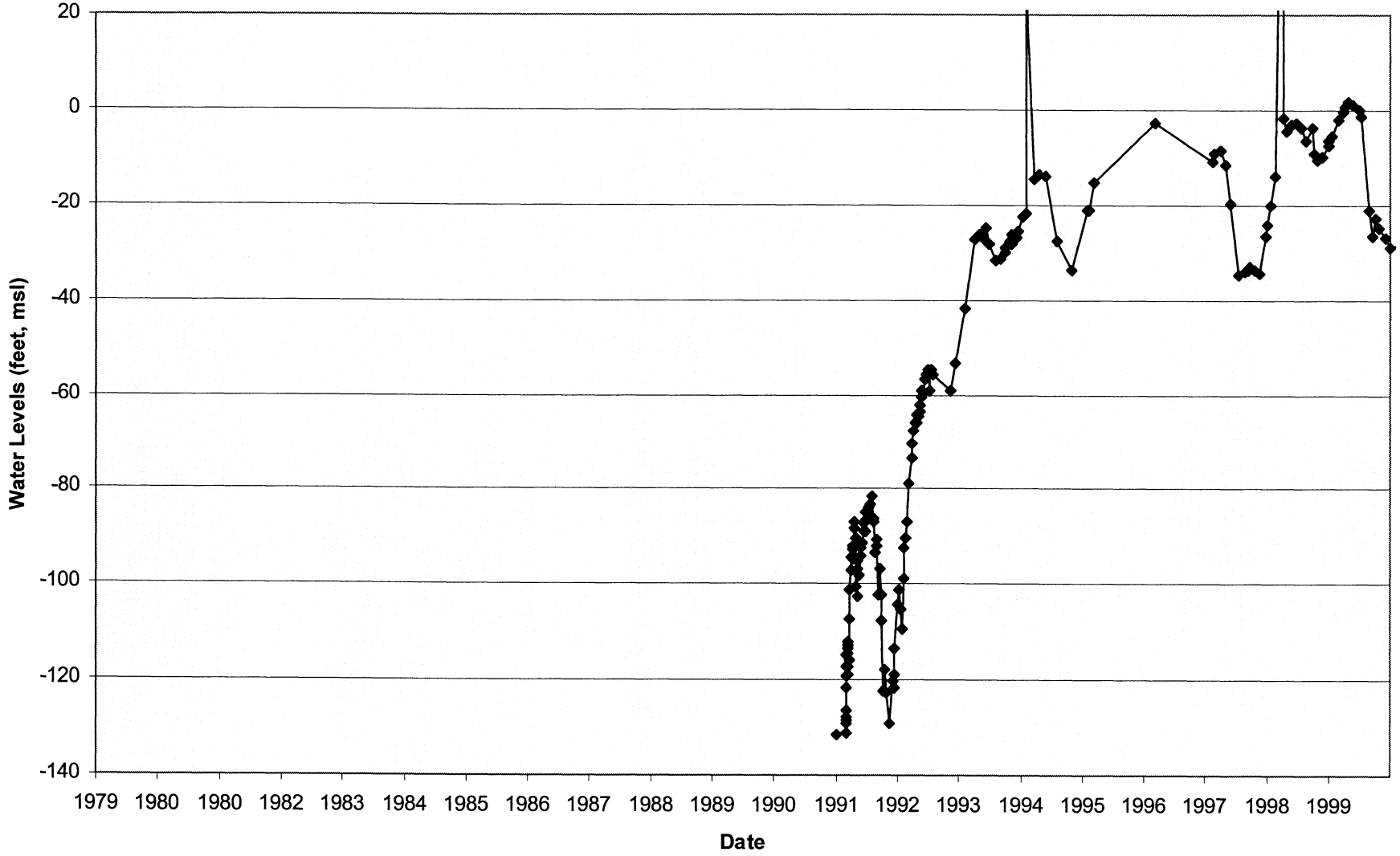
## Hydrograph - State Well No. 2N22W-23B2



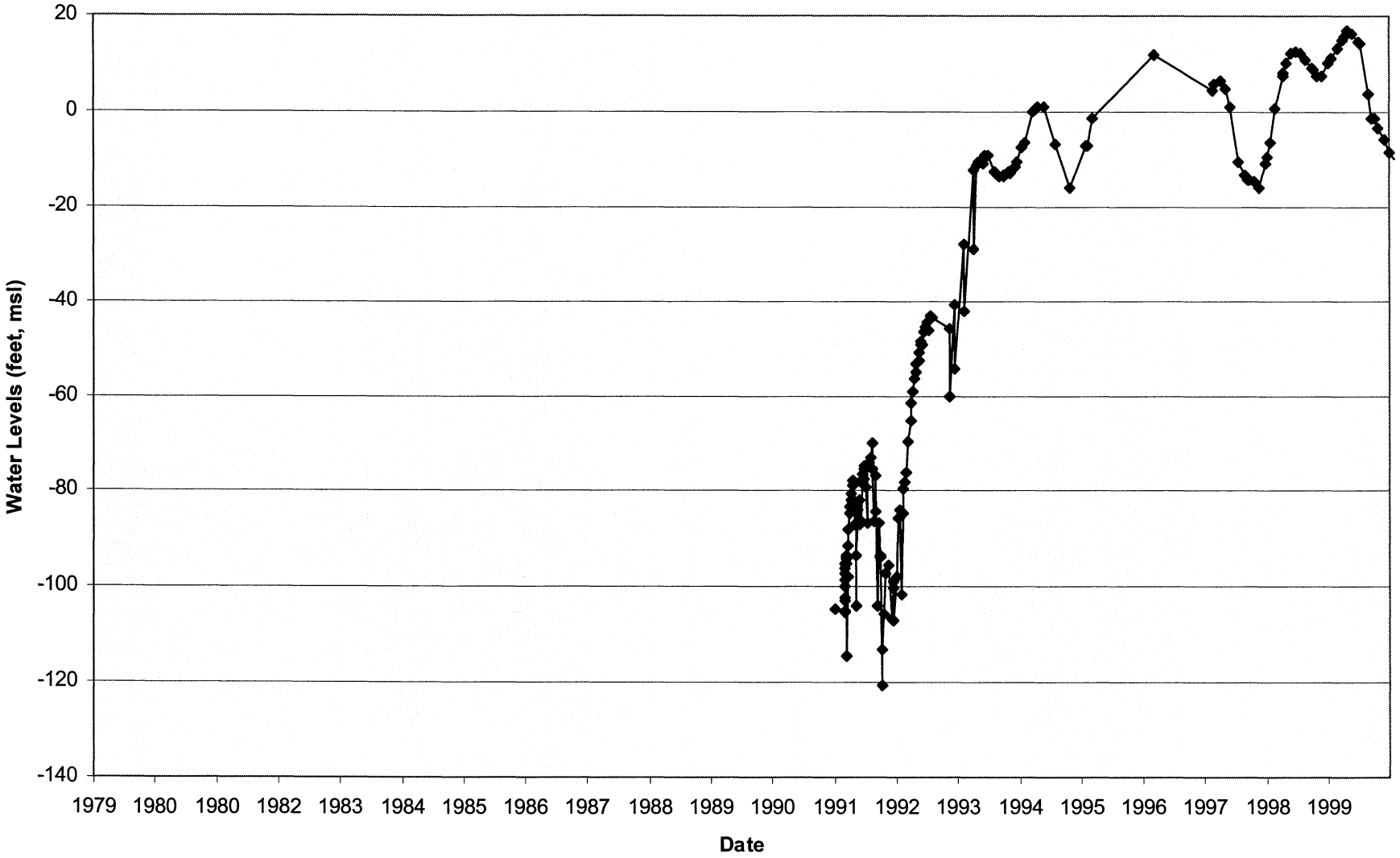
## Hydrograph - State Well No. 2N22W-23B3



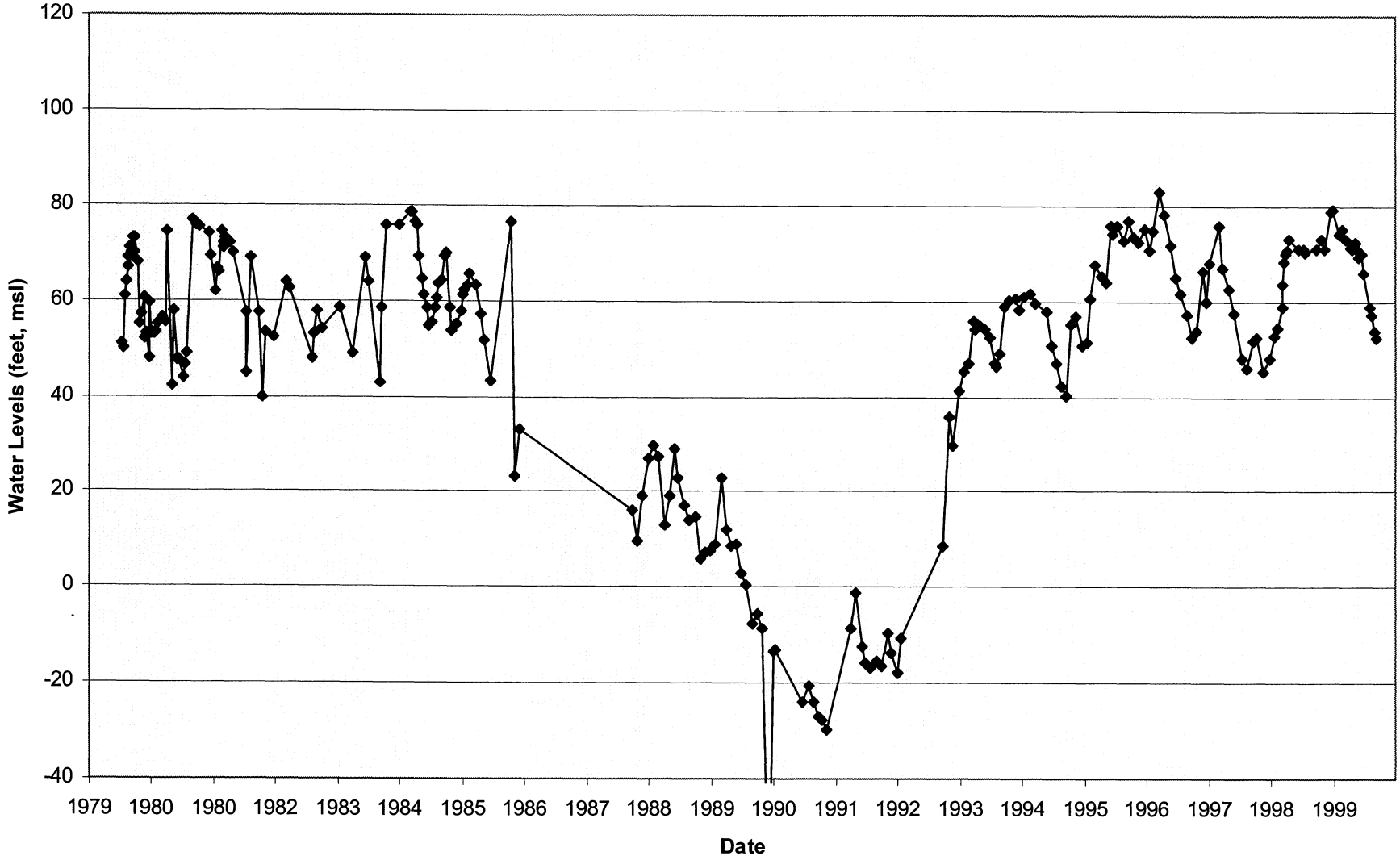
## Hydrograph - State Well No. 2N22W-23B4



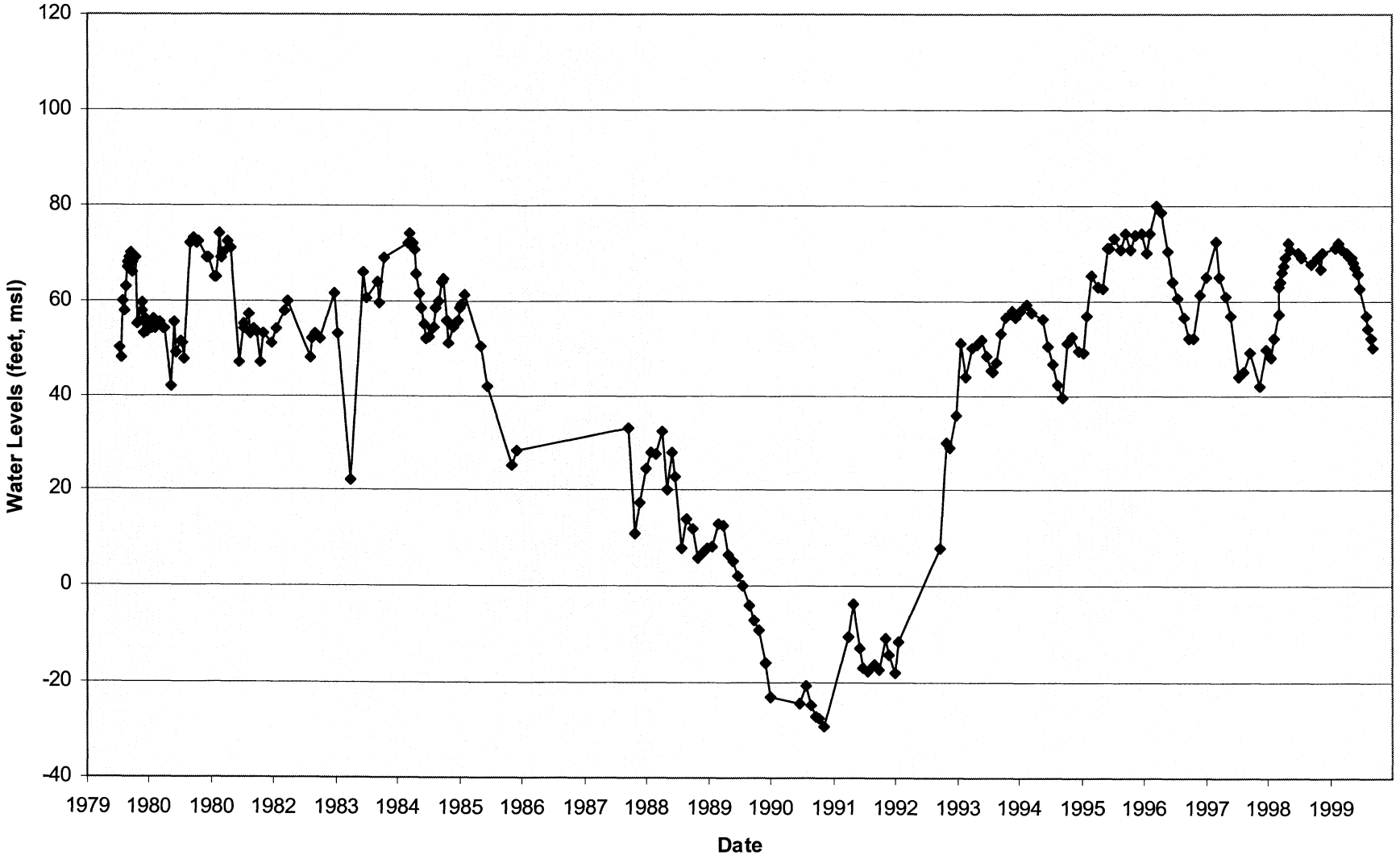
## Hydrograph - State Well No. 2N22W-23B5



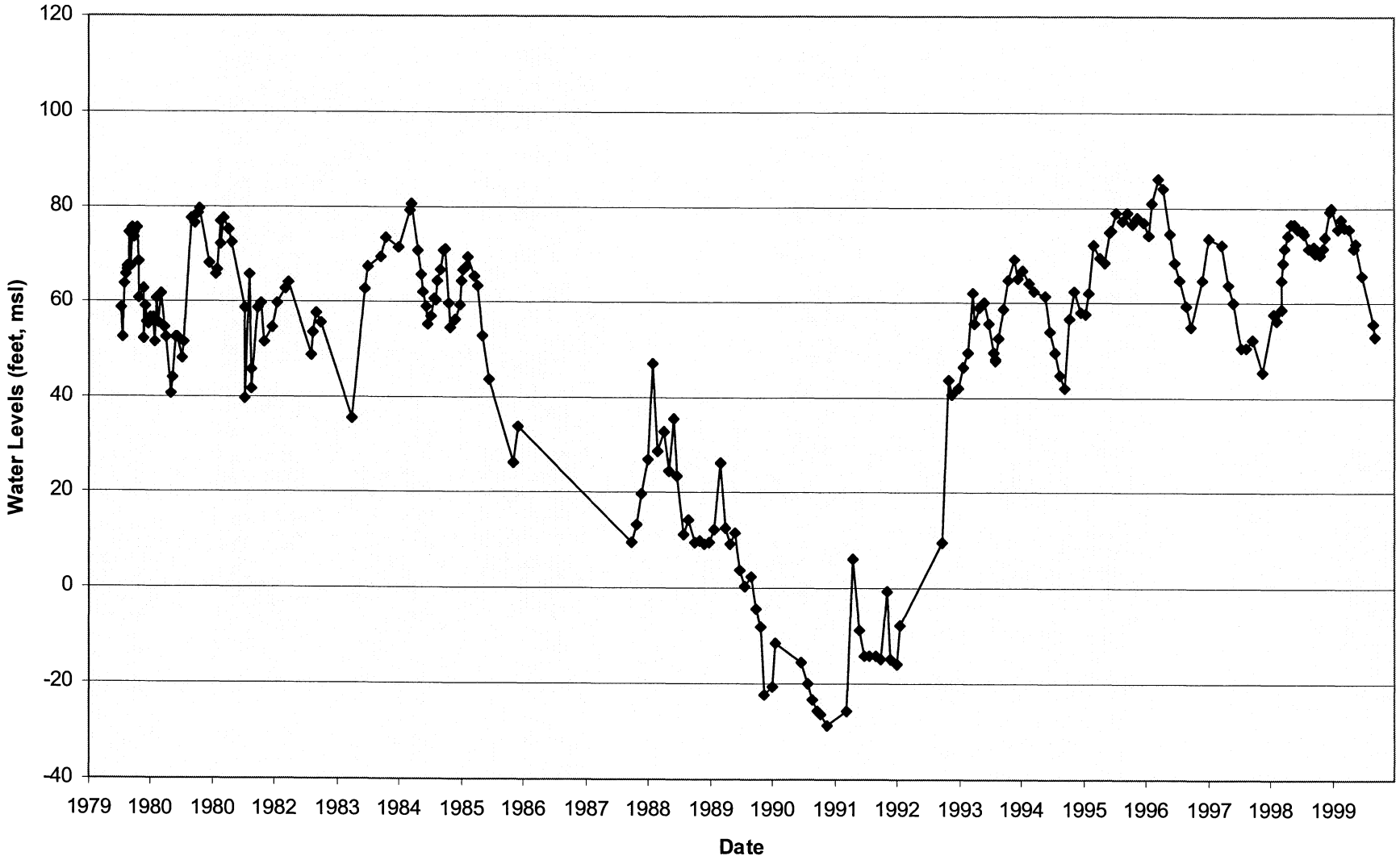
## Hydrograph - State Well No. 2N22W-23C1



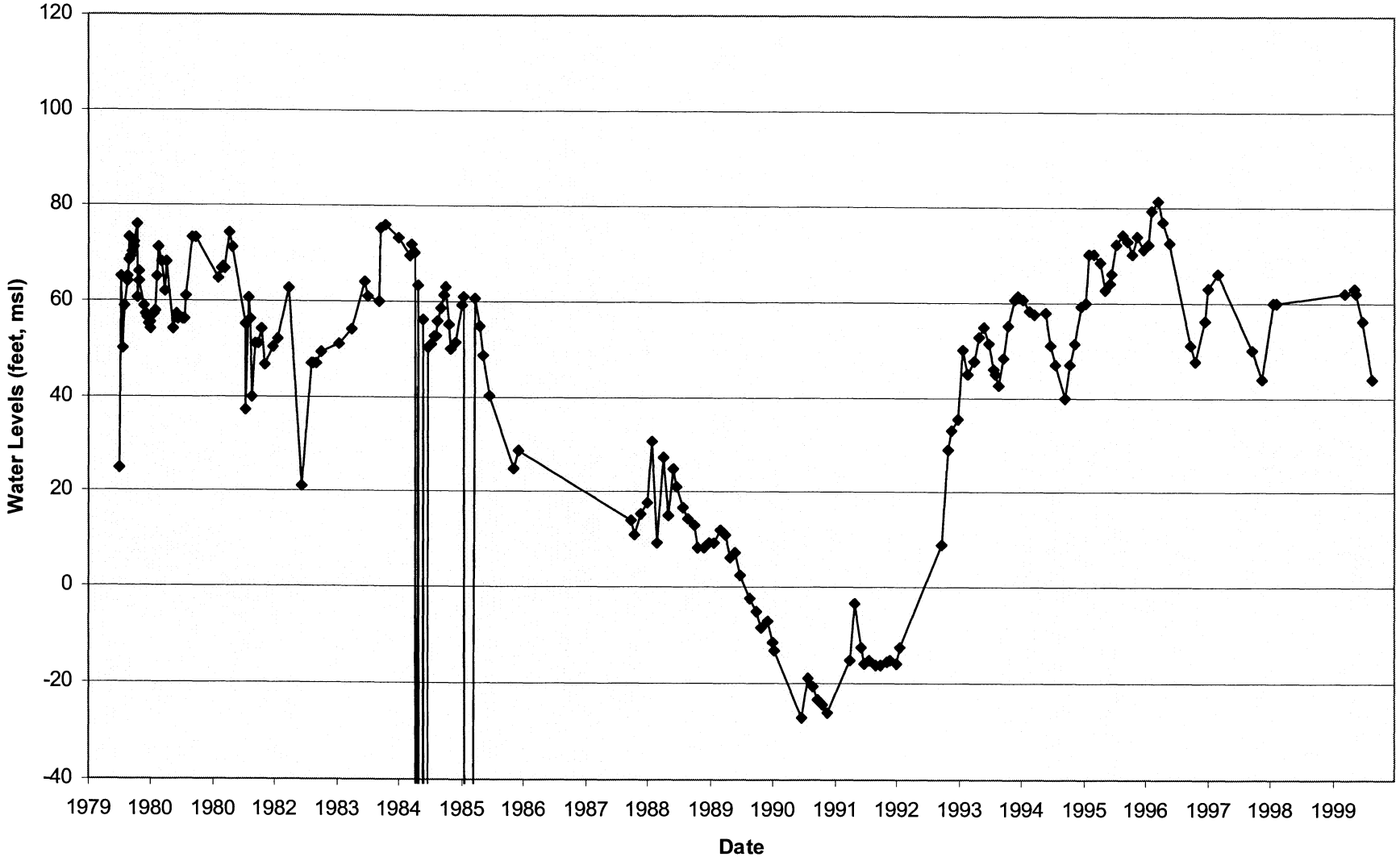
## Hydrograph - State Well No. 2N22W-23C2



## Hydrograph - State Well No. 2N22W-23G2



## Hydrograph - State Well No. 2N22W-23K5



# APPENDIX 4.5-2
# Mathematical Groundwater Model

## APPENDIX 4.5-2
## MATHEMATICAL GROUNDWATER MODEL

To aid in evaluation of potential impacts associated with the project, a mathematical groundwater flow and solute transport model was developed for the River Park study area, defined by the Montalvo Forebay and an area extending approximately four miles southwest (see Figure 1). The groundwater flow component of the River Park model was adapted from the regional groundwater flow model of the Santa Clara-Calleguas Basin developed by the US Geological Survey ([USGS], 1998), making use of the USGS quasi-three-dimensional modular groundwater flow model MODFLOW (McDonald and Harbaugh, 1988). The solute transport component of the River Park model was developed based on the US Environmental Protection Agency's (USEPA) three-dimensional modular solute transport model MT3D (USEPA, 1990). Details of River Park model development and application are summarized below.

### 4.5-2.1 River Park Groundwater Flow Model

To simulate groundwater flow in response to well pumpage and recharge within the study area, the USGS regional model was reduced and focused on the River Park study area. This involved:

- reduction of the USGS regional model domain from 1500 square miles to 40 square miles (see Figure 1);
- refinement of the regional USGS finite-difference model grid from 60 rows and 100 columns (0.25 square miles per cell) to 52 rows and 60 columns (0.013 square miles per cell) for enhanced resolution and accuracy within the study area;
- relocation of select river cells in the USGS regional model to more accurately represent the location of the Santa Clara River;
- calibration of the River Park model to steady-state conditions representing Fall conditions.

All other components of the USGS regional model, as documented by USGS (1998) were maintained in the River Park model without revisions.

#### 4.5-2.1.1 Model Revisions

In reducing the USGS regional model domain to form the River Park model domain, estimates of groundwater flux (inflow and outflow) across the River Park model boundaries were obtained from the regional USGS model. As a result of increasing the River Park model resolution through reducing individual model cell dimensions in the regional USGS model, 16 model cells in the River Park model corresponded to a single cell within USGS regional model. Well pumpage and recharge terms within each cell of the USGS regional model were evenly distributed within the corresponding 16 River Park model cells. Hydraulic properties (e.g. hydraulic conductivity) and aquifer geometry (i.e. aquifer elevations) were maintained from the USGS model.

As a benefit of refining the model resolution, the ability to more accurately represent and locate model river cells was increased. Specifically, due to the large dimensions of the USGS model, select river cells covered an area outside of the actual footprint of the Santa Clara river channel. With the more refined dimensions of the River Park model grid, select river cells (Reach 21 in USGS model) were relocated to ensure groundwater-surface water interaction is limited to areas within the footprint of the Santa River channel. All other components of the Santa Clara river within the River Park model domain were maintained from the regional USGS model.

#### 4.5-2.1.2 Model Calibration

Calibration of the River Park model focused on steady-state conditions represented by fall 1997 groundwater elevations across the study area. Review of historical data representative of fall conditions suggests near average conditions with respect to groundwater elevations. Accordingly, fall 1997 groundwater elevations were considered representative of average fall conditions.

Since development of the River Park model involved limited changes to the previously calibrated USGS regional model, calibration of the River Park model involved minor changes to calibration parameters. Specifically, groundwater inflow from the Santa Paula and West Los Posas sub-basins to the Montalvo Forebay was used as the primary calibration parameter. The calibrated groundwater inflow term used in the River Park model approximated $1.6 \times 10^5$ acre-ft per year (AFY), yielding a close match between field-measured and model-simulated groundwater level elevations. This comparison is depicted on Figure 2. As indicated on this figure, the slight modification of the groundwater inflow term along the northern boundary of the River Park model resulted in a close match between field-measured and model-simulated groundwater elevations.

### 4.5-2.2 River Park Solute Transport Model

To simulate the transport of chemicals emanating from the River Park project gravel pits (i.e. Large Woolsey Pit, Vickers/Small Woolsey Pit, and Brigham Pit) toward nearby water supply wells, a solute transport model based on the USEPA's MT3D model was developed and used in conjunction with the River Park groundwater flow model. Specifically, the distribution of groundwater elevations from the flow model was combined with transport parameters such as porosity, retardation coefficient, and multi-dimensional dispersion coefficients (see Table 1).

**Table 1**
**Chemical Transport Parameters**

| Parameter | Value | Source |
|---|---|---|
| Aquifer porosity | 0.26 | Mean site-specific value |
| Retardation Factor | 1 | Conservative, non-reactive chemical |
| Longitudinal dispersion coefficient | 25 ft | Professional judgment based on observed sediments |
| Transverse dispersion coefficient | 0.33 x Longitudinal Dispersion Coefficient | Calculated from longitudinal dispersion coefficient per ASTM (1998). USEPA (1991) |
| Vertical dispersion coefficient | 0.05 x Longitudinal Dispersion Coefficient | Calculated from longitudinal dispersion coefficient per ASTM (1998). USEPA (1991) |

As a conservative measure, transport simulations were limited to migration of a generic, recalcitrant, non-reactive chemical. Hence, transport in groundwater only accounted for advective and dispersive transport, ignoring the potential occurrence of attenuation processes such as adsorption, biodegradation, and hydrolysis. Accordingly, the simulated scenarios are most representative of conservative, non-reactive species such as chlorides or many total dissolved solids (TDS) constituents. Model results may be considered a highly conservative

representation of transport for degradable, reactive species such as various pesticides and volatile organic compounds (VOCs).

#### 4.5-2.2.1 Solute Transport Simulations

Making use of the simulated groundwater elevation distribution and transport parameters, model simulations were performed to develop a mathematical relationship between chemical recharge (i.e. River Park project pits) and discharge (water supply wells) locations (see Table 2). This relationship was expressed as dilution-attenuation factors (DAFs) defined by the following equation (American Society for Testing and Materials [ASTM], ASTM, 1998; USEPA, 1991):

$$DAF = C_r \div C_d$$

Where,

$DAF$ = Dilution-attenuation factor
$C_r$ = Chemical concentration at point of recharge to groundwater (i.e. pits)
$C_d$ = Chemical concentration at point of discharge (i.e. specified water supply wells)

Specifically, the DAF represents the ratio between the simulated concentration at the point which a chemical is introduced to groundwater, and the resulting concentration at the point of chemical capture at specified receptor locations. Based on the simulated flow and transport processes, the DAF represents the potential attenuation of a chemical between the source and receptor locations due solely to dilution. Correspondingly, the DAF may be used to back-calculate allowable chemical concentrations at the pits, such that their transport toward nearby water supply wells will not result in adverse water quality impacts.

To represent introduction of chemicals into the gravel pits, model simulations were performed based on constant pit recharge rates corresponding to mean (Scenario 1) and maximum (Scenario 2) values derived from available data from 1979 to 1999 (see Table 3). A uniform concentration of 1000 ug/l was assigned to the simulated recharge. Use of a continuous, uniform recharge rate and source concentration is highly conservative, maximizes resulting chemical concentrations at nearby water supply wells, and yields more conservative (i.e. lower) DAF values.

Based on these source conditions, model simulations were performed reflecting introduction of a conservative chemical under both average and maximum recharge conditions. The simulated chemical plumes after 100 years are depicted on Figures 3 and 4. These figures further reflect the presence of water supply wells located within the footprint of the chemical plumes. As expected, a larger chemical plume in groundwater is generated in response to a greater recharge rate.

Simulation results were used to estimate DAFs and chemical travel times for each of the ten water supply wells depicted in Table 2 and on Figures 3 and 4 (see Tables 4 and 5). This information was used to back-calculate allowable chemical concentrations at the pits, ensuring protection of water quality at nearby water supply wells.

### 4.5-2.3 References

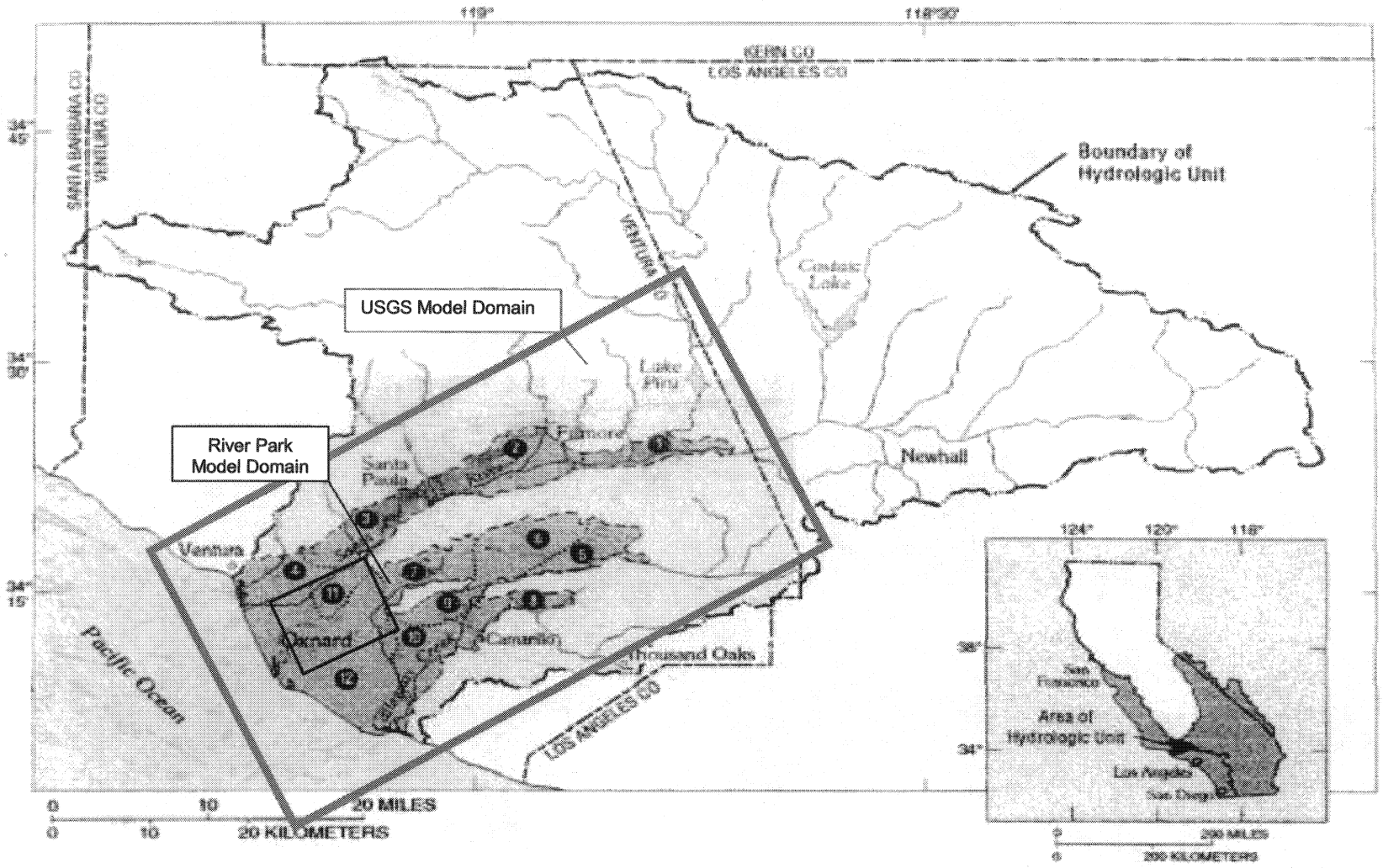
American Society for Testing and Materials (ASTM), 1998. Standard Provisional Guide for Risk-Based Corrective Action, PS 104-98.

McDonald, M.G. and A.W. Harbaugh, 1998. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model, Techniques of Water Resources Investigations of the United States Geological Survey, Book 6, Chapter A1.

US Environmental Protection Agency (USEPA), 1990. MT3D: A Modular Three-Dimensional Transport Model for Simulation of Advection, Dispersion and Chemical Reaction of Contaminants in Groundwater Systems, R.S. Kerr Environmental Research Laboratory, Ada Oklahoma.

USEPA, 1991. Multimedia Exposure Assessment Model (MULTIMED) for Evaluation the Land Disposal of Wastes-Model Theory, Environmental Research Laboratory, Office of Research and Development, US EPA, Athens Georgia.

US Geological Survey (USGS), 1998. Preliminary Draft, Simulation of Ground-Water/Surface-Water Flow in the Santa Clara-Calleguas Basin, Ventura County, California.

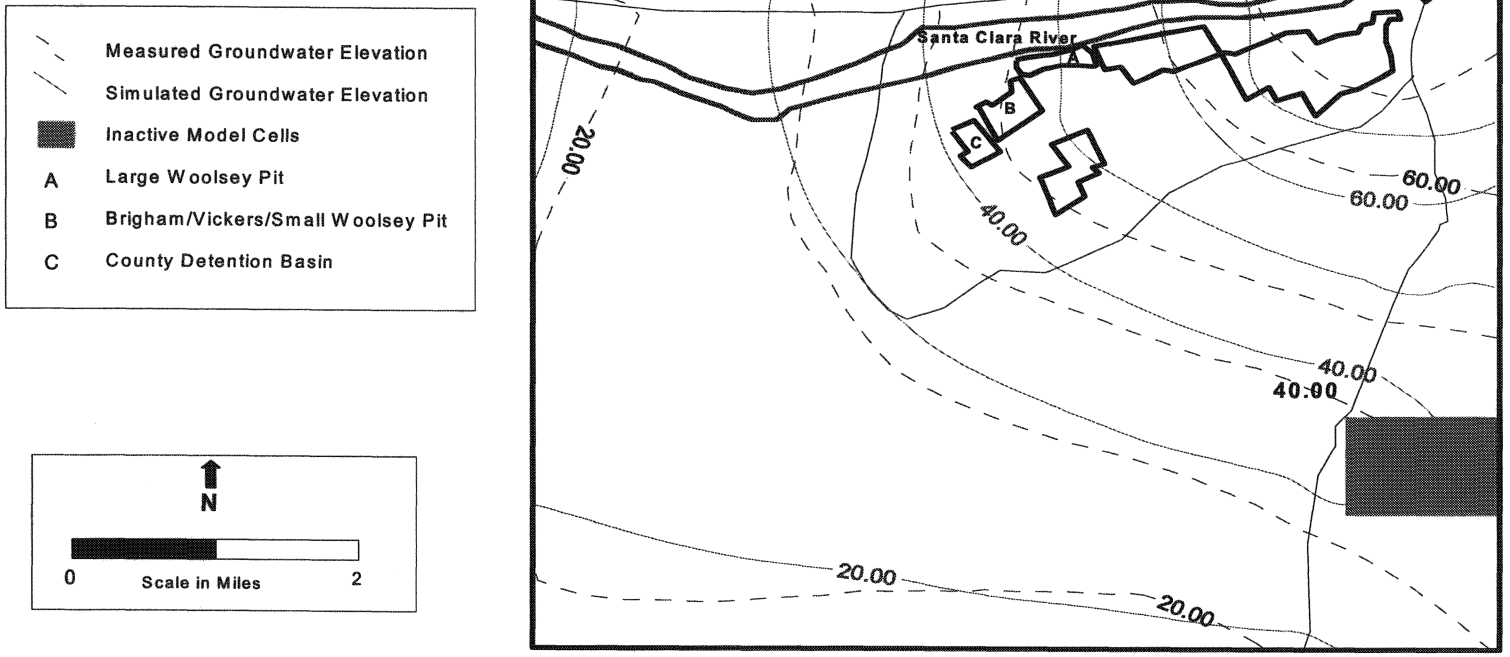



**MODEL DOMAIN**

Source: USGS, 1998

Figure 1

November 2000

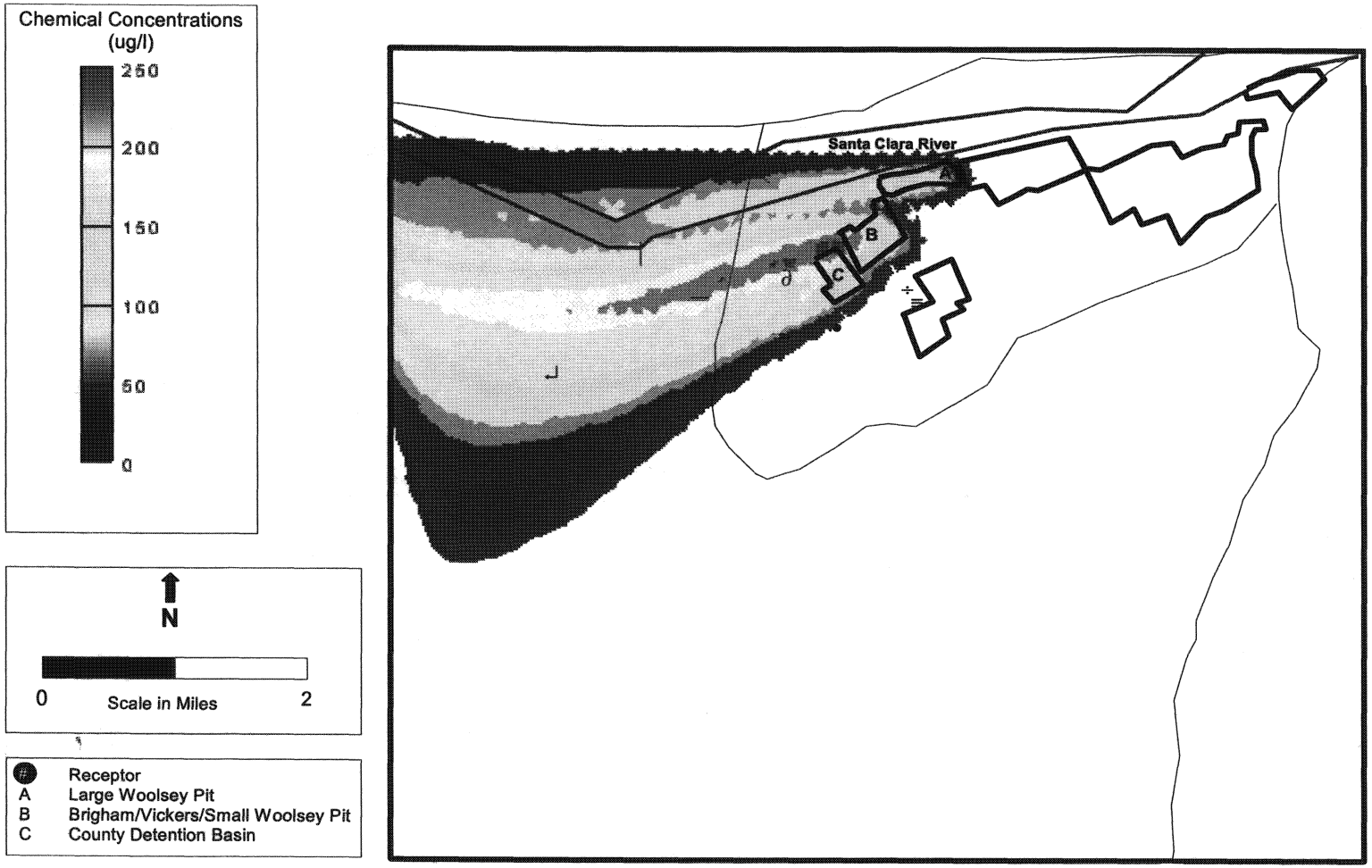



**Model Calibration Results-Fall Conditions**

Figure
2
December 2000

**Simulated 100-year plume for Non-Reactive Chemical – Average pit recharge rates.**

Figure
**3**
December
2000




**Simulated 100-year plume for Non-Reactive Chemical – Maximum Pit Recharge Rates**

Figure
**4**
December
2000

**Table 2. Receptor Well Locations**

| Well # | Well ID | TOP PERFORATION | BOTTOM PERFORATION | AQUIFER DESIGNATION | WELL USE | BASIN NAME |
|---|---|---|---|---|---|---|
| 1 | 02N22W22Q01S | 100 | 142 | OXNARD | IRRIGATION | FOREBAY |
| 2 | 02N22W22R04S | 120 | 290 | OXNARD-MUGU | MUNICIPAL | FOREBAY |
| 3 | 02N22W23C02S | 139 | 290 | OXNARD-MUGU | MUNICIPAL | FOREBAY |
| 4 | 02N22W23D06S | 130 | 370 | OXNARD-MUGU | IRRIGATION | FOREBAY |
| 5 | 02N22W23F04S | 124 | 250 | OXNARD | DOMESTIC | FOREBAY |
| 6 | 02N22W27B01S | 145 | 230 | OXNARD | DOMESTIC | FOREBAY |
| 7 | 02N22W27L01S | 107 | 242 | OXNARD | MUNICIPAL | FOREBAY |
| 8 | 02N22W28C06S | 170 | 430 | OXNARD-MUGU | MUNI-IRR | OXNARD |
| 9 | 02N22W28H02S | 125 | 280 | OXNARD-MUGU | IRRIGATION | OXNARD |
| 10 | 02N22W33L03S | 138 | 198 | OXNARD | DOMESTIC | OXNARD |

**Table 3. Recharge Summary Table**

| Year | Recharge from Brigham | Recharge from Vickers / Small Woolsey | Recharge form Large Woolsey | Yearly Total Recharge | Yearly Total Recharge Calc. from Total Gravel Pit Balance |
|---|---|---|---|---|---|
| | Acre-Ft | Acre-Ft | Acre-Ft | Acre-Ft | Acre-Ft |
| 1979-1980 | 324.77 | 468.93 | 244.86 | 1038.56 | 1038.56 |
| 1980-1981 | 126.00 | 187.90 | 84.39 | 398.28 | 397.76 |
| 1981-1982 | 107.60 | 174.03 | 64.30 | 345.93 | 342.53 |
| 1982-1983 | 386.15 | 565.76 | 294.38 | 1246.28 | 1242.53 |
| 1983-1984 | 120.66 | 179.14 | 82.06 | 381.86 | 379.83 |
| 1984-1985 | 96.02 | 153.81 | 59.10 | 308.94 | 305.25 |
| 1985-1986 | 275.03 | 406.47 | 208.06 | 889.56 | 886.90 |
| 1986-1987 | 68.65 | 115.81 | 41.07 | 225.53 | 224.82 |
| 1987-1988 | 119.18 | 186.80 | 79.43 | 385.41 | 382.17 |
| 1988-1989 | 90.47 | 137.48 | 57.13 | 285.08 | 285.08 |
| 1989-1990 | 40.27 | 60.73 | 22.04 | 123.04 | 123.11 |
| 1990-1991 | 168.38 | 239.93 | 126.65 | 534.96 | 534.96 |
| 1991-1992 | 260.63 | 370.62 | 200.39 | 831.65 | 828.38 |
| 1992-1993 | 377.74 | 539.03 | 296.32 | 1213.09 | 1213.09 |
| 1993-1994 | 110.78 | 168.21 | 76.54 | 355.53 | 350.38 |
| 1994-1995 | 377.37 | 541.54 | 295.35 | 1214.27 | 1210.81 |
| 1995-1996 | 156.10 | 226.21 | 112.81 | 495.11 | 493.76 |
| 1996-1997 | 173.60 | 255.26 | 126.06 | 554.92 | 554.24 |
| 1997-1998 | 516.69 | 746.92 | 393.33 | 1656.94 | 1655.56 |
| 1998-1999 | 68.06 | 111.29 | 35.82 | 215.17 | 206.10 |
| **MEAN** | **198.21** | **291.79** | **145.00** | **635.01** | |
| **MAX** | **516.69** | **746.92** | **393.33** | **1656.94** | |
| **MIN** | **40.27** | **60.73** | **22.04** | **123.04** | |

*Note: Yearly Total Recharge in this table is equal to the sum of recharge values derived from a balance for each individual pit. B/c negative recharges are zeroed out in each balance, the sum of individual recharge values do not equate perfectly with the yearly recharge value from the total pit water balance.

| Table 4. Dilution Attenuation Factor Calculations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| COPC | Recharge Scenario | Attenuation Factor at R-1 | Attenuation Factor at R-2 | Attenuation Factor at R-3 | Attenuation Factor at R-4 | Attenuation Factor at R-5 | Attenuation Factor at R-6 | Attenuation Factor at R-7 | Attenuation Factor at R-8 | Attenuation Factor at R-9 | Attenuation Factor at R-10 |
| TDS | Avg. Recharge | 15.8 | 1,000.0 | NA | 2,857.1 | NA | 44.1 | 43.7 | 36.0 | 11.9 | 17.6 |
| TDS | Max. Recharge | 7.6 | 444.4 | NA | 1,000.0 | NA | 18.2 | 16.1 | 16.2 | 4.6 | 7.2 |

| Table 5. Travel Time Calculations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| COPC | Recharge Scenario | Travel Time to R-1 | Travel Time to R-2 | Travel Time to R-3 | Travel Time to R-4 | Travel Time to R-5 | Travel Time to R-6 | Travel Time to R-7 | Travel Time to R-8 | Travel Time to R-9 | Travel Time to R-10 |
| TDS | Avg. Recharge | 0.75 | 50.00 | NA | 50.00 | NA | 4.00 | 5.00 | 10.00 | 2.00 | 15.00 |
| TDS | Max. Recharge | 0.45 | 33.00 | NA | 33.00 | NA | 2.00 | 3.00 | 6.00 | 1.20 | 10.00 |

# APPENDIX 4.5-3

## Site Water Balances

# ATTACHMENT 1
# EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Existing Gravel Pits
## 1979-80 to 1998-99 Water Years
## (Includes Beedy Street Runoff)

**Data used for calculations:**

Soil Moisture Holding Capacity: 2.40 inches

Total Gravel Pit Area: 213.1 acres (Note: Gravel Pit Exposed Water Surface Area Is Based on 1992 and 1997 Gravel Pit Configuration)

Total area of development contributing runoff into gravel pits (ASL):

Drainage Area 170 acres (Beedy Street)

Runoff Factor for development contributingrunoff into gravel pits:

Drainage Area 0.500

Lake Factor on Pan Evaporation = 0.75

Soil Factor on Pan Evaporation = 0.35

**Definition of terms:**

Pg = Precipitation (inches). Station 239E El Rio - UWCD (7/1/79 - 6/30/99)

Qprec = Water yield in gravel pits generated from precipitation (acre-feet) = Pg/12 * Total Gravel Pit Area

Qrunoff = Water yield generated from Beedy Street runoff (acre-feet). Qrunoff = Pg/12 * 170 * 0.5

Epan = Pan Evaporation at El Rio (inches). Data from 1985-1999. Pan evaporation values for months earlier than January 1985 are based on average pan evaporation for each month between 1985-1999

AEsoil = Actual evaporation from soil (inches).

When water levels are above pit botttom:

If (Pg + SM1 - (Epan * 0.35)) > 0; AEsoil = Epan *0.35

If (Pg + SM1 - (Epan * 0.35)) $\leq$ 0; AEsoil = Pg + SM1

When water levels are below pit botttom:

If (Pg + (Qrunoff*12/213.1) + SM1 - (Epan*.35)) > 0; AEsoil = Epan*.35.

If (Pg + (Qrunoff*12/213.1) + SM1 - (Epan*.35)) $\leq$ 0; AEsoil = Pg + (Qrunoff*12/213.1) + SM1

Qesoil = Water lost to soil moisture evaporation (acre-feet) = (AEsoil/12) * (Total Gravel Pit Area - Exposed Surface Water Area)

AElake = Actual evaporation from exposed surface water (inches) = Epan * 0.75

Qelake = Water lost to surface water evaporation (acre-feet) = (AElake/12) * Exposed Surface Water Area

SM1 = Soil moisture at the beginning of the month (inches). SM1 = SM2 from previous month

SM2 = Soil moisture at end of the month (inches).

When water levels in pits are above pit bottom:

If (Pg + SM1 - AEsoil) < 2.4; SM2 = Pg + SM1 - AEsoil.

If (Pg + SM1 - AEsoil) $\geq$ 2.4; SM2 = 2.4.

If (Pg + SM1 - AEsoil) < 0; SM2 = 0.0.

When water levels are below pit bottom:

If (Pg + Qrunoff*12/213.1 + SM1 - AEsoil) < 2.4; SM2 = Pg + Qrunoff*12/213.1 + SM1 - AEsoil.

If (Pg + Qrunoff*12/213.1 + SM1 - AEsoil) $\geq$ 2.4; SM2 = 2.4.

If (Pg + Qrunoff*12/213.1 + SM1 - AEsoil) < 0; SM2 = 0.0.

Qsoil = Groundwater recharge from soil to gravel pits (inches).

When water levels are above pit bottom:

Qsoil = Pg - AEsoil - (SM2 - SM1)

When water levels are below pit bottom:

Qsoil = Pg +Qrunoff*12/213.1 - AEsoil - (SM2 - SM1)

Qtotal = Total groundwater recharge from gravel pits (acre-feet).

When water levels are above pit bottom:

Qtotal = Qsoil/12 * (Total Gravel Pit Area - Exposed Surface Water Area) + Pg/12 * (Exposed Surface Water Area) + Qrunoff - Qelake

When water levels are below pit bottom:

Qtotal = Qsoil/12 * 213.1

# ATTACHMENT 1
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Existing Gravel Pits
## 1979-80 to 1998-99 Water Years
## (Includes Beedy Street Runoff)

| Water Year 1979-1980 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.62 | 0.48 | 1.28 | 2.03 | 7.62 | 10.19 | 2.86 | 0.39 | 0.29 | 0.00 | 25.76 |
| Qprec (af) | 0.00 | 0.00 | 11.01 | 8.52 | 22.73 | 36.05 | 135.32 | 180.96 | 50.79 | 6.93 | 5.15 | 0.00 | 457.45 |
| Qrunoff (af) | 0.00 | 0.00 | 4.39 | 3.40 | 9.07 | 14.38 | 53.98 | 72.18 | 20.26 | 2.76 | 2.05 | 0.00 | 182.47 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.00 | 0.00 | 0.62 | 0.48 | 1.28 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 1.14 | 0.00 | 10.73 |
| Qesoil (af) | 0.00 | 0.00 | 3.90 | 2.89 | 7.72 | 7.71 | 6.83 | 6.91 | 8.68 | 10.51 | 6.03 | 0.00 | 61.18 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 58.68 | 55.58 | 46.55 | 43.46 | 37.83 | 33.83 | 29.98 | 31.95 | 40.14 | 51.27 | 56.68 | 58.42 | 544.35 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.71 | 2.40 | 2.40 | 2.40 | 0.85 | 0.00 | 8.76 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.71 | 2.40 | 2.40 | 2.40 | 0.85 | 0.00 | 0.00 | 8.76 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.75 | 8.96 | 1.32 | 0.00 | 0.00 | 0.00 | 15.03 |
| Qtotal (af) | -58.68 | -55.58 | -35.05 | -34.43 | -13.75 | 4.77 | 142.62 | 214.28 | 22.23 | -43.69 | -51.01 | -58.42 | **33.31** |
| Water Elev (ft) | 60.00 | 59.00 | 59.50 | 60.00 | 60.50 | 61.00 | 61.50 | 62.00 | 62.50 | 63.00 | 64.15 | 65.30 | |
| Surface area (acres) | 140.8 | 137.7 | 137.7 | 140.8 | 140.8 | 143.2 | 143.2 | 145.6 | 145.6 | 148.1 | 149.7 | 151.2 | |

| Water Year 1980-1981 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 2.12 | 1.85 | 5.67 | 0.18 | 0.00 | 0.00 | 11.14 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 23.44 | 37.65 | 32.85 | 100.69 | 3.20 | 0.00 | 0.00 | 197.83 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.35 | 15.02 | 13.10 | 40.16 | 1.28 | 0.00 | 0.00 | 78.91 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 0.64 | 0.00 | 7.84 |
| Qesoil (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.69 | 7.07 | 7.41 | 8.37 | 9.48 | 3.47 | 0.00 | 43.49 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 60.71 | 54.34 | 50.06 | 48.17 | 40.22 | 33.83 | 29.47 | 30.88 | 40.81 | 53.47 | 56.08 | 53.18 | 551.21 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 | 1.57 | 2.40 | 0.64 | 0.00 | 5.56 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 | 1.57 | 2.40 | 0.64 | 0.00 | 0.00 | 5.56 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.30 | 0.00 | 0.00 | 0.00 | 3.30 |
| Qtotal (af) | -60.71 | -54.34 | -50.06 | -48.17 | -40.22 | -8.73 | 10.41 | 3.93 | 87.17 | -49.88 | -56.08 | -53.18 | **-319.85** |
| Water Elev (ft) | 62.10 | 58.90 | 63.85 | 68.80 | 64.95 | 61.10 | 60.55 | 60.00 | 63.65 | 67.30 | 63.55 | 59.80 | |
| Surface area (acres) | 145.6 | 134.6 | 148.1 | 156.0 | 149.7 | 143.2 | 140.8 | 140.8 | 148.1 | 154.4 | 148.1 | 137.7 | |

| Water Year 1981-1982 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.89 | 1.96 | 0.72 | 2.52 | 0.34 | 4.07 | 1.73 | 0.00 | 0.00 | 12.23 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 15.80 | 34.81 | 12.79 | 44.75 | 6.04 | 72.28 | 30.72 | 0.00 | 0.00 | 217.18 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 6.30 | 13.88 | 5.10 | 17.85 | 2.41 | 28.83 | 12.25 | 0.00 | 0.00 | 86.63 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.89 | 1.51 | 1.18 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 0.07 | 11.64 |
| Qesoil (af) | 0.00 | 0.00 | 0.00 | 7.69 | 13.74 | 11.02 | 10.13 | 9.47 | 10.95 | 12.69 | 16.35 | 0.64 | 92.66 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 52.42 | 46.31 | 37.90 | 33.80 | 27.83 | 23.76 | 22.92 | 26.46 | 35.27 | 46.60 | 45.67 | 40.00 | 438.94 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.00 | 1.35 | 0.46 | 2.40 | 2.19 | 0.07 | 6.92 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.00 | 1.35 | 0.46 | 2.40 | 2.19 | 0.07 | 0.00 | 6.92 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.59 | 0.00 | 0.00 | 0.00 | 0.59 |
| Qtotal (af) | -52.42 | -46.31 | -37.90 | -19.37 | 2.97 | -12.63 | 17.92 | -20.63 | 41.11 | -14.94 | -45.67 | -40.00 | **-227.88** |
| Water Elev (ft) | 54.90 | 50.00 | 49.20 | 48.40 | 46.95 | 45.50 | 48.77 | 52.05 | 55.32 | 58.60 | 52.60 | 46.60 | |
| Surface area (acres) | 125.8 | 114.7 | 112.1 | 109.5 | 103.5 | 100.6 | 109.5 | 120.6 | 128.0 | 134.6 | 120.6 | 103.5 | |

# ATTACHMENT 1
# EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Existing Gravel Pits
## 1979-80 to 1998-99 Water Years
## (Includes Beedy Street Runoff)

| Water Year 1982-1983 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.90 | 0.42 | 4.41 | 1.82 | 7.62 | 5.23 | 5.90 | 3.60 | 0.14 | 0.01 | 30.05 |
| Qprec (af) | 0.00 | 0.00 | 15.98 | 7.46 | 78.31 | 32.32 | 135.32 | 92.88 | 104.77 | 63.93 | 2.49 | 0.18 | 533.64 |
| Qrunoff (af) | 0.00 | 0.00 | 6.38 | 2.98 | 31.24 | 12.89 | 53.98 | 37.05 | 41.79 | 25.50 | 0.99 | 0.07 | 212.85 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.07 | 0.00 | 0.90 | 0.42 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 0.43 | 12.65 |
| Qesoil (af) | 0.60 | 0.00 | 7.77 | 3.73 | 14.85 | 13.77 | 11.78 | 11.82 | 14.09 | 16.75 | 15.83 | 2.81 | 113.80 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 45.63 | 45.25 | 37.01 | 32.88 | 25.44 | 20.85 | 19.37 | 21.42 | 28.54 | 37.90 | 46.79 | 51.99 | 413.09 |
| SM1 (in) | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 0.42 | 14.89 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 0.42 | 0.00 | 14.82 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 | 0.50 | 6.45 | 4.00 | 4.36 | 1.66 | 0.00 | 0.00 | 17.47 |
| Qtotal (af) | -45.63 | -45.25 | -22.43 | -26.18 | 45.57 | 10.60 | 158.14 | 96.68 | 103.93 | 34.78 | -44.36 | -51.80 | **214.05** |
| Water Elev (ft) | 48.25 | 49.90 | 48.45 | 47.00 | 43.70 | 40.40 | 42.30 | 44.20 | 46.35 | 48.50 | 53.60 | 58.70 | |
| Surface area (acres) | 109.5 | 112.1 | 109.5 | 106.5 | 94.7 | 88.2 | 92.5 | 97.6 | 103.5 | 109.5 | 123.5 | 134.6 | |

| Water Year 1983-1984 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.96 | 0.85 | 2.76 | 3.07 | 4.40 | 0.19 | 0.01 | 0.38 | 0.25 | 0.00 | 0.00 | 12.87 |
| Qprec (af) | 0.00 | 17.05 | 15.09 | 49.01 | 54.52 | 78.14 | 3.37 | 0.18 | 6.75 | 4.44 | 0.00 | 0.00 | 228.55 |
| Qrunoff (af) | 0.00 | 6.80 | 6.02 | 19.55 | 21.75 | 31.17 | 1.35 | 0.07 | 2.69 | 1.77 | 0.00 | 0.00 | 91.16 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.00 | 0.96 | 0.85 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 0.58 | 0.25 | 0.00 | 0.00 | 9.60 |
| Qesoil (af) | 0.00 | 5.20 | 4.78 | 9.72 | 8.16 | 6.82 | 6.04 | 6.33 | 2.98 | 1.29 | 0.00 | 0.00 | 51.33 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 59.69 | 59.78 | 49.24 | 44.96 | 39.79 | 35.73 | 31.67 | 33.18 | 41.69 | 52.37 | 53.31 | 48.57 | 549.98 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.03 | 2.40 | 2.40 | 1.42 | 0.20 | 0.00 | 0.00 | 0.00 | 7.45 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 1.03 | 2.40 | 2.40 | 1.42 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 7.45 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 3.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.27 |
| Qtotal (af) | -59.69 | -41.13 | -32.90 | 8.08 | 20.90 | 66.75 | -27.93 | -32.98 | -34.21 | -47.45 | -53.31 | -48.57 | **-282.44** |
| Water Elev (ft) | 61.05 | 63.40 | 62.80 | 62.20 | 63.80 | 65.40 | 65.35 | 65.30 | 65.60 | 65.90 | 60.10 | 54.30 | |
| Surface area (acres) | 143.2 | 148.1 | 145.6 | 145.6 | 148.1 | 151.2 | 151.2 | 151.2 | 151.2 | 151.2 | 140.8 | 125.8 | |

| Water Year 1984-1985 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.05 | 0.27 | 0.31 | 2.55 | 4.00 | 1.10 | 1.70 | 0.94 | 0.00 | 0.00 | 0.00 | 10.92 |
| Qprec (af) | 0.00 | 0.89 | 4.79 | 5.51 | 45.28 | 71.03 | 19.53 | 30.19 | 16.69 | 0.00 | 0.00 | 0.00 | 193.92 |
| Qrunoff (af) | 0.00 | 0.35 | 1.91 | 2.20 | 18.06 | 28.33 | 7.79 | 12.04 | 6.66 | 0.00 | 0.00 | 0.00 | 77.35 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.81 | 4.74 | 4.96 | 5.72 | 7.17 | 7.96 | 65.92 |
| AEsoil (in) | 0.00 | 0.05 | 0.27 | 0.31 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 1.41 | 0.00 | 0.00 | 9.60 |
| Qesoil (af) | 0.00 | 0.39 | 1.92 | 2.09 | 11.23 | 11.43 | 10.28 | 11.16 | 12.00 | 10.01 | 0.00 | 0.00 | 70.49 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.86 | 3.56 | 3.72 | 4.29 | 5.38 | 5.97 | 49.44 |
| Qelake(af) | 51.50 | 48.69 | 43.27 | 40.87 | 33.20 | 25.86 | 28.72 | 39.22 | 40.35 | 45.75 | 47.73 | 43.90 | 489.06 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.05 | 2.40 | 2.17 | 2.21 | 1.41 | 0.00 | 0.00 | 9.23 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.05 | 2.40 | 2.17 | 2.21 | 1.41 | 0.00 | 0.00 | 0.00 | 9.23 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 |
| Qtotal (af) | -51.50 | -47.83 | -38.48 | -35.26 | 11.11 | 50.38 | -9.87 | -8.42 | -23.50 | -45.75 | -47.73 | -43.90 | **-290.74** |
| Water Elev (ft) | 53.55 | 52.80 | 55.35 | 57.90 | 53.10 | 48.30 | 52.85 | 57.40 | 56.20 | 55.00 | 47.90 | 40.80 | |
| Surface area (acres) | 123.5 | 120.6 | 128.0 | 132.4 | 123.5 | 109.5 | 120.6 | 132.4 | 130.2 | 128.0 | 106.5 | 88.2 | |

# ATTACHMENT 1
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Existing Gravel Pits
## 1979-80 to 1998-99 Water Years
## (Includes Beedy Street Runoff)

| Water Year 1985-1986 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.01 | 0.43 | 4.06 | 0.74 | 3.91 | 7.03 | 4.82 | 1.13 | 0.03 | 0.00 | 22.16 |
| Qprec (af) | 0.00 | 0.00 | 0.18 | 7.64 | 72.10 | 13.14 | 69.44 | 124.84 | 85.60 | 20.07 | 0.53 | 0.00 | 393.52 |
| Qrunoff (af) | 0.00 | 0.00 | 0.07 | 3.05 | 28.76 | 5.24 | 27.70 | 49.80 | 34.14 | 8.00 | 0.21 | 0.00 | 156.97 |
| Epan (in) | 8.32 | 7.86 | 7.17 | 6.35 | 4.21 | 4.49 | 4.12 | 3.35 | 4.26 | 5.99 | 5.93 | 5.76 | 67.81 |
| AEsoil (in) | 0.00 | 0.00 | 0.01 | 0.43 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 1.46 | 0.00 | 11.15 |
| Qesoil (af) | 0.00 | 0.00 | 0.12 | 5.48 | 18.53 | 19.21 | 16.93 | 13.60 | 16.17 | 20.69 | 14.08 | 0.00 | 124.79 |
| AElake(in) | 6.24 | 5.90 | 5.38 | 4.76 | 3.16 | 3.37 | 3.09 | 2.51 | 3.20 | 4.49 | 4.45 | 4.32 | 50.86 |
| Qelake(af) | 43.90 | 40.07 | 32.38 | 23.87 | 16.37 | 18.64 | 18.60 | 15.48 | 22.10 | 35.44 | 36.18 | 36.21 | 339.25 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 1.57 | 2.40 | 2.40 | 2.40 | 1.43 | 0.00 | 12.60 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 1.57 | 2.40 | 2.40 | 2.40 | 1.43 | 0.00 | 0.00 | 12.60 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 | 1.64 | 5.86 | 3.33 | 0.00 | 0.00 | 0.00 | 11.01 |
| Qtotal (af) | -43.90 | -40.07 | -32.25 | -18.67 | 35.78 | -9.30 | 51.84 | 145.56 | 81.47 | -18.52 | -35.73 | -36.21 | **80.01** |
| Water Elev (ft) | 38.45 | 36.10 | 30.65 | 25.20 | 26.70 | 28.20 | 30.00 | 31.80 | 37.75 | 43.70 | 44.80 | 45.90 | |
| Surface area (acres) | 84.4 | 81.6 | 72.2 | 60.1 | 62.2 | 66.4 | 72.2 | 73.9 | 83.0 | 94.7 | 97.6 | 100.6 | |

| Water Year 1986-1987 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.01 | 0.00 | 1.15 | 0.00 | 1.38 | 0.24 | 1.87 | 1.91 | 1.90 | 0.02 | 0.00 | 0.04 | 8.52 |
| Qprec (af) | 0.18 | 0.00 | 20.42 | 0.00 | 24.51 | 4.26 | 33.21 | 33.92 | 33.74 | 0.36 | 0.00 | 0.71 | 151.30 |
| Qrunoff (af) | 0.07 | 0.00 | 8.15 | 0.00 | 9.78 | 1.70 | 13.25 | 13.53 | 13.46 | 0.14 | 0.00 | 0.28 | 60.35 |
| Epan (in) | 7.34 | 6.66 | 5.38 | 4.98 | 4.48 | 3.82 | 3.55 | 4.21 | 4.54 | 5.64 | 5.59 | 5.75 | 61.94 |
| AEsoil (in) | 0.01 | 0.00 | 1.15 | 0.00 | 1.38 | 0.24 | 1.24 | 1.47 | 1.59 | 1.40 | 0.00 | 0.04 | 8.52 |
| Qesoil (af) | 0.09 | 0.00 | 11.76 | 0.00 | 15.45 | 2.75 | 14.06 | 16.50 | 17.61 | 15.29 | 0.00 | 0.53 | 94.04 |
| AElake(in) | 5.51 | 5.00 | 4.04 | 3.74 | 3.36 | 2.87 | 2.66 | 3.16 | 3.41 | 4.23 | 4.19 | 4.31 | 46.46 |
| Qelake(af) | 47.50 | 43.10 | 30.39 | 25.39 | 22.04 | 18.05 | 17.15 | 20.71 | 22.74 | 28.75 | 24.22 | 19.36 | 319.43 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 1.06 | 1.38 | 0.00 | 0.00 | 3.07 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 1.06 | 1.38 | 0.00 | 0.00 | 0.00 | 3.07 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | -47.35 | -43.10 | -13.58 | -25.39 | -3.21 | -14.84 | 8.14 | 5.35 | 3.41 | -28.48 | -24.22 | -18.90 | **-202.18** |
| Water Elev (ft) | 46.05 | 46.20 | 41.35 | 36.50 | 34.40 | 32.30 | 33.60 | 34.90 | 35.65 | 36.40 | 29.65 | 22.90 | |
| Surface area (acres) | 103.5 | 103.5 | 90.4 | 81.6 | 78.7 | 75.6 | 77.3 | 78.7 | 80.1 | 81.6 | 69.3 | 53.9 | |

| Water Year 1987-1988 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.11 | 0.00 | 0.00 | 1.58 | 1.20 | 3.06 | 2.38 | 1.09 | 0.58 | 2.30 | 0.00 | 0.00 | 12.30 |
| Qprec (af) | 1.95 | 0.00 | 0.00 | 28.06 | 21.31 | 54.34 | 42.26 | 19.36 | 10.30 | 40.84 | 0.00 | 0.00 | 218.43 |
| Qrunoff (af) | 0.78 | 0.00 | 0.00 | 11.19 | 8.50 | 21.68 | 16.86 | 7.72 | 4.11 | 16.29 | 0.00 | 0.00 | 87.13 |
| Epan (in) | 6.58 | 6.92 | 5.79 | 4.71 | 4.66 | 3.37 | 4.03 | 5.15 | 7.20 | 6.02 | 8.56 | 7.46 | 70.45 |
| AEsoil (in) | 0.11 | 0.00 | 0.00 | 1.58 | 1.20 | 1.18 | 1.41 | 1.80 | 2.27 | 2.11 | 0.19 | 0.00 | 11.85 |
| Qesoil (af) | 1.50 | 0.00 | 0.00 | 22.16 | 16.91 | 16.96 | 19.30 | 22.98 | 28.90 | 27.23 | 2.64 | 0.00 | 158.58 |
| AElake(in) | 4.94 | 5.19 | 4.34 | 3.53 | 3.50 | 2.53 | 3.02 | 3.86 | 5.40 | 4.52 | 6.42 | 5.60 | 52.84 |
| Qelake(af) | 20.44 | 20.80 | 16.81 | 13.19 | 12.81 | 8.54 | 12.32 | 19.36 | 27.06 | 21.84 | 26.16 | 20.89 | 220.23 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.88 | 2.40 | 1.69 | 0.00 | 0.19 | 0.00 | 6.16 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.88 | 2.40 | 1.69 | 0.00 | 0.19 | 0.00 | 0.00 | 6.16 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 |
| Qtotal (af) | -19.21 | -20.80 | -16.81 | 3.90 | 0.09 | 23.47 | 20.40 | -6.17 | -20.05 | 5.58 | -26.16 | -20.89 | **-76.67** |
| Water Elev (ft) | 20.90 | 18.90 | 16.90 | 14.90 | 13.80 | 12.70 | 19.30 | 25.90 | 25.20 | 24.50 | 19.70 | 14.90 | |
| Surface area (acres) | 49.7 | 48.1 | 46.5 | 44.8 | 44.0 | 40.5 | 48.9 | 60.1 | 60.1 | 58.0 | 48.9 | 44.8 | |

# ATTACHMENT 1
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Existing Gravel Pits
## 1979-80 to 1998-99 Water Years
## (Includes Beedy Street Runoff)

| Water Year 1988-1989 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.96 | 2.73 | 0.76 | 2.64 | 0.88 | 0.20 | 0.11 | 0.00 | 8.30 |
| Qprec (af) | 0.00 | 0.00 | 0.36 | 0.00 | 17.05 | 48.48 | 13.50 | 46.88 | 15.63 | 3.55 | 1.95 | 0.00 | 147.39 |
| Qrunoff (af) | 0.00 | 0.00 | 0.14 | 0.00 | 6.80 | 19.34 | 5.38 | 18.70 | 6.23 | 1.42 | 0.78 | 0.00 | 58.79 |
| Epan (in) | 6.82 | 7.17 | 6.49 | 4.77 | 4.16 | 4.99 | 4.10 | 3.32 | 4.34 | 6.01 | 6.36 | 6.03 | 64.56 |
| AEsoil (in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.96 | 1.75 | 1.44 | 1.16 | 1.52 | 1.35 | 0.11 | 0.00 | 8.30 |
| Qesoil (af) | 0.00 | 0.00 | 0.30 | 0.00 | 15.38 | 28.09 | 23.02 | 18.35 | 24.16 | 21.59 | 1.77 | 0.00 | 132.66 |
| AElake(in) | 5.12 | 5.38 | 4.87 | 3.58 | 3.12 | 3.74 | 3.08 | 2.49 | 3.26 | 4.51 | 4.77 | 4.52 | 48.42 |
| Qelake(af) | 18.75 | 16.61 | 13.63 | 8.74 | 5.41 | 6.27 | 5.27 | 4.90 | 6.03 | 7.81 | 8.09 | 7.49 | 109.00 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.31 | 1.79 | 1.15 | 0.00 | 0.00 | 4.23 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.31 | 1.79 | 1.15 | 0.00 | 0.00 | 0.00 | 4.23 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | -18.75 | -16.61 | -13.43 | -8.74 | 3.06 | 17.64 | 1.42 | 19.00 | 1.84 | -6.05 | -7.12 | -7.49 | **-35.25** |
| Water Elev (ft) | 13.20 | 11.50 | 10.50 | 9.50 | 5.80 | 2.10 | 4.90 | 7.70 | 6.80 | 5.90 | 3.90 | 1.90 | |
| Surface area (acres) | 44.0 | 37.1 | 33.6 | 29.3 | 20.8 | 20.1 | 20.6 | 23.6 | 22.2 | 20.8 | 20.3 | 19.9 | |

| Water Year 1989-1990 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.08 | 0.19 | 0.50 | 0.00 | 2.24 | 1.71 | 0.00 | 0.03 | 0.71 | 0.00 | 5.46 |
| Qprec (af) | 0.00 | 0.00 | 1.42 | 3.37 | 8.88 | 0.00 | 39.78 | 30.37 | 0.00 | 0.53 | 12.61 | 0.00 | 96.96 |
| Qrunoff (af) | 0.00 | 0.00 | 0.57 | 1.35 | 3.54 | 0.00 | 15.87 | 12.11 | 0.00 | 0.21 | 5.03 | 0.00 | 38.68 |
| Epan (in) | 6.83 | 5.96 | 5.35 | 4.58 | 5.12 | 4.71 | 3.86 | 3.42 | 4.37 | 4.45 | 6.21 | 6.47 | 61.33 |
| AEsoil (in) | 0.00 | 0.00 | 0.11 | 0.27 | 0.70 | 0.00 | 1.35 | 1.20 | 1.53 | 0.91 | 0.99 | 0.00 | 7.06 |
| Qesoil (af) | 0.00 | 0.00 | 1.99 | 4.72 | 12.42 | 0.00 | 23.99 | 21.26 | 27.16 | 16.20 | 17.64 | 0.00 | 125.38 |
| AElake(in) | 5.12 | 4.47 | 4.01 | 3.44 | 3.84 | 3.53 | 2.90 | 2.57 | 3.28 | 3.34 | 4.66 | 4.85 | 46.00 |
| Qelake(af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.78 | 2.40 | 0.87 | 0.00 | 0.00 | 5.05 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.78 | 2.40 | 0.87 | 0.00 | 0.00 | 0.00 | 5.05 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.26 | 0.00 | 0.00 | 0.00 | 0.00 | **10.26** |
| Water Elev (ft) | -1.35 | -4.60 | -5.68 | -6.77 | -7.85 | -8.93 | -10.02 | -11.10 | -13.75 | -16.40 | -28.70 | -41.00 | |
| Surface area (acres) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |

| Water Year 1990-1991 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.98 | 2.50 | 8.61 | 0.00 | 0.00 | 0.00 | 12.64 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 0.00 | 9.77 | 0.00 | 17.40 | 44.40 | 152.90 | 0.00 | 0.00 | 0.00 | 224.47 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 0.00 | 3.90 | 0.00 | 6.94 | 17.71 | 60.99 | 0.00 | 0.00 | 0.00 | 89.53 |
| Epan (in) | 7.48 | 6.45 | 5.61 | 5.27 | 4.90 | 4.42 | 3.35 | 2.81 | 3.45 | 5.52 | 6.52 | 5.78 | 61.56 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.77 | 0.00 | 1.17 | 0.98 | 1.21 | 1.93 | 0.47 | 0.00 | 6.53 |
| Qesoil (af) | 0.00 | 0.00 | 0.00 | 0.00 | 13.66 | 0.00 | 20.82 | 17.47 | 21.44 | 34.31 | 8.31 | 0.00 | 116.01 |
| AElake(in) | 5.61 | 4.84 | 4.21 | 3.95 | 3.68 | 3.32 | 2.51 | 2.11 | 2.59 | 4.14 | 4.89 | 4.34 | 46.17 |
| Qelake(af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 2.40 | 2.40 | 0.47 | 0.00 | 5.47 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 2.40 | 2.40 | 0.47 | 0.00 | 0.00 | 5.47 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.31 | 10.84 | 0.00 | 0.00 | 0.00 | 11.15 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.54 | 192.44 | 0.00 | 0.00 | 0.00 | **197.99** |
| Water Elev (ft) | -44.20 | -47.40 | -42.00 | -36.60 | -32.30 | -28.00 | -29.55 | -31.10 | -26.05 | -21.00 | -22.15 | -23.30 | |
| Surface area (acres) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |

# ATTACHMENT 1
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Existing Gravel Pits
## 1979-80 to 1998-99 Water Years
## (Includes Beedy Street Runoff)

| Water Year 1991-1992 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.02 | 0.00 | 0.16 | 0.14 | 3.87 | 1.99 | 7.87 | 4.26 | 0.08 | 0.00 | 0.00 | 18.39 |
| Qprec (af) | 0.00 | 0.36 | 0.00 | 2.84 | 2.49 | 68.72 | 35.34 | 139.76 | 75.65 | 1.42 | 0.00 | 0.00 | 326.58 |
| Qrunoff (af) | 0.00 | 0.14 | 0.00 | 1.13 | 0.99 | 27.41 | 14.10 | 55.75 | 30.18 | 0.57 | 0.00 | 0.00 | 130.26 |
| Epan (in) | 5.96 | 5.45 | 4.31 | 3.97 | 4.38 | 2.92 | 3.63 | 3.10 | 3.02 | 4.54 | 4.45 | 5.83 | 51.56 |
| AEsoil (in) | 0.00 | 0.03 | 0.00 | 0.22 | 0.20 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 0.89 | 0.00 | 7.36 |
| Qesoil (af) | 0.00 | 0.50 | 0.00 | 3.97 | 3.48 | 18.15 | 22.56 | 19.27 | 18.77 | 25.09 | 14.17 | 0.00 | 125.96 |
| AElake(in) | 4.47 | 4.09 | 3.23 | 2.98 | 3.29 | 2.19 | 2.72 | 2.33 | 2.27 | 3.41 | 3.34 | 4.37 | 38.67 |
| Qelake(af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.71 | 6.18 | 7.58 | 20.47 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.89 | 0.00 | 10.49 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.89 | 0.00 | 0.00 | 10.49 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.99 | 1.51 | 9.92 | 4.90 | 0.00 | 0.00 | 0.00 | 18.33 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 35.37 | 26.87 | 176.24 | 87.05 | -5.98 | -6.18 | -7.58 | **305.79** |
| Water Elev (ft) | -25.20 | -27.10 | -30.05 | -33.00 | -32.10 | -31.20 | -28.75 | -26.30 | -9.20 | 7.90 | 6.90 | 5.90 | |
| Surface area (acres) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 23.6 | 22.2 | 20.8 | |

| Water Year 1992-1993 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.09 | 0.00 | 0.00 | 1.05 | 0.00 | 4.74 | 7.55 | 8.92 | 3.72 | 0.00 | 0.10 | 0.68 | 26.85 |
| Qprec (af) | 1.60 | 0.00 | 0.00 | 18.65 | 0.00 | 84.17 | 134.08 | 158.40 | 66.06 | 0.00 | 1.78 | 12.08 | 476.81 |
| Qrunoff (af) | 0.64 | 0.00 | 0.00 | 7.44 | 0.00 | 33.58 | 53.48 | 63.18 | 26.35 | 0.00 | 0.71 | 4.82 | 190.19 |
| Epan (in) | 6.26 | 6.66 | 5.08 | 4.05 | 5.19 | 3.22 | 2.52 | 2.98 | 3.61 | 5.34 | 5.73 | 6.50 | 57.14 |
| AEsoil (in) | 0.09 | 0.00 | 0.00 | 1.05 | 0.00 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 0.63 | 0.68 | 8.64 |
| Qesoil (af) | 1.45 | 0.00 | 0.00 | 16.58 | 0.00 | 13.97 | 10.23 | 11.68 | 13.35 | 18.45 | 5.92 | 6.04 | 97.66 |
| AElake(in) | 4.70 | 5.00 | 3.81 | 3.04 | 3.89 | 2.42 | 1.89 | 2.24 | 2.71 | 4.01 | 4.30 | 4.88 | 42.86 |
| Qelake(af) | 7.87 | 0.00 | 6.46 | 5.98 | 15.34 | 12.95 | 11.64 | 14.66 | 19.48 | 31.60 | 36.02 | 43.27 | 205.27 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.53 | 0.00 | 10.13 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.53 | 0.00 | 0.00 | 10.13 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.21 | 6.67 | 7.88 | 2.46 | 0.00 | 0.00 | 0.00 | 18.21 |
| Qtotal (af) | -7.08 | 0.00 | -6.46 | 3.52 | -15.34 | 61.08 | 165.68 | 195.25 | 59.58 | -31.60 | -34.48 | -32.42 | **357.75** |
| Water Elev (ft) | 2.40 | -1.10 | 3.05 | 7.20 | 17.45 | 27.70 | 31.25 | 34.80 | 39.15 | 43.50 | 45.50 | 47.50 | |
| Surface area (acres) | 20.1 | 0.0 | 20.3 | 23.6 | 47.3 | 64.3 | 73.9 | 78.7 | 86.3 | 94.7 | 100.6 | 106.5 | |

| Water Year 1993-1994 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.55 | 0.70 | 1.41 | 0.49 | 4.96 | 2.82 | 0.39 | 0.26 | 0.00 | 11.58 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 9.77 | 12.43 | 25.04 | 8.70 | 88.08 | 50.08 | 6.93 | 4.62 | 0.00 | 205.64 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 3.90 | 4.96 | 9.99 | 3.47 | 35.13 | 19.98 | 2.76 | 1.84 | 0.00 | 82.03 |
| Epan (in) | 6.51 | 5.88 | 4.78 | 4.50 | 4.50 | 3.64 | 3.63 | 3.49 | 3.96 | 4.60 | 4.07 | 5.22 | 54.78 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.55 | 0.70 | 1.27 | 0.63 | 1.22 | 1.39 | 1.61 | 1.42 | 0.02 | 8.81 |
| Qesoil (af) | 0.00 | 0.00 | 0.00 | 5.43 | 6.05 | 9.51 | 4.56 | 8.67 | 10.09 | 11.72 | 10.98 | 0.12 | 67.12 |
| AElake(in) | 4.88 | 4.41 | 3.59 | 3.38 | 3.38 | 2.73 | 2.72 | 2.62 | 2.97 | 3.45 | 3.05 | 3.92 | 41.09 |
| Qelake(af) | 40.93 | 34.79 | 28.28 | 26.63 | 30.79 | 28.11 | 28.53 | 27.91 | 31.12 | 36.15 | 30.68 | 38.38 | 382.30 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 2.40 | 2.40 | 1.18 | 0.02 | 6.13 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 2.40 | 2.40 | 1.18 | 0.02 | 0.00 | 6.13 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.34 | 1.43 | 0.00 | 0.00 | 0.00 | 2.77 |
| Qtotal (af) | -40.93 | -34.79 | -28.28 | -18.39 | -19.44 | -3.60 | -19.92 | 69.61 | 28.84 | -29.30 | -26.22 | -38.38 | **-160.82** |
| Water Elev (ft) | 45.35 | 43.20 | 43.10 | 43.00 | 48.10 | 53.20 | 54.35 | 55.50 | 54.95 | 54.40 | 52.70 | 51.00 | |
| Surface area (acres) | 100.6 | 94.7 | 94.7 | 94.7 | 109.5 | 123.5 | 125.8 | 128.0 | 125.8 | 125.8 | 120.6 | 117.6 | |

# ATTACHMENT 1
# EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Existing Gravel Pits
## 1979-80 to 1998-99 Water Years
## (Includes Beedy Street Runoff)

| Water Year 1994-1995 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.18 | 0.39 | 1.63 | 0.97 | 14.23 | 1.08 | 8.16 | 0.58 | 0.78 | 0.34 | 28.34 |
| Qprec (af) | 0.00 | 0.00 | 3.20 | 6.93 | 28.95 | 17.23 | 252.70 | 19.18 | 144.91 | 10.30 | 13.85 | 6.04 | 503.27 |
| Qrunoff (af) | 0.00 | 0.00 | 1.28 | 2.76 | 11.55 | 6.87 | 100.80 | 7.65 | 57.80 | 4.11 | 5.53 | 2.41 | 200.74 |
| Epan (in) | 5.58 | 5.84 | 4.64 | 4.27 | 3.84 | 2.60 | 1.64 | 2.53 | 3.64 | 5.25 | 4.65 | 4.98 | 49.46 |
| AEsoil (in) | 0.02 | 0.00 | 0.18 | 0.39 | 1.34 | 0.91 | 0.57 | 0.89 | 1.27 | 1.84 | 1.63 | 0.64 | 9.67 |
| Qesoil (af) | 0.13 | 0.00 | 1.69 | 3.75 | 12.60 | 8.08 | 4.96 | 7.26 | 9.82 | 13.71 | 11.55 | 4.27 | 77.83 |
| AElake(in) | 4.19 | 4.38 | 3.48 | 3.20 | 2.88 | 1.95 | 1.23 | 1.90 | 2.73 | 3.94 | 3.49 | 3.74 | 37.10 |
| Qelake(af) | 38.18 | 36.72 | 29.17 | 26.06 | 24.14 | 17.31 | 11.22 | 18.14 | 27.43 | 40.54 | 37.19 | 41.20 | 347.29 |
| SM1 (in) | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 0.35 | 2.40 | 2.40 | 2.40 | 1.14 | 0.30 | 9.29 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 0.35 | 2.40 | 2.40 | 2.40 | 1.14 | 0.30 | 0.00 | 9.27 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.60 | 0.19 | 6.89 | 0.00 | 0.00 | 0.00 | 18.68 |
| Qtotal (af) | -38.18 | -36.72 | -26.39 | -20.12 | 1.07 | -1.83 | 319.58 | 1.43 | 165.45 | -30.46 | -23.35 | -35.05 | **275.46** |
| Water Elev (ft) | 48.20 | 45.40 | 45.00 | 44.60 | 45.80 | 47.00 | 48.74 | 50.49 | 52.23 | 53.98 | 55.72 | 57.46 | |
| Surface area (acres) | 109.5 | 100.6 | 100.6 | 97.6 | 100.6 | 106.5 | 109.5 | 114.7 | 120.6 | 123.5 | 128.0 | 132.4 | |

| Water Year 1995-1996 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 1.99 | 1.24 | 7.59 | 1.40 | 0.60 | 0.11 | 0.00 | 13.04 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 0.00 | 1.95 | 35.34 | 22.02 | 134.79 | 24.86 | 10.66 | 1.95 | 0.00 | 231.57 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.78 | 14.10 | 8.78 | 53.76 | 9.92 | 4.25 | 0.78 | 0.00 | 92.37 |
| Epan (in) | 5.83 | 6.20 | 4.90 | 4.67 | 3.20 | 2.88 | 3.02 | 2.41 | 3.74 | 5.56 | 6.06 | 5.40 | 53.87 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 1.16 | 0.00 | 7.44 |
| Qesoil (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 4.93 | 5.00 | 3.96 | 6.15 | 9.15 | 5.47 | 0.00 | 35.21 |
| AElake(in) | 4.37 | 4.65 | 3.68 | 3.50 | 2.40 | 2.16 | 2.27 | 1.81 | 2.81 | 4.17 | 4.55 | 4.05 | 40.40 |
| Qelake(af) | 50.16 | 54.54 | 44.60 | 43.68 | 30.57 | 27.80 | 29.51 | 23.60 | 36.63 | 54.45 | 59.35 | 51.58 | 506.48 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 1.17 | 2.40 | 2.40 | 1.05 | 0.00 | 8.00 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 1.17 | 2.40 | 2.40 | 1.05 | 0.00 | 0.00 | 8.00 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.51 | 0.09 | 0.00 | 0.00 | 0.00 | 5.60 |
| Qtotal (af) | -50.16 | -54.54 | -44.60 | -43.68 | -28.39 | 11.91 | -4.57 | 155.18 | -8.00 | -42.37 | -57.14 | -51.58 | **-217.95** |
| Water Elev (ft) | 59.21 | 60.95 | 62.69 | 64.44 | 66.18 | 67.93 | 69.67 | 71.41 | 73.16 | 74.90 | 70.65 | 66.40 | |
| Surface area (acres) | 137.7 | 140.8 | 145.6 | 149.7 | 152.8 | 154.4 | 156.4 | 156.7 | 156.7 | 156.7 | 156.7 | 152.8 | |

| Water Year 1996-1997 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 1.18 | 2.63 | 5.50 | 4.45 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 13.82 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 20.95 | 46.70 | 97.67 | 79.02 | 1.07 | 0.00 | 0.00 | 0.00 | 0.00 | 245.42 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 8.36 | 18.63 | 38.96 | 31.52 | 0.43 | 0.00 | 0.00 | 0.00 | 0.00 | 97.89 |
| Epan (in) | 5.91 | 5.65 | 4.94 | 4.85 | 4.25 | 3.58 | 2.41 | 4.35 | 5.53 | 6.93 | 7.31 | 6.40 | 62.11 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 1.18 | 1.49 | 1.25 | 0.84 | 1.52 | 0.94 | 0.00 | 0.00 | 0.00 | 7.22 |
| Qesoil (af) | 0.00 | 0.00 | 0.00 | 8.81 | 12.20 | 10.82 | 5.98 | 8.87 | 5.08 | 0.00 | 0.00 | 0.00 | 51.76 |
| AElake(in) | 4.43 | 4.24 | 3.71 | 3.64 | 3.19 | 2.69 | 1.81 | 3.26 | 4.15 | 5.20 | 5.48 | 4.80 | 46.58 |
| Qelake(af) | 51.99 | 46.75 | 39.51 | 37.45 | 30.47 | 24.49 | 19.27 | 38.93 | 51.17 | 65.51 | 64.31 | 51.18 | 521.03 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.14 | 2.40 | 2.40 | 0.94 | 0.00 | 0.00 | 0.00 | 6.88 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.14 | 2.40 | 2.40 | 0.94 | 0.00 | 0.00 | 0.00 | 0.00 | 6.88 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.99 | 3.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.60 |
| Qtotal (af) | -51.99 | -46.75 | -39.51 | -16.94 | 13.30 | 90.46 | 85.29 | -37.79 | -51.17 | -65.51 | -64.31 | -51.18 | **-236.10** |
| Water Elev (ft) | 60.00 | 57.74 | 55.48 | 53.22 | 50.96 | 48.70 | 55.30 | 61.90 | 63.70 | 65.50 | 60.60 | 55.70 | |
| Surface area (acres) | 140.8 | 132.4 | 128.0 | 123.5 | 114.7 | 109.5 | 128.0 | 143.2 | 148.1 | 151.2 | 140.8 | 128.0 | |

# ATTACHMENT 1
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Existing Gravel Pits
## 1979-80 to 1998-99 Water Years
## (Includes Beedy Street Runoff)

| Water Year 1997-1998 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.04 | 0.00 | 2.21 | 6.54 | 3.06 | 18.64 | 3.17 | 1.55 | 2.74 | 0.02 | 37.97 |
| Qprec (af) | 0.00 | 0.00 | 0.71 | 0.00 | 39.25 | 116.14 | 54.34 | 331.02 | 56.29 | 27.53 | 48.66 | 0.36 | 674.28 |
| Qrunoff (af) | 0.00 | 0.00 | 0.28 | 0.00 | 15.65 | 46.33 | 21.68 | 132.03 | 22.45 | 10.98 | 19.41 | 0.14 | 268.95 |
| Epan (in) | 6.61 | 6.43 | 6.09 | 6.53 | 3.61 | 4.24 | 2.72 | 2.99 | 4.92 | 5.66 | 6.41 | 6.63 | 62.84 |
| AEsoil (in) | 0.00 | 0.00 | 0.04 | 0.00 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 2.32 | 13.05 |
| Qesoil (af) | 0.00 | 0.00 | 0.38 | 0.00 | 12.47 | 14.91 | 8.69 | 8.32 | 11.90 | 11.54 | 11.86 | 11.35 | 91.42 |
| AElake(in) | 4.96 | 4.82 | 4.57 | 4.90 | 2.71 | 3.18 | 2.04 | 2.24 | 3.69 | 4.25 | 4.81 | 4.97 | 47.13 |
| Qelake(af) | 47.39 | 40.42 | 38.29 | 41.05 | 21.36 | 24.52 | 17.60 | 21.99 | 40.03 | 50.65 | 59.95 | 63.99 | 467.25 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 | 2.40 | 2.40 | 2.40 | 2.40 | 1.97 | 2.40 | 14.92 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 | 2.40 | 2.40 | 2.40 | 2.40 | 1.97 | 2.40 | 0.10 | 15.02 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.60 | 2.11 | 17.59 | 1.45 | 0.00 | 0.07 | 0.00 | 24.82 |
| Qtotal (af) | -47.39 | -40.42 | -37.67 | -41.05 | 11.73 | 108.43 | 49.72 | 432.74 | 26.82 | -21.18 | -6.03 | -63.59 | **372.11** |
| Water Elev (ft) | 50.75 | 45.80 | 45.45 | 45.10 | 43.65 | 42.20 | 46.75 | 51.30 | 56.20 | 61.10 | 64.20 | 67.30 | |
| Surface area (acres) | 114.7 | 100.6 | 100.6 | 100.6 | 94.7 | 92.5 | 103.5 | 117.6 | 130.2 | 143.2 | 149.7 | 154.4 | |

| Water Year 1998-1999 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.11 | 0.11 | 0.85 | 0.63 | 1.91 | 0.80 | 2.79 | 2.48 | 0.03 | 0.24 | 9.95 |
| Qprec (af) | 0.00 | 0.00 | 1.95 | 1.95 | 15.09 | 11.19 | 33.92 | 14.21 | 49.55 | 44.04 | 0.53 | 4.26 | 176.70 |
| Qrunoff (af) | 0.00 | 0.00 | 0.78 | 0.78 | 6.02 | 4.46 | 13.53 | 5.67 | 19.76 | 17.57 | 0.21 | 1.70 | 70.48 |
| Epan (in) | 7.37 | 7.28 | 5.24 | 5.68 | 3.71 | 4.10 | 3.89 | 3.78 | 4.63 | 5.87 | 5.94 | 6.51 | 64.00 |
| AEsoil (in) | 2.40 | 0.00 | 0.11 | 0.11 | 0.85 | 0.63 | 1.36 | 1.32 | 1.62 | 2.05 | 1.65 | 0.24 | 12.35 |
| Qesoil (af) | 12.05 | 0.00 | 0.57 | 0.60 | 4.27 | 3.00 | 6.44 | 6.22 | 7.62 | 9.66 | 7.80 | 1.17 | 59.39 |
| AElake(in) | 5.53 | 5.46 | 3.93 | 4.26 | 2.78 | 3.08 | 2.92 | 2.84 | 3.47 | 4.40 | 4.46 | 4.88 | 48.00 |
| Qelake(af) | 70.40 | 69.54 | 49.53 | 52.56 | 35.44 | 39.98 | 38.02 | 37.02 | 45.35 | 57.49 | 58.05 | 62.83 | 616.21 |
| SM1 (in) | 2.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.03 | 1.20 | 1.62 | 0.00 | 5.79 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.03 | 1.20 | 1.62 | 0.00 | 0.00 | 3.39 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | -70.40 | -69.54 | -47.37 | -50.43 | -18.59 | -27.33 | 0.40 | -20.91 | 10.85 | -7.54 | -57.45 | -58.04 | **-416.33** |
| Water Elev (ft) | 66.90 | 66.50 | 65.15 | 63.80 | 66.10 | 68.40 | 69.55 | 70.70 | 71.20 | 71.70 | 69.65 | 67.60 | |
| Surface area (acres) | 152.8 | 152.8 | 151.2 | 148.1 | 152.8 | 156.0 | 156.4 | 156.7 | 156.7 | 156.7 | 156.4 | 154.4 | |

# ATTACHMENT 2
# EXISTING CONDITIONS MONTHLY WATER BALANCE
# RiverPark B Drainage Basins
# 1979-80 to 1998-99 Water Years

**Data used for calculations:**

Soil Evaporation Depth: 30 inches

Soil Moisture Holding Capacity: 5.40 inches (0.18 in/in * 30 in)

Total Detention Basin Area: 29.3 acres

Total Area of Agriculture Flowing into Detention Basin: 330 acres (North El Rio Drain Hydrology Study, 3/24/94)

Runoff Factor: 0.604

Soil Factor on Pan Evaporation: 0.35

**Definition of terms:**

Pg = Precipitation (inches). Station 239E El Rio - UWCD (7/1/79 - 6/30/99)

Qrunoff = Water generated from ag runoff outside of Riverpark draining into basin (acre-feet) = (Pg * 0.604/12) * 330

Epan = Pan Evaporation at El Rio (inches). Data from 1985-1999. Pan evaporation values for months earlier than January 1985 are based on average pan evaporation for each month between 1985-1999

PEsoil = Potential soil evaporation (inches). Epan * 0.35

AEsoil = Actual soil evaporation (inches).

If (Pg + Qrunoff*12/29.3 + SM1 - PEsoil) > 0; AEsoil = PEsoil.

If (Pg + Qrunoff*12/29.3 + SM1 - PEsoil) $\leq$ 0; AEsoil = Pg + Qrunoff*12/29.3 + SM1.

SM1 = Soil moisture at the beginning of the month (inches). SM1 = SM2 from previous month

SM2 = Soil moisture at end of the month (inches).

If (Pg + Qrunoff*12/29.3 + SM1 - AEsoil) < 5.4; SM2 = Pg + Qrunoff*12/29.3 + SM1 - AEsoil.

If (Pg + Qrunoff*12/29.3 + SM1 - AEsoil) $\geq$ 5.4; SM2 = 5.4.

If (Pg + Qrunoff*12/29.3 + SM1 - AEsoil) $\leq$ 0; SM2 = 0.0.

Qsoil = Groundwater recharge (inches).

If (Pg + Qrunoff*12/29.3 - AEsoil - (SM2 - SM1) > 0; Qsoil = Pg + Qrunoff*12/29.3 + AEsoil - SM2 - SM1).

If (Pg + Qrunoff*12/29.3 - AEsoil - (SM2 - SM1) $\leq$ 0; Qsoil = 0

Qtotal = Total groundwater recharge from detention basin (acre-feet).

Qtotal = (Qsoil/12) * 29.3

# ATTACHMENT 2
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Drainage Basins
## 1979-80 to 1998-99 Water Years

| Water Year 1979-1980 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.62 | 0.48 | 1.28 | 2.03 | 7.62 | 10.19 | 2.86 | 0.39 | 0.29 | 0.00 | 25.76 |
| Qrunoff (af) | 0.00 | 0.00 | 10.30 | 7.97 | 21.26 | 33.72 | 126.57 | 169.26 | 47.50 | 6.48 | 4.82 | 0.00 | 427.87 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.00 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 16.62 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.65 | 0.89 | 4.63 | 5.40 | 5.40 | 5.40 | 5.40 | 5.06 | 4.13 | 36.95 |
| SM2 (in) | 0.00 | 0.00 | 0.65 | 0.89 | 4.63 | 5.40 | 5.40 | 5.40 | 5.40 | 5.06 | 4.13 | 1.96 | 38.92 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.23 | 30.07 | 40.55 | 10.18 | 0.00 | 0.00 | 0.00 | 87.03 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 15.21 | 73.42 | 99.01 | 24.86 | 0.00 | 0.00 | 0.00 | **212.50** |
| **Water Year 1980-1981** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 2.12 | 1.85 | 5.67 | 0.18 | 0.00 | 0.00 | 11.14 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 21.93 | 35.21 | 30.73 | 94.18 | 2.99 | 0.00 | 0.00 | 185.04 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 1.96 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.08 | 13.37 |
| SM1 (in) | 1.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.09 | 5.40 | 5.40 | 5.40 | 4.20 | 2.08 | 28.53 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.09 | 5.40 | 5.40 | 5.40 | 4.20 | 2.08 | 0.00 | 26.57 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.21 | 6.36 | 21.70 | 0.00 | 0.00 | 0.00 | 34.27 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 15.16 | 15.52 | 52.99 | 0.00 | 0.00 | 0.00 | **83.67** |
| **Water Year 1981-1982** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.89 | 1.96 | 0.72 | 2.52 | 0.34 | 4.07 | 1.73 | 0.00 | 0.00 | 12.23 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 14.78 | 32.56 | 11.96 | 41.86 | 5.65 | 67.60 | 28.74 | 0.00 | 0.00 | 203.14 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 14.72 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.92 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.28 | 37.60 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 1.92 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.28 | 1.12 | 38.71 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 3.05 | 1.63 | 9.16 | 0.17 | 15.14 | 5.15 | 0.00 | 0.00 | 34.30 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 7.45 | 3.98 | 22.36 | 0.40 | 36.97 | 12.58 | 0.00 | 0.00 | **83.75** |
| **Water Year 1982-1983** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.90 | 0.42 | 4.41 | 1.82 | 7.62 | 5.23 | 5.90 | 3.60 | 0.14 | 0.01 | 30.05 |
| Qrunoff (af) | 0.00 | 0.00 | 14.95 | 6.98 | 73.25 | 30.23 | 126.57 | 86.87 | 98.00 | 59.80 | 2.33 | 0.17 | 499.13 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 1.12 | 0.00 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 17.73 |
| SM1 (in) | 1.12 | 0.00 | 0.00 | 1.80 | 1.79 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.85 | 40.95 |
| SM2 (in) | 0.00 | 0.00 | 1.80 | 1.79 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.85 | 1.73 | 41.57 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 12.96 | 6.14 | 30.07 | 20.21 | 22.65 | 12.82 | 0.00 | 0.00 | 104.85 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 31.66 | 14.99 | 73.42 | 49.36 | 55.29 | 31.30 | 0.00 | 0.00 | **256.01** |

# ATTACHMENT 2
# EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Drainage Basins
## 1979-80 to 1998-99 Water Years

| Water Year 1983-1984 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.96 | 0.85 | 2.76 | 3.07 | 4.40 | 0.19 | 0.01 | 0.38 | 0.25 | 0.00 | 0.00 | 12.87 |
| Qrunoff (af) | 0.00 | 15.95 | 14.12 | 45.84 | 50.99 | 73.08 | 3.16 | 0.17 | 6.31 | 4.15 | 0.00 | 0.00 | 213.77 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 1.73 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 0.80 | 19.25 |
| SM1 (in) | 1.73 | 0.00 | 1.67 | 3.27 | 5.40 | 5.40 | 5.40 | 5.01 | 3.82 | 3.83 | 2.92 | 0.80 | 39.25 |
| SM2 (in) | 0.00 | 1.67 | 3.27 | 5.40 | 5.40 | 5.40 | 5.01 | 3.82 | 3.83 | 2.92 | 0.80 | 0.00 | 37.52 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 7.45 | 11.08 | 16.72 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 35.25 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 18.20 | 27.06 | 40.82 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **86.07** |
| **Water Year 1984-1985** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.05 | 0.27 | 0.31 | 2.55 | 4.00 | 1.10 | 1.70 | 0.94 | 0.00 | 0.00 | 0.00 | 10.92 |
| Qrunoff (af) | 0.00 | 0.83 | 4.48 | 5.15 | 42.36 | 66.44 | 18.27 | 28.24 | 15.61 | 0.00 | 0.00 | 0.00 | 181.38 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.81 | 4.74 | 4.96 | 5.72 | 7.17 | 7.96 | 65.92 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 2.00 | 2.51 | 2.79 | 23.07 |
| AEsoil (in) | 0.00 | 0.39 | 1.89 | 1.45 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 2.00 | 2.51 | 0.89 | 16.69 |
| SM1 (in) | 0.00 | 0.00 | -0.19 | -0.97 | -1.15 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.40 | 0.89 | 28.98 |
| SM2 (in) | 0.00 | -0.19 | -0.97 | -1.15 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.40 | 0.89 | 0.00 | 28.98 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 15.08 | 3.18 | 5.31 | 2.12 | 0.00 | 0.00 | 0.00 | 28.08 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 5.86 | 36.81 | 7.76 | 12.97 | 5.17 | 0.00 | 0.00 | 0.00 | **68.57** |
| **Water Year 1985-1986** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.01 | 0.43 | 4.06 | 0.74 | 3.91 | 7.03 | 4.82 | 1.13 | 0.03 | 0.00 | 22.16 |
| Qrunoff (af) | 0.00 | 0.00 | 0.17 | 7.14 | 67.44 | 12.29 | 64.95 | 116.77 | 80.06 | 18.77 | 0.50 | 0.00 | 368.08 |
| Epan (in) | 8.32 | 7.86 | 7.17 | 6.35 | 4.21 | 4.49 | 4.12 | 3.35 | 4.26 | 5.99 | 5.93 | 5.76 | 67.81 |
| PEsoil(in) | 2.91 | 2.75 | 2.51 | 2.22 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 2.08 | 2.02 | 23.73 |
| AEsoil (in) | 0.00 | 0.00 | 0.08 | 2.22 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 2.08 | 2.02 | 15.64 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | -0.04 | -0.50 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.45 | 35.31 |
| SM2 (in) | 0.00 | 0.00 | -0.04 | -0.50 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.45 | 1.43 | 36.75 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 9.28 | 1.46 | 14.59 | 27.65 | 18.27 | 2.54 | 0.00 | 0.00 | 73.78 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 22.65 | 3.57 | 35.62 | 67.51 | 44.61 | 6.19 | 0.00 | 0.00 | **180.15** |
| **Water Year 1986-1987** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.01 | 0.00 | 1.15 | 0.00 | 1.38 | 0.24 | 1.87 | 1.91 | 1.90 | 0.02 | 0.00 | 0.04 | 8.52 |
| Qrunoff (af) | 0.17 | 0.00 | 19.10 | 0.00 | 22.92 | 3.99 | 31.06 | 31.73 | 31.56 | 0.33 | 0.00 | 0.66 | 141.52 |
| Epan (in) | 7.34 | 6.66 | 5.38 | 4.98 | 4.48 | 3.82 | 3.55 | 4.21 | 4.54 | 5.64 | 5.59 | 5.75 | 61.94 |
| PEsoil(in) | 2.57 | 2.33 | 1.88 | 1.74 | 1.57 | 1.34 | 1.24 | 1.47 | 1.59 | 1.97 | 1.96 | 2.01 | 21.68 |
| AEsoil (in) | 1.51 | -0.04 | 1.88 | 1.74 | 1.57 | 1.34 | 1.24 | 1.47 | 1.59 | 1.97 | 1.96 | 1.86 | 18.10 |
| SM1 (in) | 1.43 | -0.04 | 0.00 | 2.83 | 1.09 | 5.18 | 4.83 | 5.40 | 5.40 | 5.40 | 3.51 | 1.55 | 36.58 |
| SM2 (in) | -0.04 | 0.00 | 2.83 | 1.09 | 5.18 | 4.83 | 5.40 | 5.40 | 5.40 | 3.51 | 1.55 | -0.15 | 35.00 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.85 | 6.36 | 6.20 | 0.00 | 0.00 | 0.00 | 18.41 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 14.28 | 15.52 | 15.14 | 0.00 | 0.00 | 0.00 | **44.95** |

# ATTACHMENT 2
# EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Drainage Basins
## 1979-80 to 1998-99 Water Years

| Water Year 1987-1988 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.11 | 0.00 | 0.00 | 1.58 | 1.20 | 3.06 | 2.38 | 1.09 | 0.58 | 2.30 | 0.00 | 0.00 | 12.30 |
| Qrunoff (af) | 1.83 | 0.00 | 0.00 | 26.24 | 19.93 | 50.83 | 39.53 | 18.10 | 9.63 | 38.20 | 0.00 | 0.00 | 204.30 |
| Epan (in) | 6.58 | 6.92 | 5.79 | 4.71 | 4.66 | 3.37 | 4.03 | 5.15 | 7.20 | 6.02 | 8.56 | 7.46 | 70.45 |
| PEsoil(in) | 2.30 | 2.42 | 2.03 | 1.65 | 1.63 | 1.18 | 1.41 | 1.80 | 2.52 | 2.11 | 3.00 | 2.61 | 24.66 |
| AEsoil (in) | 0.71 | -0.41 | 0.00 | 1.65 | 1.63 | 1.18 | 1.41 | 1.80 | 2.52 | 2.11 | 3.00 | 2.40 | 18.00 |
| SM1 (in) | -0.15 | -0.41 | 0.00 | 0.00 | 4.83 | 5.40 | 5.40 | 5.40 | 5.40 | 5.26 | 5.40 | 2.40 | 38.94 |
| SM2 (in) | -0.41 | 0.00 | 0.00 | 4.83 | 5.40 | 5.40 | 5.40 | 5.40 | 5.26 | 5.40 | 2.40 | 0.00 | 39.08 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 2.72 | 11.37 | 8.35 | 2.67 | 0.00 | 7.18 | 0.00 | 0.00 | 32.28 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 6.64 | 27.75 | 20.38 | 6.51 | 0.00 | 17.53 | 0.00 | 0.00 | **78.81** |
| **Water Year 1988-1989** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.96 | 2.73 | 0.76 | 2.64 | 0.88 | 0.20 | 0.11 | 0.00 | 8.30 |
| Qrunoff (af) | 0.00 | 0.00 | 0.33 | 0.00 | 15.95 | 45.35 | 12.62 | 43.85 | 14.62 | 3.32 | 1.83 | 0.00 | 137.86 |
| Epan (in) | 6.82 | 7.17 | 6.49 | 4.77 | 4.16 | 4.99 | 4.10 | 3.32 | 4.34 | 6.01 | 6.36 | 6.03 | 64.56 |
| PEsoil(in) | 2.39 | 2.51 | 2.27 | 1.67 | 1.46 | 1.75 | 1.44 | 1.16 | 1.52 | 2.10 | 2.23 | 2.11 | 22.60 |
| AEsoil (in) | 0.00 | 0.00 | 0.16 | -0.07 | 1.46 | 1.75 | 1.44 | 1.16 | 1.52 | 2.10 | 2.23 | 2.11 | 13.84 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | -0.07 | 0.00 | 2.48 | 5.40 | 5.40 | 5.40 | 5.40 | 4.12 | 2.34 | 30.46 |
| SM2 (in) | 0.00 | 0.00 | -0.07 | 0.00 | 2.48 | 5.40 | 5.40 | 5.40 | 5.40 | 4.12 | 2.34 | 0.23 | 30.69 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.53 | 1.68 | 9.66 | 2.09 | 0.00 | 0.00 | 0.00 | 19.96 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 15.93 | 4.10 | 23.59 | 5.10 | 0.00 | 0.00 | 0.00 | **48.73** |
| **Water Year 1989-1990** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.08 | 0.19 | 0.50 | 0.00 | 2.24 | 1.71 | 0.00 | 0.03 | 0.71 | 0.00 | 5.46 |
| Qrunoff (af) | 0.00 | 0.00 | 1.33 | 3.16 | 8.31 | 0.00 | 37.21 | 28.40 | 0.00 | 0.50 | 11.79 | 0.00 | 90.69 |
| Epan (in) | 6.83 | 5.96 | 5.35 | 4.58 | 5.12 | 4.71 | 3.86 | 3.42 | 4.37 | 4.45 | 6.21 | 6.47 | 61.33 |
| PEsoil(in) | 2.39 | 2.09 | 1.87 | 1.60 | 1.79 | 1.65 | 1.35 | 1.20 | 1.53 | 1.56 | 2.17 | 2.26 | 21.47 |
| AEsoil (in) | 0.23 | 0.00 | 0.62 | 1.19 | 1.79 | -0.45 | 1.35 | 1.20 | 1.53 | 1.56 | 2.17 | 2.26 | 13.46 |
| SM1 (in) | 0.23 | 0.00 | 0.00 | -0.30 | -0.70 | -0.45 | 0.00 | 5.40 | 5.40 | 3.87 | 2.44 | 3.17 | 19.07 |
| SM2 (in) | 0.00 | 0.00 | -0.30 | -0.70 | -0.45 | 0.00 | 5.40 | 5.40 | 3.87 | 2.44 | 3.17 | 0.91 | 19.74 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.43 | 5.81 | 0.00 | 0.00 | 0.00 | 0.00 | 8.25 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.94 | 14.20 | 0.00 | 0.00 | 0.00 | 0.00 | **20.13** |
| **Water Year 1990-1991** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.98 | 2.50 | 8.61 | 0.00 | 0.00 | 0.00 | 12.64 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 0.00 | 9.14 | 0.00 | 16.28 | 41.53 | 143.01 | 0.00 | 0.00 | 0.00 | 209.95 |
| Epan (in) | 7.48 | 6.45 | 5.61 | 5.27 | 4.90 | 4.42 | 3.35 | 2.81 | 3.45 | 5.52 | 6.52 | 5.78 | 61.56 |
| PEsoil(in) | 2.62 | 2.26 | 1.96 | 1.84 | 1.72 | 1.55 | 1.17 | 0.98 | 1.21 | 1.93 | 2.28 | 2.02 | 21.55 |
| AEsoil (in) | 0.91 | 0.00 | 0.00 | 0.00 | 1.72 | 0.54 | 1.17 | 0.98 | 1.21 | 1.93 | 2.28 | 1.19 | 11.93 |
| SM1 (in) | 0.91 | 0.00 | 0.00 | 0.00 | 0.00 | 0.54 | 0.00 | 2.85 | 5.40 | 5.40 | 3.47 | 1.19 | 19.75 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.54 | 0.00 | 2.85 | 5.40 | 5.40 | 3.47 | 1.19 | 0.00 | 18.84 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.71 | 34.09 | 0.00 | 0.00 | 0.00 | 40.80 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 16.39 | 83.24 | 0.00 | 0.00 | 0.00 | **99.63** |

# ATTACHMENT 2
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Drainage Basins
## 1979-80 to 1998-99 Water Years

| Water Year 1991-1992 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.02 | 0.00 | 0.16 | 0.14 | 3.87 | 1.99 | 7.87 | 4.26 | 0.08 | 0.00 | 0.00 | 18.39 |
| Qrunoff (af) | 0.00 | 0.33 | 0.00 | 2.66 | 2.33 | 64.28 | 33.05 | 130.72 | 70.76 | 1.33 | 0.00 | 0.00 | 305.46 |
| Epan (in) | 5.96 | 5.45 | 4.31 | 3.97 | 4.38 | 2.92 | 3.63 | 3.10 | 3.02 | 4.54 | 4.45 | 5.83 | 51.56 |
| PEsoil(in) | 2.09 | 1.91 | 1.51 | 1.39 | 1.53 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 1.56 | 2.04 | 18.05 |
| AEsoil (in) | 0.00 | 0.16 | -0.07 | 1.25 | 0.50 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 1.56 | 2.04 | 11.45 |
| SM1 (in) | 0.00 | 0.00 | -0.07 | 0.00 | -0.59 | -0.52 | 5.40 | 5.40 | 5.40 | 5.40 | 4.14 | 2.58 | 27.14 |
| SM2 (in) | 0.00 | -0.07 | 0.00 | -0.59 | -0.52 | 5.40 | 5.40 | 5.40 | 5.40 | 4.14 | 2.58 | 0.54 | 27.68 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.93 | 6.89 | 31.18 | 16.41 | 0.00 | 0.00 | 0.00 | 63.40 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 21.79 | 16.82 | 76.13 | 40.06 | 0.00 | 0.00 | 0.00 | **154.81** |
| **Water Year 1992-1993** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.09 | 0.00 | 0.00 | 1.05 | 0.00 | 4.74 | 7.55 | 8.92 | 3.72 | 0.00 | 0.10 | 0.68 | 26.85 |
| Qrunoff (af) | 1.49 | 0.00 | 0.00 | 17.44 | 0.00 | 78.73 | 125.41 | 148.16 | 61.79 | 0.00 | 1.66 | 11.29 | 445.98 |
| Epan (in) | 6.26 | 6.66 | 5.08 | 4.05 | 5.19 | 3.22 | 2.52 | 2.98 | 3.61 | 5.34 | 5.73 | 6.50 | 57.14 |
| PEsoil(in) | 2.19 | 2.33 | 1.78 | 1.42 | 1.82 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 2.01 | 2.28 | 20.00 |
| AEsoil (in) | 1.24 | -0.33 | 0.00 | 1.42 | 1.82 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 2.01 | 2.28 | 14.61 |
| SM1 (in) | 0.54 | -0.33 | 0.00 | 0.00 | 2.89 | 1.07 | 5.40 | 5.40 | 5.40 | 5.40 | 3.53 | 1.94 | 31.23 |
| SM2 (in) | -0.33 | 0.00 | 0.00 | 2.89 | 1.07 | 5.40 | 5.40 | 5.40 | 5.40 | 3.53 | 1.94 | 2.45 | 33.14 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.98 | 30.07 | 35.53 | 13.99 | 0.00 | 0.00 | 0.00 | 93.56 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 34.13 | 73.43 | 86.75 | 34.15 | 0.00 | 0.00 | 0.00 | **228.45** |
| **Water Year 1993-1994** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.55 | 0.70 | 1.41 | 0.49 | 4.96 | 2.82 | 0.39 | 0.26 | 0.00 | 11.58 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 9.14 | 11.63 | 23.42 | 8.14 | 82.39 | 46.84 | 6.48 | 4.32 | 0.00 | 192.34 |
| Epan (in) | 6.51 | 5.88 | 4.78 | 4.50 | 4.50 | 3.64 | 3.63 | 3.49 | 3.96 | 4.60 | 4.07 | 5.22 | 54.78 |
| PEsoil(in) | 2.28 | 2.06 | 1.67 | 1.58 | 1.58 | 1.27 | 1.27 | 1.22 | 1.39 | 1.61 | 1.42 | 1.83 | 19.17 |
| AEsoil (in) | 2.28 | 0.17 | 0.00 | 1.58 | 1.58 | 1.27 | 1.27 | 1.22 | 1.39 | 1.61 | 1.42 | 1.83 | 15.61 |
| SM1 (in) | 2.45 | 0.17 | 0.00 | 0.00 | 0.68 | 1.97 | 5.40 | 5.40 | 5.40 | 5.40 | 5.39 | 5.03 | 37.29 |
| SM2 (in) | 0.17 | 0.00 | 0.00 | 0.68 | 1.97 | 5.40 | 5.40 | 5.40 | 5.40 | 5.39 | 5.03 | 3.20 | 38.05 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.08 | 0.74 | 19.11 | 10.18 | 0.00 | 0.00 | 0.00 | 31.11 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.64 | 1.80 | 46.67 | 24.85 | 0.00 | 0.00 | 0.00 | **75.96** |
| **Water Year 1994-1995** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.18 | 0.39 | 1.63 | 0.97 | 14.23 | 1.08 | 8.16 | 0.58 | 0.78 | 0.34 | 28.34 |
| Qrunoff (af) | 0.00 | 0.00 | 2.99 | 6.48 | 27.07 | 16.11 | 236.36 | 17.94 | 135.54 | 9.63 | 12.96 | 5.65 | 470.73 |
| Epan (in) | 5.58 | 5.84 | 4.64 | 4.27 | 3.84 | 2.60 | 1.64 | 2.53 | 3.64 | 5.25 | 4.65 | 4.98 | 49.46 |
| PEsoil(in) | 1.95 | 2.04 | 1.62 | 1.49 | 1.34 | 0.91 | 0.57 | 0.89 | 1.27 | 1.84 | 1.63 | 1.74 | 17.31 |
| AEsoil (in) | 1.95 | 1.25 | 1.40 | 1.49 | 1.34 | 0.91 | 0.57 | 0.89 | 1.27 | 1.84 | 1.63 | 1.74 | 16.30 |
| SM1 (in) | 3.20 | 1.25 | 0.00 | -0.67 | -0.56 | 4.78 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 40.40 |
| SM2 (in) | 1.25 | 0.00 | -0.67 | -0.56 | 4.78 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.05 | 42.25 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.44 | 57.77 | 3.54 | 32.18 | 0.54 | 1.57 | 0.00 | 98.04 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.97 | 141.05 | 8.65 | 78.57 | 1.32 | 3.83 | 0.00 | **239.39** |

# ATTACHMENT 2
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark B Drainage Basins
## 1979-80 to 1998-99 Water Years

| Water Year 1995-1996 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 1.99 | 1.24 | 7.59 | 1.40 | 0.60 | 0.11 | 0.00 | 13.04 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 0.00 | 1.83 | 33.05 | 20.60 | 126.07 | 23.25 | 9.97 | 1.83 | 0.00 | 216.59 |
| Epan (in) | 5.83 | 6.20 | 4.90 | 4.67 | 3.20 | 2.88 | 3.02 | 2.41 | 3.74 | 5.56 | 6.06 | 5.40 | 53.87 |
| PEsoil(in) | 2.04 | 2.17 | 1.72 | 1.63 | 1.12 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 2.12 | 1.89 | 18.85 |
| AEsoil (in) | 2.04 | 2.17 | 0.84 | 0.00 | 0.86 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 2.12 | 1.89 | 16.08 |
| SM1 (in) | 5.05 | 3.01 | 0.84 | 0.00 | 0.00 | -0.41 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.73 | 39.22 |
| SM2 (in) | 3.01 | 0.84 | 0.00 | 0.00 | -0.41 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.73 | 1.84 | 36.01 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.34 | 4.03 | 30.27 | 4.43 | 0.51 | 0.00 | 0.00 | 40.59 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.28 | 9.83 | 73.92 | 10.82 | 1.25 | 0.00 | 0.00 | **99.11** |
| **Water Year 1996-1997** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 1.18 | 2.63 | 5.50 | 4.45 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 13.82 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 19.60 | 43.68 | 91.36 | 73.91 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 229.55 |
| Epan (in) | 5.91 | 5.65 | 4.94 | 4.85 | 4.25 | 3.58 | 2.41 | 4.35 | 5.53 | 6.93 | 7.31 | 6.40 | 62.11 |
| PEsoil(in) | 2.07 | 1.98 | 1.73 | 1.70 | 1.49 | 1.25 | 0.84 | 1.52 | 1.94 | 2.43 | 2.56 | 2.24 | 21.74 |
| AEsoil (in) | 1.84 | 0.00 | 0.00 | 1.70 | 1.49 | 1.25 | 0.84 | 1.52 | 1.94 | 2.19 | 0.00 | 0.00 | 12.77 |
| SM1 (in) | 1.84 | 0.00 | 0.00 | 0.00 | 3.14 | 5.40 | 5.40 | 5.40 | 4.12 | 2.19 | 0.00 | 0.00 | 27.49 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 3.14 | 5.40 | 5.40 | 5.40 | 4.12 | 2.19 | 0.00 | 0.00 | 0.00 | 25.65 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 7.04 | 21.30 | 17.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 45.73 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 17.18 | 52.00 | 42.49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **111.66** |
| **Water Year 1997-1998** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.04 | 0.00 | 2.21 | 6.54 | 3.06 | 18.64 | 3.17 | 1.55 | 2.74 | 0.02 | 37.97 |
| Qrunoff (af) | 0.00 | 0.00 | 0.66 | 0.00 | 36.71 | 108.63 | 50.83 | 309.61 | 52.65 | 25.75 | 45.51 | 0.33 | 630.68 |
| Epan (in) | 6.61 | 6.43 | 6.09 | 6.53 | 3.61 | 4.24 | 2.72 | 2.99 | 4.92 | 5.66 | 6.41 | 6.63 | 62.84 |
| PEsoil(in) | 2.31 | 2.25 | 2.13 | 2.29 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 2.32 | 21.99 |
| AEsoil (in) | 0.00 | 0.00 | 0.31 | -0.15 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 2.32 | 13.18 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | -0.15 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 37.65 |
| SM2 (in) | 0.00 | 0.00 | -0.15 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.16 | 40.81 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 25.33 | 11.59 | 75.37 | 11.27 | 4.37 | 8.99 | 0.00 | 139.33 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 5.85 | 61.84 | 28.31 | 184.04 | 27.53 | 10.68 | 21.95 | 0.00 | **340.20** |
| **Water Year 1998-1999** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.11 | 0.11 | 0.85 | 0.63 | 1.91 | 0.80 | 2.79 | 2.48 | 0.03 | 0.24 | 9.95 |
| Qrunoff (af) | 0.00 | 0.00 | 1.83 | 1.83 | 14.12 | 10.46 | 31.73 | 13.29 | 46.34 | 41.19 | 0.50 | 3.99 | 165.27 |
| Epan (in) | 7.37 | 7.28 | 5.24 | 5.68 | 3.71 | 4.10 | 3.89 | 3.78 | 4.63 | 5.87 | 5.94 | 6.51 | 64.00 |
| PEsoil(in) | 2.58 | 2.55 | 1.83 | 1.99 | 1.30 | 1.44 | 1.36 | 1.32 | 1.62 | 2.05 | 2.08 | 2.28 | 22.40 |
| AEsoil (in) | 2.58 | 0.58 | 0.86 | 0.45 | 1.30 | 1.44 | 1.36 | 1.32 | 1.62 | 2.05 | 2.08 | 2.28 | 17.92 |
| SM1 (in) | 3.16 | 0.58 | 0.00 | -0.41 | -0.41 | 1.78 | 2.93 | 5.40 | 5.40 | 5.40 | 5.40 | 3.44 | 32.68 |
| SM2 (in) | 0.58 | 0.00 | -0.41 | -0.41 | 1.78 | 2.93 | 5.40 | 5.40 | 5.40 | 5.40 | 3.44 | 2.15 | 31.67 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.00 | 1.96 | 9.82 | 8.11 | 0.00 | 0.00 | 23.88 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.76 | 4.78 | 23.97 | 19.81 | 0.00 | 0.00 | **58.32** |

# ATTACHMENT 3
# EXISTING CONDITIONS MONTHLY WATER BALANCE
# RiverPark A and B Open Space
# 1979-80 to 1998-99 Water Years

**Data used for calculations:**

Soil Evaporation Depth: 30 inches

Soil moisture holding capacity: 2.40 inches (0.08 in/in * 30 in)

Total Open Space Area: 209.5 acres

Runoff Factor: 0.26 = 20% imperviousness * (0.8) + (0.1)

**Definition of terms:**

Pg = Precipitation (inches). Station 239E El Rio - UWCD (7/1/79 - 6/30/99)

Pg-runoff = Precipitation minus precipitation lost to runoff leaving open space area. Pg-runoff = Pg - Pg*0.26

Epan = Pan Evaporation (inches) at El Rio from 1985-1999. Monthly averages used for 1979-1985.

PEsoil = Potential soil evaporation (inches). Epan * 0.35

AEsoil = Actual soil evaporation (inches).

If (Pg-runoff + SM1 - PEsoil) > 0; AEsoil = PEsoil.

If (Pg-runoff + SM1 - PEsoil) $\leq$ 0; AEsoil = Pg-runoff + SM1.

SM1 = Soil moisture at the beginning of the month (inches). SM1 = SM2 from previous month

SM2 = Soil moisture at end of the month (inches). If Pg-runoff + SM1 - AEsoil < 2.40; SM2 = Pg-runoff + SM1 - AEsoil.

If (Pg-runoff + SM1 - AEsoil) > 2.4; SM2 = 2.4.

Qsoil = Groundwater recharge (inches).

If Pg-runoff - AEsoil - (SM2 - SM1) > 0; Qsoil = Pg-runoff - AEsoil - (SM2 - SM1).

If Pg-runoff - AEsoil - (SM2 - SM1) $\leq$ 0; Qsoil = 0.

Qtotal = Total groundwater recharge (acre-feet). Qtotal = Qsoil/12 * 209.5.

# ATTACHMENT 3
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark A and B Open Space
## 1979-80 to 1998-99 Water Years

| Water Year 1979-1980 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.62 | 0.48 | 1.28 | 2.03 | 7.62 | 10.19 | 2.86 | 0.39 | 0.29 | 0.00 | 25.76 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.46 | 0.36 | 0.95 | 1.50 | 5.64 | 7.54 | 2.12 | 0.29 | 0.21 | 0.00 | 19.06 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.00 | 0.46 | 0.36 | 0.95 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 0.96 | 0.00 | 9.93 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 2.40 | 2.40 | 2.40 | 0.75 | 0.00 | 8.13 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 2.40 | 2.40 | 2.40 | 0.75 | 0.00 | 0.00 | 8.13 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.25 | 6.31 | 0.57 | 0.00 | 0.00 | 0.00 | 9.13 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 39.20 | 110.20 | 10.00 | 0.00 | 0.00 | 0.00 | **159.40** |
| **Water Year 1980-1981** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 2.12 | 1.85 | 5.67 | 0.18 | 0.00 | 0.00 | 11.14 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 1.57 | 1.37 | 4.20 | 0.13 | 0.00 | 0.00 | 8.24 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 1.17 | 1.23 | 1.54 | 1.94 | 0.59 | 0.00 | 7.45 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 | 0.54 | 2.40 | 0.59 | 0.00 | 3.93 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 | 0.54 | 2.40 | 0.59 | 0.00 | 0.00 | 3.93 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.79 | 0.00 | 0.00 | 0.00 | 0.79 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.78 | 0.00 | 0.00 | 0.00 | **13.78** |
| **Water Year 1981-1982** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.89 | 1.96 | 0.72 | 2.52 | 0.34 | 4.07 | 1.73 | 0.00 | 0.00 | 12.23 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.66 | 1.45 | 0.53 | 1.86 | 0.25 | 3.01 | 1.28 | 0.00 | 0.00 | 9.05 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.66 | 1.45 | 0.53 | 1.17 | 0.94 | 1.54 | 1.94 | 0.81 | 0.00 | 9.05 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.69 | 0.00 | 1.47 | 0.81 | 0.00 | 2.97 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.69 | 0.00 | 1.47 | 0.81 | 0.00 | 0.00 | 2.97 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| **Water Year 1982-1983** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.90 | 0.42 | 4.41 | 1.82 | 7.62 | 5.23 | 5.90 | 3.60 | 0.14 | 0.01 | 30.05 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.67 | 0.31 | 3.26 | 1.35 | 5.64 | 3.87 | 4.37 | 2.66 | 0.10 | 0.01 | 22.24 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.00 | 0.67 | 0.31 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 0.39 | 12.20 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.76 | 1.78 | 2.40 | 2.40 | 2.40 | 2.40 | 0.38 | 13.52 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.76 | 1.78 | 2.40 | 2.40 | 2.40 | 2.40 | 0.38 | 0.00 | 13.52 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.85 | 2.64 | 2.82 | 0.73 | 0.00 | 0.00 | 10.04 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 67.19 | 46.12 | 49.28 | 12.66 | 0.00 | 0.00 | **175.24** |

# ATTACHMENT 3
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark A and B Open Space
## 1979-80 to 1998-99 Water Years

| Water Year 1983-1984 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.96 | 0.85 | 2.76 | 3.07 | 4.40 | 0.19 | 0.01 | 0.38 | 0.25 | 0.00 | 0.00 | 12.87 |
| Pg-runoff(in) | 0.00 | 0.71 | 0.63 | 2.04 | 2.27 | 3.26 | 0.14 | 0.01 | 0.28 | 0.19 | 0.00 | 0.00 | 9.52 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.71 | 0.63 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 0.43 | 0.19 | 0.00 | 0.00 | 8.91 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.31 | 1.08 | 2.40 | 1.37 | 0.15 | 0.00 | 0.00 | 0.00 | 5.31 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.31 | 1.08 | 2.40 | 1.37 | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 5.31 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.61 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.71 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **10.71** |
| **Water Year 1984-1985** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.05 | 0.27 | 0.31 | 2.55 | 4.00 | 1.10 | 1.70 | 0.94 | 0.00 | 0.00 | 0.00 | 10.92 |
| Pg-runoff(in) | 0.00 | 0.04 | 0.20 | 0.23 | 1.89 | 2.96 | 0.81 | 1.26 | 0.70 | 0.00 | 0.00 | 0.00 | 8.08 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.81 | 4.74 | 4.96 | 5.72 | 7.17 | 7.96 | 65.92 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 2.00 | 2.51 | 2.79 | 23.07 |
| AEsoil (in) | 0.00 | 0.04 | 0.20 | 0.23 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 0.06 | 0.00 | 0.00 | 8.08 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 2.02 | 1.50 | 1.10 | 0.06 | 0.00 | 0.00 | 5.06 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 2.02 | 1.50 | 1.10 | 0.06 | 0.00 | 0.00 | 0.00 | 5.06 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| **Water Year 1985-1986** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.01 | 0.43 | 4.06 | 0.74 | 3.91 | 7.03 | 4.82 | 1.13 | 0.03 | 0.00 | 22.16 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.01 | 0.32 | 3.00 | 0.55 | 2.89 | 5.20 | 3.57 | 0.84 | 0.02 | 0.00 | 16.40 |
| Epan (in) | 8.32 | 7.86 | 7.17 | 6.35 | 4.21 | 4.49 | 4.12 | 3.35 | 4.26 | 5.99 | 5.93 | 5.76 | 67.81 |
| PEsoil(in) | 2.91 | 2.75 | 2.51 | 2.22 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 2.08 | 2.02 | 23.73 |
| AEsoil (in) | 0.00 | 0.00 | 0.01 | 0.32 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 1.16 | 0.00 | 10.73 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.53 | 0.51 | 1.96 | 2.40 | 2.40 | 1.14 | 0.00 | 9.94 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.53 | 0.51 | 1.96 | 2.40 | 2.40 | 1.14 | 0.00 | 0.00 | 9.94 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.59 | 2.08 | 0.00 | 0.00 | 0.00 | 5.66 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 62.64 | 36.24 | 0.00 | 0.00 | 0.00 | **98.88** |
| **Water Year 1986-1987** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.01 | 0.00 | 1.15 | 0.00 | 1.38 | 0.24 | 1.87 | 1.91 | 1.90 | 0.02 | 0.00 | 0.04 | 8.52 |
| Pg-runoff(in) | 0.01 | 0.00 | 0.85 | 0.00 | 1.02 | 0.18 | 1.38 | 1.41 | 1.41 | 0.01 | 0.00 | 0.03 | 6.30 |
| Epan (in) | 7.34 | 6.66 | 5.38 | 4.98 | 4.48 | 3.82 | 3.55 | 4.21 | 4.54 | 5.64 | 5.59 | 5.75 | 61.94 |
| PEsoil(in) | 2.57 | 2.33 | 1.88 | 1.74 | 1.57 | 1.34 | 1.24 | 1.47 | 1.59 | 1.97 | 1.96 | 2.01 | 21.68 |
| AEsoil (in) | 0.01 | 0.00 | 0.85 | 0.00 | 1.02 | 0.18 | 1.24 | 1.47 | 1.49 | 0.01 | 0.00 | 0.03 | 6.30 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.08 | 0.00 | 0.00 | 0.00 | 0.22 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |

# ATTACHMENT 3
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark A and B Open Space
## 1979-80 to 1998-99 Water Years

| Water Year 1987-1988 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.11 | 0.00 | 0.00 | 1.58 | 1.20 | 3.06 | 2.38 | 1.09 | 0.58 | 2.30 | 0.00 | 0.00 | 12.30 |
| Pg-runoff(in) | 0.08 | 0.00 | 0.00 | 1.17 | 0.89 | 2.26 | 1.76 | 0.81 | 0.43 | 1.70 | 0.00 | 0.00 | 9.10 |
| Epan (in) | 6.58 | 6.92 | 5.79 | 4.71 | 4.66 | 3.37 | 4.03 | 5.15 | 7.20 | 6.02 | 8.56 | 7.46 | 70.45 |
| PEsoil(in) | 2.30 | 2.42 | 2.03 | 1.65 | 1.63 | 1.18 | 1.41 | 1.80 | 2.52 | 2.11 | 3.00 | 2.61 | 24.66 |
| AEsoil (in) | 0.08 | 0.00 | 0.00 | 1.17 | 0.89 | 1.18 | 1.41 | 1.80 | 0.87 | 1.70 | 0.00 | 0.00 | 9.10 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.08 | 1.44 | 0.44 | 0.00 | 0.00 | 0.00 | 2.96 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.08 | 1.44 | 0.44 | 0.00 | 0.00 | 0.00 | 0.00 | 2.96 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| **Water Year 1988-1989** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.96 | 2.73 | 0.76 | 2.64 | 0.88 | 0.20 | 0.11 | 0.00 | 8.30 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.01 | 0.00 | 0.71 | 2.02 | 0.56 | 1.95 | 0.65 | 0.15 | 0.08 | 0.00 | 6.14 |
| Epan (in) | 6.82 | 7.17 | 6.49 | 4.77 | 4.16 | 4.99 | 4.10 | 3.32 | 4.34 | 6.01 | 6.36 | 6.03 | 64.56 |
| PEsoil(in) | 2.39 | 2.51 | 2.27 | 1.67 | 1.46 | 1.75 | 1.44 | 1.16 | 1.52 | 2.10 | 2.23 | 2.11 | 22.60 |
| AEsoil (in) | 0.00 | 0.00 | 0.01 | 0.00 | 0.71 | 1.75 | 0.84 | 1.16 | 1.44 | 0.15 | 0.08 | 0.00 | 6.14 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 | 0.00 | 0.79 | 0.00 | 0.00 | 0.00 | 1.07 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 | 0.00 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 | 1.07 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| **Water Year 1989-1990** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.08 | 0.19 | 0.50 | 0.00 | 2.24 | 1.71 | 0.00 | 0.03 | 0.71 | 0.00 | 5.46 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.06 | 0.14 | 0.37 | 0.00 | 1.66 | 1.27 | 0.00 | 0.02 | 0.53 | 0.00 | 4.04 |
| Epan (in) | 6.83 | 5.96 | 5.35 | 4.58 | 5.12 | 4.71 | 3.86 | 3.42 | 4.37 | 4.45 | 6.21 | 6.47 | 61.33 |
| PEsoil(in) | 2.39 | 2.09 | 1.87 | 1.60 | 1.79 | 1.65 | 1.35 | 1.20 | 1.53 | 1.56 | 2.17 | 2.26 | 21.47 |
| AEsoil (in) | 0.00 | 0.00 | 0.06 | 0.14 | 0.37 | 0.00 | 1.35 | 1.20 | 0.38 | 0.02 | 0.53 | 0.00 | 4.04 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.31 | 0.38 | 0.00 | 0.00 | 0.00 | 0.68 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.31 | 0.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.68 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| **Water Year 1990-1991** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.98 | 2.50 | 8.61 | 0.00 | 0.00 | 0.00 | 12.64 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.41 | 0.00 | 0.73 | 1.85 | 6.37 | 0.00 | 0.00 | 0.00 | 9.35 |
| Epan (in) | 7.48 | 6.45 | 5.61 | 5.27 | 4.90 | 4.42 | 3.35 | 2.81 | 3.45 | 5.52 | 6.52 | 5.78 | 61.56 |
| PEsoil(in) | 2.62 | 2.26 | 1.96 | 1.84 | 1.72 | 1.55 | 1.17 | 0.98 | 1.21 | 1.93 | 2.28 | 2.02 | 21.55 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.41 | 0.00 | 0.73 | 0.98 | 1.21 | 1.93 | 0.47 | 0.00 | 5.72 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.87 | 2.40 | 0.47 | 0.00 | 3.73 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.87 | 2.40 | 0.47 | 0.00 | 0.00 | 3.73 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.63 | 0.00 | 0.00 | 0.00 | 3.63 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 63.38 | 0.00 | 0.00 | 0.00 | **63.38** |

# ATTACHMENT 3
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark A and B Open Space
## 1979-80 to 1998-99 Water Years

| Water Year 1991-1992 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.02 | 0.00 | 0.16 | 0.14 | 3.87 | 1.99 | 7.87 | 4.26 | 0.08 | 0.00 | 0.00 | 18.39 |
| Pg-runoff(in) | 0.00 | 0.01 | 0.00 | 0.12 | 0.10 | 2.86 | 1.47 | 5.82 | 3.15 | 0.06 | 0.00 | 0.00 | 13.61 |
| Epan (in) | 5.96 | 5.45 | 4.31 | 3.97 | 4.38 | 2.92 | 3.63 | 3.10 | 3.02 | 4.54 | 4.45 | 5.83 | 51.56 |
| PEsoil(in) | 2.09 | 1.91 | 1.51 | 1.39 | 1.53 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 1.56 | 2.04 | 18.05 |
| AEsoil (in) | 0.00 | 0.01 | 0.00 | 0.12 | 0.10 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 0.87 | 0.00 | 7.13 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.84 | 2.04 | 2.40 | 2.40 | 0.87 | 0.00 | 9.56 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.84 | 2.04 | 2.40 | 2.40 | 0.87 | 0.00 | 0.00 | 9.56 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.38 | 2.10 | 0.00 | 0.00 | 0.00 | 6.48 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 76.51 | 36.58 | 0.00 | 0.00 | 0.00 | **113.10** |
| **Water Year 1992-1993** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.09 | 0.00 | 0.00 | 1.05 | 0.00 | 4.74 | 7.55 | 8.92 | 3.72 | 0.00 | 0.10 | 0.68 | 26.85 |
| Pg-runoff(in) | 0.07 | 0.00 | 0.00 | 0.78 | 0.00 | 3.51 | 5.59 | 6.60 | 2.75 | 0.00 | 0.07 | 0.50 | 19.87 |
| Epan (in) | 6.26 | 6.66 | 5.08 | 4.05 | 5.19 | 3.22 | 2.52 | 2.98 | 3.61 | 5.34 | 5.73 | 6.50 | 57.14 |
| PEsoil(in) | 2.19 | 2.33 | 1.78 | 1.42 | 1.82 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 2.01 | 2.28 | 20.00 |
| AEsoil (in) | 0.07 | 0.00 | 0.00 | 0.78 | 0.00 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 0.61 | 0.50 | 8.14 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.38 | 2.40 | 2.40 | 2.40 | 0.53 | 0.00 | 10.11 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.38 | 2.40 | 2.40 | 2.40 | 0.53 | 0.00 | 0.00 | 10.11 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.69 | 5.56 | 1.49 | 0.00 | 0.00 | 0.00 | 11.73 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 81.80 | 97.03 | 26.00 | 0.00 | 0.00 | 0.00 | **204.83** |
| **Water Year 1993-1994** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.55 | 0.70 | 1.41 | 0.49 | 4.96 | 2.82 | 0.39 | 0.26 | 0.00 | 11.58 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.41 | 0.52 | 1.04 | 0.36 | 3.67 | 2.09 | 0.29 | 0.19 | 0.00 | 8.57 |
| Epan (in) | 6.51 | 5.88 | 4.78 | 4.50 | 4.50 | 3.64 | 3.63 | 3.49 | 3.96 | 4.60 | 4.07 | 5.22 | 54.78 |
| PEsoil(in) | 2.28 | 2.06 | 1.67 | 1.58 | 1.58 | 1.27 | 1.27 | 1.22 | 1.39 | 1.61 | 1.42 | 1.83 | 19.17 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.41 | 0.52 | 1.04 | 0.36 | 1.22 | 1.39 | 1.61 | 1.27 | 0.00 | 7.82 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 1.08 | 0.00 | 5.88 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 1.08 | 0.00 | 0.00 | 5.88 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.70 | 0.00 | 0.00 | 0.00 | 0.75 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.85 | 12.23 | 0.00 | 0.00 | 0.00 | **13.09** |
| **Water Year 1994-1995** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.18 | 0.39 | 1.63 | 0.97 | 14.23 | 1.08 | 8.16 | 0.58 | 0.78 | 0.34 | 28.34 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.13 | 0.29 | 1.21 | 0.72 | 10.53 | 0.80 | 6.04 | 0.43 | 0.58 | 0.25 | 20.97 |
| Epan (in) | 5.58 | 5.84 | 4.64 | 4.27 | 3.84 | 2.60 | 1.64 | 2.53 | 3.64 | 5.25 | 4.65 | 4.98 | 49.46 |
| PEsoil(in) | 1.95 | 2.04 | 1.62 | 1.49 | 1.34 | 0.91 | 0.57 | 0.89 | 1.27 | 1.84 | 1.63 | 1.74 | 17.31 |
| AEsoil (in) | 0.00 | 0.00 | 0.13 | 0.29 | 1.21 | 0.72 | 0.57 | 0.89 | 1.27 | 1.84 | 1.57 | 0.25 | 8.74 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.31 | 2.40 | 0.99 | 0.00 | 8.11 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.31 | 2.40 | 0.99 | 0.00 | 0.00 | 8.11 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.56 | 0.00 | 4.68 | 0.00 | 0.00 | 0.00 | 12.23 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 131.92 | 0.00 | 81.67 | 0.00 | 0.00 | 0.00 | **213.59** |

# ATTACHMENT 3
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## RiverPark A and B Open Space
## 1979-80 to 1998-99 Water Years

| Water Year 1995-1996 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 1.99 | 1.24 | 7.59 | 1.40 | 0.60 | 0.11 | 0.00 | 13.04 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 1.47 | 0.92 | 5.62 | 1.04 | 0.44 | 0.08 | 0.00 | 9.65 |
| Epan (in) | 5.83 | 6.20 | 4.90 | 4.67 | 3.20 | 2.88 | 3.02 | 2.41 | 3.74 | 5.56 | 6.06 | 5.40 | 53.87 |
| PEsoil(in) | 2.04 | 2.17 | 1.72 | 1.63 | 1.12 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 2.12 | 1.89 | 18.85 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 0.71 | 0.00 | 6.95 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.33 | 2.40 | 2.13 | 0.63 | 0.00 | 5.94 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.33 | 2.40 | 2.13 | 0.63 | 0.00 | 0.00 | 5.94 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.70 | 0.00 | 0.00 | 0.00 | 0.00 | 2.70 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 47.11 | 0.00 | 0.00 | 0.00 | 0.00 | **47.11** |
| **Water Year 1996-1997** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 1.18 | 2.63 | 5.50 | 4.45 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 13.82 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.87 | 1.95 | 4.07 | 3.29 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 10.23 |
| Epan (in) | 5.91 | 5.65 | 4.94 | 4.85 | 4.25 | 3.58 | 2.41 | 4.35 | 5.53 | 6.93 | 7.31 | 6.40 | 62.11 |
| PEsoil(in) | 2.07 | 1.98 | 1.73 | 1.70 | 1.49 | 1.25 | 0.84 | 1.52 | 1.94 | 2.43 | 2.56 | 2.24 | 21.74 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.87 | 1.49 | 1.25 | 0.84 | 1.52 | 0.92 | 0.00 | 0.00 | 0.00 | 6.90 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 2.40 | 2.40 | 0.92 | 0.00 | 0.00 | 0.00 | 6.18 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 2.40 | 2.40 | 0.92 | 0.00 | 0.00 | 0.00 | 0.00 | 6.18 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.88 | 2.45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.33 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 15.29 | 42.76 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **58.05** |
| **Water Year 1997-1998** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.04 | 0.00 | 2.21 | 6.54 | 3.06 | 18.64 | 3.17 | 1.55 | 2.74 | 0.02 | 37.97 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.03 | 0.00 | 1.64 | 4.84 | 2.26 | 13.79 | 2.35 | 1.15 | 2.03 | 0.01 | 28.10 |
| Epan (in) | 6.61 | 6.43 | 6.09 | 6.53 | 3.61 | 4.24 | 2.72 | 2.99 | 4.92 | 5.66 | 6.41 | 6.63 | 62.84 |
| PEsoil(in) | 2.31 | 2.25 | 2.13 | 2.29 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 2.32 | 21.99 |
| AEsoil (in) | 0.00 | 0.00 | 0.03 | 0.00 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 1.36 | 12.09 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.37 | 2.40 | 2.40 | 2.40 | 2.40 | 1.57 | 1.35 | 12.89 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.37 | 2.40 | 2.40 | 2.40 | 2.40 | 1.57 | 1.35 | 0.00 | 12.89 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.33 | 1.31 | 12.75 | 0.62 | 0.00 | 0.00 | 0.00 | 16.01 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 23.18 | 22.91 | 222.54 | 10.89 | 0.00 | 0.00 | 0.00 | **279.52** |
| **Water Year 1998-1999** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.11 | 0.11 | 0.85 | 0.63 | 1.91 | 0.80 | 2.79 | 2.48 | 0.03 | 0.24 | 9.95 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.08 | 0.08 | 0.63 | 0.47 | 1.41 | 0.59 | 2.06 | 1.84 | 0.02 | 0.18 | 7.36 |
| Epan (in) | 7.37 | 7.28 | 5.24 | 5.68 | 3.71 | 4.10 | 3.89 | 3.78 | 4.63 | 5.87 | 5.94 | 6.51 | 64.00 |
| PEsoil(in) | 2.58 | 2.55 | 1.83 | 1.99 | 1.30 | 1.44 | 1.36 | 1.32 | 1.62 | 2.05 | 2.08 | 2.28 | 22.40 |
| AEsoil (in) | 0.00 | 0.00 | 0.08 | 0.08 | 0.63 | 0.47 | 1.36 | 0.64 | 1.62 | 2.05 | 0.25 | 0.18 | 7.36 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.44 | 0.22 | 0.00 | 0.72 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.44 | 0.22 | 0.00 | 0.00 | 0.72 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |

# ATTACHMENT 4
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## Agricultural Acreage
## (Includes 154.5-acre and 2.8-acre parcels)
## 1979-80 to 1998-99 Water Years

| Year | Period | Well 02N22W21H01S Pumping | | Well 02N22W22G01S Pumping | | Well 02N22W22H01S Pumping | | Total Water Year Usage | 20% Gw Recharge | 80% Consumptive Use |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Period | Water Year | Period | Water Year | Period | Water Year | | | |
| | | (AF) | (AF) | (AF) | (AF) | (AF) | (AF) | (AF) | (AF) | (AF) |
| 1979 | 2 | 10.80 | | 14.68 | | 19.00 | | | | |
| 1980 | 1 | 8.19 | 18.99 | 1.36 | 16.04 | 0.00 | 19.00 | 54.03 | 10.806 | -43.224 |
| 1980 | 2 | 13.84 | | 16.85 | | 19.00 | | | | |
| 1981 | 1 | 8.86 | 22.70 | 16.75 | 33.60 | 25.40 | 44.40 | 100.70 | 20.14 | -80.56 |
| 1981 | 2 | 10.58 | | 17.32 | | 19.00 | | | | |
| 1982 | 1 | 353.57 | 364.15 | 160.87 | 178.19 | 9.50 | 28.50 | 570.84 | 114.168 | -456.672 |
| 1982 | 2 | 337.49 | | 161.80 | | 9.50 | | | | |
| 1983 | 1 | 234.66 | 572.15 | 123.83 | 285.63 | 9.50 | 19.00 | 876.78 | 175.356 | -701.424 |
| 1983 | 2 | 258.46 | | 159.03 | | 9.50 | | | | |
| 1984 | 1 | 421.05 | 679.51 | 249.94 | 408.97 | 9.50 | 19.00 | 1107.48 | 221.496 | -885.984 |
| 1984 | 2 | 124.09 | | 278.05 | | 9.50 | | | | |
| 1985 | 1 | 177.61 | 301.70 | 162.68 | 440.73 | 9.50 | 19.00 | 761.43 | 152.286 | -609.144 |
| 1985 | 2 | 81.32 | | 266.69 | | 9.50 | | | | |
| 1986 | 1 | 21.08 | 102.40 | 256.51 | 523.20 | 9.50 | 19.00 | 644.60 | 128.92 | -515.68 |
| 1986 | 2 | 101.50 | | 262.91 | | 9.50 | | | | |
| 1987 | 1 | 168.50 | 270.00 | 295.00 | 557.91 | 9.50 | 19.00 | 846.91 | 169.382 | -677.528 |
| 1987 | 2 | 66.39 | | 221.42 | | 9.50 | | | | |
| 1988 | 1 | 21.50 | 87.89 | 290.68 | 512.10 | 9.50 | 19.00 | 618.99 | 123.798 | -495.192 |
| 1988 | 2 | 76.29 | | 142.18 | | 7.00 | | | | |
| 1989 | 1 | 60.32 | 136.61 | 225.53 | 367.71 | 8.40 | 15.40 | 519.72 | 103.944 | -415.776 |
| 1989 | 2 | 19.23 | | 205.72 | | 0.00 | | | | |
| 1990 | 1 | 0.00 | 19.23 | 229.84 | 435.56 | 0.00 | 0.00 | 454.79 | 90.958 | -363.832 |
| 1990 | 2 | 121.85 | | 335.11 | | 15.64 | | | | |
| 1991 | 1 | 154.01 | 275.86 | 54.78 | 389.89 | 23.06 | 38.70 | 704.45 | 140.89 | -563.56 |
| 1991 | 2 | 213.41 | | 3.14 | | 18.55 | | | | |
| 1992 | 1 | 148.07 | 361.48 | 41.74 | 44.88 | 18.55 | 37.10 | 443.46 | 88.692 | -354.768 |
| 1992 | 2 | 182.20 | | 37.64 | | 23.85 | | | | |
| 1993 | 1 | 183.79 | 365.99 | 29.00 | 66.64 | 38.16 | 62.01 | 494.64 | 98.928 | -395.712 |
| 1993 | 2 | 199.09 | | 67.68 | | 38.16 | | | | |
| 1994 | 1 | 238.38 | 437.47 | 31.39 | 99.07 | 38.16 | 76.32 | 612.86 | 122.572 | -490.288 |
| 1994 | 2 | 203.38 | | 48.41 | | 0.00 | | | | |
| 1995 | 1 | 186.69 | 390.07 | 31.80 | 80.21 | 0.00 | 0.00 | 470.28 | 94.056 | -376.224 |
| 1995 | 2 | 236.70 | | 75.90 | | 1.00 | | | | |
| 1996 | 1 | 195.20 | 431.90 | 35.05 | 110.95 | 1.00 | 2.00 | 544.85 | 108.97 | -435.88 |
| 1996 | 2 | 201.68 | | 75.95 | | 0.00 | | | | |
| 1997 | 1 | 317.30 | 518.98 | 37.19 | 113.14 | 0.00 | 0.00 | 632.12 | 126.424 | -505.696 |
| 1997 | 2 | 210.82 | | 68.27 | | 0.00 | | | | |
| 1998 | 1 | 182.00 | 392.82 | 26.90 | 95.17 | 0.00 | 0.00 | 487.99 | 97.598 | -390.392 |
| 1998 | 2 | 295.42 | | 50.36 | | 0.00 | | | | |
| 1999 | 1 | 237.10 | 532.52 | 21.70 | 72.06 | 0.00 | 0.00 | 604.58 | 120.916 | -483.664 |

| Well | Average | Average | Average |
|---|---|---|---|
| | (AF) | (AF) | (AF) |
| 02N22W21H01S | 165.89 | 148.23 | 314.12 |
| 02N22W22G01S | 116.13 | 125.46 | 241.58 |
| 02N22W22H01S | 11.54 | 10.91 | 21.87 |

| Water Year | Yearly Gw | Consumptive |
|---|---|---|
| (AF) | (AF) | (AF) |
| 577.58 | 115.52 | -462.06 |

# ATTACHMENT 4
## EXISTING CONDITIONS MONTHLY WATER BALANCE
## Agricultural Acreage
## (Includes 35-acre and 15.7-acre parcels)
## 1979-80 to 1998-99 Water Years

| Year | Period | *Total Annual Irrigation | *Annual Irrigation Application Rate | Area of Campbell Basin Agriculture | 20% Gw Recharge | 80% Consumptive Use |
|---|---|---|---|---|---|---|
| | | (AF) | (AF/acre) | (acres) | (AF) | (AF) |
| 1979 | 2 | | | | | |
| 1980 | 1 | 54.03 | 0.343 | 50.7 | 3.48 | -13.93 |
| 1980 | 2 | | | | | |
| 1981 | 1 | 100.7 | 0.640 | 50.7 | 6.49 | -25.97 |
| 1981 | 2 | | | | | |
| 1982 | 1 | 570.84 | 3.629 | 50.7 | 36.80 | -147.19 |
| 1982 | 2 | | | | | |
| 1983 | 1 | 876.78 | 5.574 | 50.7 | 56.52 | -226.08 |
| 1983 | 2 | | | | | |
| 1984 | 1 | 1107.48 | 7.041 | 50.7 | 71.39 | -285.57 |
| 1984 | 2 | | | | | |
| 1985 | 1 | 761.43 | 4.841 | 50.7 | 49.08 | -196.34 |
| 1985 | 2 | | | | | |
| 1986 | 1 | 644.6 | 4.098 | 50.7 | 41.55 | -166.21 |
| 1986 | 2 | | | | | |
| 1987 | 1 | 846.91 | 5.384 | 50.7 | 54.59 | -218.38 |
| 1987 | 2 | | | | | |
| 1988 | 1 | 618.99 | 3.935 | 50.7 | 39.90 | -159.61 |
| 1988 | 2 | | | | | |
| 1989 | 1 | 519.72 | 3.304 | 50.7 | 33.50 | -134.01 |
| 1989 | 2 | | | | | |
| 1990 | 1 | 454.79 | 2.891 | 50.7 | 29.32 | -117.27 |
| 1990 | 2 | | | | | |
| 1991 | 1 | 704.45 | 4.478 | 50.7 | 45.41 | -181.64 |
| 1991 | 2 | | | | | |
| 1992 | 1 | 443.46 | 2.819 | 50.7 | 28.59 | -114.35 |
| 1992 | 2 | | | | | |
| 1993 | 1 | 494.64 | 3.145 | 50.7 | 31.89 | -127.54 |
| 1993 | 2 | | | | | |
| 1994 | 1 | 612.86 | 3.896 | 50.7 | 39.51 | -158.03 |
| 1994 | 2 | | | | | |
| 1995 | 1 | 470.28 | 2.990 | 50.7 | 30.32 | -121.26 |
| 1995 | 2 | | | | | |
| 1996 | 1 | 544.85 | 3.464 | 50.7 | 35.12 | -140.49 |
| 1996 | 2 | | | | | |
| 1997 | 1 | 632.12 | 4.019 | 50.7 | 40.75 | -162.99 |
| 1997 | 2 | | | | | |
| 1998 | 1 | 487.99 | 3.102 | 50.7 | 31.46 | -125.83 |
| 1998 | 2 | | | | | |
| 1999 | 1 | 604.58 | 3.843 | 50.7 | 38.97 | -155.89 |

*values taken from Existing Conditions Agricultural Acreage (154.5-acre and 2.8-acre parcels) water balance

# ATTACHMENT 5
# POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
# RiverPark B Reworked Gravel Pits with UWCD Diversions
# 1979-80 to 1998-99 Water Years
# (No stormwater runoff in Gravel Pits)
# (Land Bridge between Brigham and Vickers/Small Woolsey at 50 Feet)

**Data used for calculations:**

Soil Moisture Holding Capacity: 2.40 inches

Total Gravel Pit Area: 213.10 acres

Lake Factor on Pan Evaporation = 0.75

Soil Factor on Pan Evaporation = 0.35

**Definition of terms:**

Pg = Precipitation (inches). Station 239E El Rio - UWCD (7/1/79 - 6/30/99)

Qprec = Water yield in gravel pits generated from precipitation (acre-feet) = Pg/12 * Total Gravel Pit Area

Qrunoff-project = Water entering gravel pits via overflow of South, North, and East detention basins (acre-feet).

Qrunoff-UWCD = Water entering gravel pits via proposed UWCD water diversion/recharge project (acre-feet).

Epan = Pan Evaporation at El Rio (inches). Data from 1985-1999. Pan evaporation values for months earlier than July 1985 are based on average pan evaporation for each month between 1985-1999

AEsoil = Actual evaporation from soil (inches).

When water levels are above pit botttom:

If (Pg + SM1 - (Epan * 0.35)) > 0; AEsoil = Epan * 0.35

If (Pg + SM1 - (Epan * 0.35)) $\leq$ 0; AEsoil = Pg + SM1

When water levels are below pit botttom:

If (Pg + (Qrunoff*12/213.1) + SM1 - (Epan * 0.35)) > 0; AEsoil = Epan * 0.35

If (Pg + (Qrunoff*12/213.1) + SM1 - (Epan * 0.35)) $\leq$ 0; AEsoil = Pg + (Qrunoff*12/213.1) + SM1

Qesoil = Water lost to soil moisture evaporation (acre-feet) = (AEsoil/12) * (Total Gravel Pit Area - Exposed Surface Water Area)

AElake = Actual evaporation from exposed surface water (inches) = Epan * 0.75

Qelake = Water lost to surface water evaporation (acre-feet) = (AElake/12) * Exposed Surface Water Area

SM1 = Soil moisture at the beginning of the month (inches). SM1 = SM2 from previous month

SM2 = Soil moisture at end of the month (inches).

When water levels in pits are above pit bottom:

If (Pg + SM1 - AEsoil) < 2.4; SM2 = Pg + SM1 - AEsoil.

If (Pg + SM1 - AEsoil) $\geq$ 2.4; SM2 = 2.4.

If (Pg + SM1 - AEsoil) $\leq$ 0; SM2 = 0.0.

When water levels are below pit bottom:

If (Pg + Qrunoff*12/213.1 + SM1 - AEsoil) < 2.4; SM2 = Pg + Qrunoff*12/213.1 + SM1 - AEsoil.

If (Pg + Qrunoff*12/213.1 + SM1 - AEsoil) $\geq$ 2.4; SM2 = 2.4.

If (Pg + Qrunoff*12/213.1 + SM1 - AEsoil) $\leq$ 0; SM2 = 0.0.

Qsoil = Groundwater recharge from soil to gravel pits (inches).

When water levels are above pit bottom:

Qsoil = Pg - AEsoil - (SM2 - SM1)

When water levels are below pit bottom:

Qsoil = Pg +Qrunoff*12/213.1 - AEsoil - (SM2 - SM1)

Qtotal = Total groundwater recharge from gravel pits (acre-feet).

When water levels are above pit bottom:

Qtotal = Qsoil/12 * (Total Gravel Pit Area - Exposed Surface Water Area) + Pg/12 * (Exposed Surface Water Area) + Qrunoff - Qelake

When water levels are below pit bottom:

Qtotal = Qsoil/12 * (Total Gravel Pit Area)

ATTACHMENT 5
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
RiverPark B Reworked Gravel Pits with UWCD Diversions
1979-80 to 1998-99 Water Years
(No stormwater runoff in Gravel Pits)
(Land Bridge between Brigham and Vickers/Small Woolsey at 50 Feet)

| Water Year 1979-1980 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.62 | 0.48 | 1.28 | 2.03 | 7.62 | 10.19 | 2.86 | 0.39 | 0.29 | 0.00 | 25.76 |
| Qprec (af) | 0.00 | 0.00 | 11.01 | 8.52 | 22.73 | 36.05 | 135.32 | 180.96 | 50.79 | 6.93 | 5.15 | 0.00 | 457.45 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 300.00 | 900.00 | 1500.00 | 3000.00 | 3000.00 | 3000.00 | 2250.00 | 750.00 | 300.00 | 15000.00 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.00 | 0.00 | 0.62 | 0.48 | 1.28 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 1.14 | 0.00 | 10.73 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 64.31 | 61.67 | 51.65 | 48.79 | 44.29 | 40.65 | 38.57 | 40.59 | 51.00 | 62.96 | 64.27 | 63.99 | 632.75 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.71 | 2.40 | 2.40 | 2.40 | 0.85 | 0.00 | 8.76 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.71 | 2.40 | 2.40 | 2.40 | 0.85 | 0.00 | 0.00 | 8.76 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.75 | 8.96 | 1.32 | 0.00 | 0.00 | 0.00 | 15.03 |
| Qtotal (af) | -64.31 | -61.67 | -43.76 | 257.53 | 873.29 | 1488.46 | 3089.85 | 3137.49 | 2996.18 | 2192.95 | 689.83 | 236.01 | **14791.84** |
| Water Elev-preUWCD ( | 60.00 | 59.00 | 59.50 | 60.00 | 60.50 | 61.00 | 61.50 | 62.00 | 62.50 | 63.00 | 64.15 | 65.30 | |
| Surface area-post (acr | 154.27 | 152.75 | 152.75 | 158.04 | 164.80 | 172.06 | 184.23 | 185.02 | 185.02 | 181.84 | 169.69 | 165.68 | |

| Water Year 1980-1981 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 2.12 | 1.85 | 5.67 | 0.18 | 0.00 | 0.00 | 11.14 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 23.44 | 37.65 | 32.85 | 100.69 | 3.20 | 0.00 | 0.00 | 197.83 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 152.34 | 457.02 | 761.70 | 1523.40 | 1523.40 | 1523.40 | 1142.55 | 380.85 | 152.34 | 7617.00 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 0.64 | 0.00 | 7.84 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 65.78 | 61.06 | 53.95 | 52.50 | 44.61 | 39.01 | 36.63 | 38.38 | 48.63 | 61.86 | 62.06 | 59.98 | 624.46 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 | 1.57 | 2.40 | 0.64 | 0.00 | 5.56 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 | 1.57 | 2.40 | 0.64 | 0.00 | 0.00 | 5.56 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.30 | 0.00 | 0.00 | 0.00 | 3.30 |
| Qtotal (af) | -65.78 | -61.06 | -53.95 | 99.84 | 412.41 | 740.86 | 1517.68 | 1511.99 | 1568.21 | 1083.37 | 318.79 | 92.36 | **7164.70** |
| Water Elev (ft) | 62.10 | 58.90 | 63.85 | 68.80 | 64.95 | 61.10 | 60.55 | 60.00 | 63.65 | 67.30 | 63.55 | 59.80 | |
| Surface area (acres) | 157.79 | 151.24 | 159.55 | 170.04 | 166.00 | 165.10 | 174.97 | 174.97 | 176.42 | 178.67 | 163.85 | 155.30 | |

| Water Year 1981-1982 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.89 | 1.96 | 0.72 | 2.52 | 0.34 | 4.07 | 1.73 | 0.00 | 0.00 | 12.23 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 15.80 | 34.81 | 12.79 | 44.75 | 6.04 | 72.28 | 30.72 | 0.00 | 0.00 | 217.18 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 161.58 | 484.74 | 807.90 | 1615.80 | 1615.80 | 1615.80 | 1211.85 | 403.95 | 161.58 | 8079.00 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.89 | 1.51 | 1.18 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 0.07 | 11.64 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 60.47 | 55.04 | 43.58 | 39.45 | 32.76 | 29.94 | 33.24 | 35.52 | 45.39 | 57.26 | 56.59 | 43.61 | 532.86 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.00 | 1.35 | 0.46 | 2.40 | 2.19 | 0.07 | 6.92 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.00 | 1.35 | 0.46 | 2.40 | 2.19 | 0.07 | 0.00 | 6.92 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.59 | 0.00 | 0.00 | 0.00 | 0.59 |
| Qtotal (af) | -60.47 | -55.04 | -43.58 | 131.61 | 471.89 | 785.56 | 1615.90 | 1584.87 | 1628.63 | 1178.43 | 347.36 | 117.97 | **7703.12** |
| Water Elev (ft) | 54.90 | 50.00 | 49.20 | 48.40 | 46.95 | 45.50 | 48.77 | 52.05 | 55.32 | 58.60 | 52.60 | 46.60 | |
| Surface area (acres) | 145.06 | 136.33 | 128.89 | 127.78 | 121.89 | 126.74 | 158.77 | 161.91 | 164.70 | 165.37 | 149.43 | 112.90 | |

ATTACHMENT 5
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
RiverPark B Reworked Gravel Pits with UWCD Diversions
1979-80 to 1998-99 Water Years
(No stormwater runoff in Gravel Pits)
(Land Bridge between Brigham and Vickers/Small Woolsey at 50 Feet)

| Water Year 1982-1983 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.90 | 0.42 | 4.41 | 1.82 | 7.62 | 5.23 | 5.90 | 3.60 | 0.14 | 0.01 | 30.05 |
| Qprec (af) | 0.00 | 0.00 | 15.98 | 7.46 | 78.31 | 32.32 | 135.32 | 92.88 | 104.77 | 63.93 | 2.49 | 0.18 | 533.64 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 276.74 | 830.22 | 1383.70 | 2767.40 | 2767.40 | 2767.40 | 2075.55 | 691.85 | 276.74 | 13837.00 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.00 | 0.00 | 0.90 | 0.42 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 0.43 | 12.58 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 50.63 | 52.04 | 41.07 | 37.15 | 31.97 | 28.45 | 33.90 | 35.84 | 45.39 | 56.06 | 58.46 | 60.05 | 531.02 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 0.42 | 14.82 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 0.42 | 0.00 | 14.82 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 | 0.50 | 6.45 | 4.00 | 4.36 | 1.66 | 0.00 | 0.00 | 17.47 |
| Qtotal (af) | -50.63 | -52.04 | -31.96 | 243.80 | 845.93 | 1377.35 | 2863.82 | 2819.35 | 2820.55 | 2075.15 | 635.19 | 216.82 | **13763.32** |
| Water Elev (ft) | 48.25 | 49.90 | 48.45 | 47.00 | 43.70 | 40.40 | 42.30 | 44.20 | 46.35 | 48.50 | 53.60 | 58.70 | |
| Surface area (acres) | 121.45 | 128.89 | 121.45 | 120.34 | 118.96 | 120.43 | 161.91 | 163.36 | 164.70 | 161.91 | 154.36 | 155.47 | |

| Water Year 1983-1984 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.96 | 0.85 | 2.76 | 3.07 | 4.40 | 0.19 | 0.01 | 0.38 | 0.25 | 0.00 | 0.00 | 12.87 |
| Qprec (af) | 0.00 | 17.05 | 15.09 | 49.01 | 54.52 | 78.14 | 3.37 | 0.18 | 6.75 | 4.44 | 0.00 | 0.00 | 228.55 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 75.02 | 225.06 | 375.10 | 750.20 | 750.20 | 750.20 | 562.65 | 187.55 | 75.02 | 3751.00 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| AEsoil (in) | 0.00 | 0.96 | 0.85 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 0.58 | 0.25 | 0.00 | 0.00 | 9.60 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.51 | 2.63 | 3.31 | 4.16 | 4.55 | 4.64 | 45.46 |
| Qelake(af) | 65.05 | 64.42 | 53.35 | 48.98 | 43.54 | 39.29 | 35.72 | 37.43 | 47.02 | 58.43 | 59.39 | 56.68 | 609.30 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.03 | 2.40 | 2.40 | 1.42 | 0.20 | 0.00 | 0.00 | 0.00 | 7.45 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 1.03 | 2.40 | 2.40 | 1.42 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 7.45 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 3.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.27 |
| Qtotal (af) | -65.05 | -51.65 | -42.18 | 62.53 | 223.80 | 408.79 | 717.18 | 712.92 | 708.58 | 507.73 | 128.16 | 18.34 | **3329.15** |
| Water Elev (ft) | 61.05 | 63.40 | 62.80 | 62.20 | 63.80 | 65.40 | 65.35 | 65.30 | 65.60 | 65.90 | 60.10 | 54.30 | |
| Surface area (acres) | 156.03 | 159.55 | 157.79 | 158.64 | 162.01 | 166.30 | 170.60 | 170.60 | 170.60 | 168.76 | 156.81 | 146.75 | |

| Water Year 1984-1985 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.05 | 0.27 | 0.31 | 2.55 | 4.00 | 1.10 | 1.70 | 0.94 | 0.00 | 0.00 | 0.00 | 10.92 |
| Qprec (af) | 0.00 | 0.89 | 4.79 | 5.51 | 45.28 | 71.03 | 19.53 | 30.19 | 16.69 | 0.00 | 0.00 | 0.00 | 193.92 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 6.08 | 18.24 | 30.40 | 60.80 | 60.80 | 60.80 | 45.60 | 15.20 | 6.08 | 304.00 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.81 | 4.74 | 4.96 | 5.72 | 7.17 | 7.96 | 65.92 |
| AEsoil (in) | 0.00 | 0.05 | 0.27 | 0.31 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 1.41 | 0.00 | 0.00 | 9.60 |
| AElake(in) | 5.00 | 4.85 | 4.06 | 3.71 | 3.23 | 2.84 | 2.86 | 3.56 | 3.72 | 4.29 | 5.38 | 5.97 | 49.44 |
| Qelake(af) | 59.79 | 56.95 | 49.60 | 46.23 | 38.55 | 28.69 | 33.97 | 44.61 | 46.21 | 52.74 | 51.09 | 43.90 | 552.32 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.05 | 2.40 | 2.17 | 2.21 | 1.41 | 0.00 | 0.00 | 9.23 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.05 | 2.40 | 2.17 | 2.21 | 1.41 | 0.00 | 0.00 | 0.00 | 9.23 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 |
| Qtotal (af) | -59.79 | -56.36 | -46.30 | -36.28 | 10.17 | 52.29 | 39.91 | 37.52 | 26.27 | -7.14 | -35.89 | -37.82 | **-113.43** |
| Water Elev (ft) | 53.55 | 52.80 | 55.35 | 57.90 | 53.10 | 48.30 | 52.85 | 57.40 | 56.20 | 55.00 | 47.90 | 40.80 | |
| Surface area (acres) | 143.43 | 141.06 | 146.69 | 149.72 | 143.43 | 121.45 | 142.64 | 150.57 | 149.05 | 147.54 | 114.02 | 88.24 | |

ATTACHMENT 5
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
RiverPark B Reworked Gravel Pits with UWCD Diversions
1979-80 to 1998-99 Water Years
(No stormwater runoff in Gravel Pits)
(Land Bridge between Brigham and Vickers/Small Woolsey at 50 Feet)

| Water Year 1985-1986 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.01 | 0.43 | 4.06 | 0.74 | 3.91 | 7.03 | 4.82 | 1.13 | 0.03 | 0.00 | 22.16 |
| Qprec (af) | 0.00 | 0.00 | 0.18 | 7.64 | 72.10 | 13.14 | 69.44 | 124.84 | 85.60 | 20.07 | 0.53 | 0.00 | 393.52 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 223.52 | 670.56 | 1117.60 | 2235.20 | 2235.20 | 2235.20 | 1676.40 | 558.80 | 223.52 | 11176.00 |
| Epan (in) | 8.32 | 7.86 | 7.17 | 6.35 | 4.21 | 4.49 | 4.12 | 3.35 | 4.26 | 5.99 | 5.93 | 5.76 | 67.81 |
| AEsoil (in) | 0.00 | 0.00 | 0.01 | 0.43 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 1.46 | 0.00 | 11.15 |
| AElake(in) | 6.24 | 5.90 | 5.38 | 4.76 | 3.16 | 3.37 | 3.09 | 2.51 | 3.20 | 4.49 | 4.45 | 4.32 | 50.86 |
| Qelake(af) | 43.90 | 40.07 | 32.38 | 26.15 | 22.77 | 28.20 | 30.88 | 25.34 | 34.48 | 47.99 | 43.00 | 41.21 | 416.38 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 1.57 | 2.40 | 2.40 | 2.40 | 1.43 | 0.00 | 12.60 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 1.57 | 2.40 | 2.40 | 2.40 | 1.43 | 0.00 | 0.00 | 12.60 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 | 1.64 | 5.86 | 3.33 | 0.00 | 0.00 | 0.00 | 11.01 |
| Qtotal (af) | -43.90 | -40.07 | -32.32 | 199.73 | 679.04 | 1095.59 | 2256.10 | 2325.70 | 2275.93 | 1640.48 | 516.09 | 182.31 | **11054.68** |
| Water Elev (ft) | 38.45 | 36.10 | 30.65 | 25.20 | 26.70 | 28.20 | 30.00 | 31.60 | 37.75 | 43.70 | 44.80 | 45.90 | |
| Surface area (acres) | 84.42 | 81.57 | 72.25 | 65.90 | 86.55 | 100.50 | 119.92 | 121.04 | 129.49 | 128.19 | 116.03 | 114.48 | |

| Water Year 1986-1987 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.01 | 0.00 | 1.15 | 0.00 | 1.38 | 0.24 | 1.87 | 1.91 | 1.90 | 0.02 | 0.00 | 0.04 | 8.52 |
| Qprec (af) | 0.18 | 0.00 | 20.42 | 0.00 | 24.51 | 4.26 | 33.21 | 33.92 | 33.74 | 0.36 | 0.00 | 0.71 | 151.30 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 50.88 | 152.64 | 254.40 | 508.80 | 508.80 | 508.80 | 381.60 | 127.20 | 50.88 | 2544.00 |
| Epan (in) | 7.34 | 6.66 | 5.38 | 4.98 | 4.48 | 3.82 | 3.55 | 4.21 | 4.54 | 5.64 | 5.59 | 5.75 | 61.94 |
| AEsoil (in) | 0.01 | 0.00 | 1.15 | 0.00 | 1.38 | 0.24 | 1.24 | 1.47 | 1.59 | 1.40 | 0.00 | 0.04 | 8.52 |
| AElake(in) | 5.51 | 5.00 | 4.04 | 3.74 | 3.36 | 2.87 | 2.66 | 3.16 | 3.41 | 4.23 | 4.19 | 4.31 | 46.46 |
| Qelake(af) | 48.89 | 44.36 | 30.39 | 25.72 | 23.08 | 19.78 | 21.42 | 26.05 | 28.35 | 33.86 | 25.49 | 19.40 | 346.80 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 1.06 | 1.38 | 0.00 | 0.00 | 3.07 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 1.06 | 1.38 | 0.00 | 0.00 | 0.00 | 3.07 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | -48.80 | -44.36 | -21.73 | 25.16 | 139.04 | 236.28 | 502.42 | 498.51 | 496.27 | 347.90 | 101.71 | 31.66 | **2264.05** |
| Water Elev (ft) | 46.05 | 46.20 | 41.35 | 36.50 | 34.40 | 32.30 | 33.60 | 34.90 | 35.65 | 36.40 | 29.65 | 22.90 | |
| Surface area (acres) | 106.58 | 106.58 | 90.38 | 82.63 | 82.42 | 82.85 | 96.54 | 99.01 | 99.91 | 96.06 | 72.96 | 54.00 | |

| Water Year 1987-1988 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.11 | 0.00 | 0.00 | 1.58 | 1.20 | 3.06 | 2.38 | 1.09 | 0.58 | 2.30 | 0.00 | 0.00 | 12.30 |
| Qprec (af) | 1.95 | 0.00 | 0.00 | 28.06 | 21.31 | 54.34 | 42.26 | 19.36 | 10.30 | 40.84 | 0.00 | 0.00 | 218.43 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 50.74 | 152.22 | 253.70 | 507.40 | 507.40 | 507.40 | 380.55 | 126.85 | 50.74 | 2537.00 |
| Epan (in) | 6.58 | 6.92 | 5.79 | 4.71 | 4.66 | 3.37 | 4.03 | 5.15 | 7.20 | 6.02 | 8.56 | 7.46 | 70.45 |
| AEsoil (in) | 0.11 | 0.00 | 0.00 | 1.58 | 1.20 | 1.18 | 1.41 | 1.80 | 2.27 | 2.11 | 0.19 | 0.00 | 11.85 |
| AElake(in) | 4.94 | 5.19 | 4.34 | 3.53 | 3.50 | 2.53 | 3.02 | 3.86 | 5.40 | 4.52 | 6.42 | 5.60 | 52.84 |
| Qelake(af) | 20.44 | 20.80 | 16.81 | 13.33 | 13.21 | 9.69 | 15.90 | 24.69 | 34.51 | 25.74 | 26.76 | 21.11 | 243.00 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.88 | 2.40 | 1.69 | 0.00 | 0.19 | 0.00 | 6.16 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.88 | 2.40 | 1.69 | 0.00 | 0.19 | 0.00 | 0.00 | 6.16 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 |
| Qtotal (af) | -19.99 | -20.80 | -16.81 | 43.37 | 143.55 | 255.74 | 509.64 | 489.68 | 476.59 | 367.92 | 100.09 | 29.63 | **2358.62** |
| Water Elev (ft) | 20.90 | 18.90 | 16.90 | 14.90 | 13.80 | 12.70 | 19.30 | 25.90 | 25.20 | 24.50 | 19.70 | 14.90 | |
| Surface area (acres) | 49.71 | 48.10 | 46.46 | 45.28 | 45.35 | 46.01 | 63.12 | 76.69 | 76.69 | 68.42 | 50.02 | 45.28 | |

ATTACHMENT 5
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
RiverPark B Reworked Gravel Pits with UWCD Diversions
1979-80 to 1998-99 Water Years
(No stormwater runoff in Gravel Pits)
(Land Bridge between Brigham and Vickers/Small Woolsey at 50 Feet)

| Water Year 1988-1989 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.96 | 2.73 | 0.76 | 2.64 | 0.88 | 0.20 | 0.11 | 0.00 | 8.30 |
| Qprec (af) | 0.00 | 0.00 | 0.36 | 0.00 | 17.05 | 48.48 | 13.50 | 46.88 | 15.63 | 3.55 | 1.95 | 0.00 | 147.39 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 11.04 | 33.12 | 55.20 | 110.40 | 110.40 | 110.40 | 82.80 | 27.60 | 11.04 | 552.00 |
| Epan (in) | 6.82 | 7.17 | 6.49 | 4.77 | 4.16 | 4.99 | 4.10 | 3.32 | 4.34 | 6.01 | 6.36 | 6.03 | 64.56 |
| AEsoil (in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.96 | 1.75 | 1.44 | 1.16 | 1.52 | 1.35 | 0.11 | 0.00 | 8.30 |
| AElake(in) | 5.12 | 5.38 | 4.87 | 3.58 | 3.12 | 3.74 | 3.08 | 2.49 | 3.26 | 4.51 | 4.77 | 4.52 | 48.42 |
| Qelake(af) | 18.78 | 16.62 | 13.63 | 9.57 | 8.28 | 10.59 | 8.95 | 7.88 | 9.92 | 13.11 | 11.38 | 9.58 | 138.28 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.31 | 1.79 | 1.15 | 0.00 | 0.00 | 4.23 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.31 | 1.79 | 1.15 | 0.00 | 0.00 | 0.00 | 4.23 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | -18.78 | -16.62 | -13.57 | 1.47 | 27.38 | 52.34 | 103.66 | 110.87 | 103.16 | 70.28 | 16.48 | 1.46 | **438.14** |
| Water Elev (ft) | 13.20 | 11.50 | 10.50 | 9.50 | 5.80 | 2.10 | 4.90 | 7.70 | 6.80 | 5.90 | 3.90 | 1.90 | |
| Surface area (acres) | 44.05 | 37.08 | 33.60 | 32.09 | 31.86 | 33.94 | 34.92 | 37.99 | 36.57 | 34.89 | 28.64 | 25.41 | |

| Water Year 1989-1990 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.08 | 0.19 | 0.50 | 0.00 | 2.24 | 1.71 | 0.00 | 0.03 | 0.71 | 0.00 | 5.46 |
| Qprec (af) | 0.00 | 0.00 | 1.42 | 3.37 | 8.88 | 0.00 | 39.78 | 30.37 | 0.00 | 0.53 | 12.61 | 0.00 | 96.96 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 1.62 | 4.86 | 8.10 | 16.20 | 16.20 | 16.20 | 12.15 | 4.05 | 1.62 | 81.00 |
| Epan (in) | 6.83 | 5.96 | 5.35 | 4.58 | 5.12 | 4.71 | 3.86 | 3.42 | 4.37 | 4.45 | 6.21 | 6.47 | 61.33 |
| AEsoil (in) | 0.00 | 0.00 | 0.08 | 0.19 | 0.50 | 0.00 | 1.35 | 1.20 | 1.40 | 0.03 | 0.71 | 0.00 | 5.46 |
| AElake(in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qelake(af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.89 | 0.81 | 1.33 | 1.18 | 1.51 | 1.54 | 1.07 | 0.00 | 8.34 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.89 | 1.40 | 0.00 | 0.00 | 0.00 | 2.29 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.89 | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 2.29 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 1.62 | 4.09 | 7.29 | 15.90 | 15.81 | 14.69 | 10.63 | 3.14 | 1.62 | **74.77** |
| Water Elev (ft) | -1.35 | -4.60 | -5.68 | -6.77 | -7.85 | -8.93 | -10.02 | -11.10 | -13.75 | -16.40 | -28.70 | -41.00 | |
| Surface area (acres) | 0.00 | 0.00 | 0.00 | 0.00 | 2.77 | 2.77 | 5.53 | 5.53 | 5.53 | 5.53 | 2.77 | 0.00 | |

| Water Year 1990-1991 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.98 | 2.50 | 8.61 | 0.00 | 0.00 | 0.00 | 12.64 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 0.00 | 9.77 | 0.00 | 17.40 | 44.40 | 152.90 | 0.00 | 0.00 | 0.00 | 224.47 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 72.34 | 217.02 | 361.70 | 723.40 | 723.40 | 723.40 | 542.55 | 180.85 | 72.34 | 3617.00 |
| Epan (in) | 7.48 | 6.45 | 5.61 | 5.27 | 4.90 | 4.42 | 3.35 | 2.81 | 3.45 | 5.52 | 6.52 | 5.78 | 61.56 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.98 | 0.98 | 1.21 | 1.93 | 0.47 | 0.00 | 6.12 |
| AElake(in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qelake(af) | 0.00 | 0.00 | 0.00 | 4.64 | 4.68 | 5.27 | 6.70 | 5.62 | 6.90 | 8.31 | 6.11 | 5.09 | 53.31 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.52 | 2.40 | 0.47 | 0.00 | 4.38 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.52 | 2.40 | 0.47 | 0.00 | 0.00 | 4.38 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.52 | 0.00 | 0.00 | 0.00 | 6.52 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 67.70 | 213.04 | 356.43 | 719.32 | 724.45 | 837.84 | 534.24 | 174.74 | 67.25 | **3695.01** |
| Water Elev (ft) | -44.20 | -47.40 | -42.00 | -36.60 | -32.30 | -28.00 | -29.55 | -31.10 | -26.05 | -21.00 | -22.15 | -23.30 | |
| Surface area (acres) | 0.00 | 0.00 | 0.00 | 14.09 | 15.28 | 19.07 | 31.98 | 31.98 | 31.98 | 24.08 | 15.00 | 14.09 | |

ATTACHMENT 5
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
RiverPark B Reworked Gravel Pits with UWCD Diversions
1979-80 to 1998-99 Water Years
(No stormwater runoff in Gravel Pits)
(Land Bridge between Brigham and Vickers/Small Woolsey at 50 Feet)

| Water Year 1991-1992 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.02 | 0.00 | 0.16 | 0.14 | 3.87 | 1.99 | 7.87 | 4.26 | 0.08 | 0.00 | 0.00 | 18.39 |
| Qprec (af) | 0.00 | 0.36 | 0.00 | 2.84 | 2.49 | 68.72 | 35.34 | 139.76 | 75.65 | 1.42 | 0.00 | 0.00 | 326.58 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 261.80 | 785.40 | 1309.00 | 2618.00 | 2618.00 | 2618.00 | 1963.50 | 654.50 | 261.80 | 13090.00 |
| Epan (in) | 5.96 | 5.45 | 4.31 | 3.97 | 4.38 | 2.92 | 3.63 | 3.10 | 3.02 | 4.54 | 4.45 | 5.83 | 51.56 |
| AEsoil (in) | 0.00 | 0.02 | 0.00 | 0.16 | 0.14 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 0.89 | 0.00 | 7.23 |
| AElake(in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.41 | 3.34 | 4.37 | 11.12 |
| Qelake(af) | 0.00 | 0.00 | 0.00 | 3.90 | 9.62 | 8.81 | 18.88 | 16.12 | 15.71 | 22.62 | 14.20 | 13.31 | 123.17 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.89 | 0.00 | 10.49 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.89 | 0.00 | 0.00 | 10.49 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 0.72 | 6.79 | 3.20 | 0.00 | 0.00 | 0.00 | 11.16 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 258.11 | 776.19 | 1321.91 | 2620.71 | 2729.89 | 2666.50 | 1941.41 | 640.30 | 248.49 | **13203.51** |
| Water Elev (ft) | -25.20 | -27.10 | -30.05 | -33.00 | -32.10 | -31.20 | -28.75 | -26.30 | -9.20 | 7.90 | 6.90 | 5.90 | |
| Surface area (acres) | 0.00 | 0.00 | 0.00 | 15.72 | 35.15 | 48.26 | 83.22 | 83.22 | 83.22 | 79.73 | 51.04 | 36.52 | |

| Water Year 1992-1993 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.09 | 0.00 | 0.00 | 1.05 | 0.00 | 4.74 | 7.55 | 8.92 | 3.72 | 0.00 | 0.10 | 0.68 | 26.85 |
| Qprec (af) | 1.60 | 0.00 | 0.00 | 18.65 | 0.00 | 84.17 | 134.08 | 158.40 | 66.06 | 0.00 | 1.78 | 12.08 | 476.81 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 300.00 | 900.00 | 1500.00 | 3000.00 | 3000.00 | 3000.00 | 2250.00 | 750.00 | 300.00 | 15000.00 |
| Epan (in) | 6.26 | 6.66 | 5.08 | 4.05 | 5.19 | 3.22 | 2.52 | 2.98 | 3.61 | 5.34 | 5.73 | 6.50 | 57.14 |
| AEsoil (in) | 0.09 | 0.00 | 0.00 | 1.05 | 0.00 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 0.63 | 0.68 | 8.64 |
| AElake(in) | 4.70 | 5.00 | 3.81 | 3.04 | 3.89 | 2.42 | 1.89 | 2.24 | 2.71 | 4.01 | 4.30 | 4.88 | 42.86 |
| Qelake(af) | 7.87 | 0.00 | 6.46 | 10.32 | 24.41 | 20.58 | 23.16 | 29.57 | 36.53 | 53.25 | 45.17 | 50.52 | 307.84 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.53 | 0.00 | 10.13 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.53 | 0.00 | 0.00 | 10.13 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.21 | 6.67 | 7.88 | 2.46 | 0.00 | 0.00 | 0.00 | 18.21 |
| Qtotal (af) | -7.72 | 0.00 | -6.46 | 293.24 | 875.59 | 1531.02 | 3106.06 | 3124.11 | 3024.14 | 2196.75 | 705.88 | 256.53 | **15099.15** |
| Water Elev (ft) | 2.40 | -1.10 | 3.05 | 7.20 | 17.45 | 27.70 | 31.25 | 34.80 | 39.15 | 43.50 | 45.50 | 47.50 | |
| Surface area (acres) | 20.11 | 0.00 | 20.34 | 40.79 | 75.25 | 102.24 | 147.06 | 158.77 | 161.91 | 159.56 | 126.12 | 124.35 | |

| Water Year 1993-1994 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.55 | 0.70 | 1.41 | 0.49 | 4.96 | 2.82 | 0.39 | 0.26 | 0.00 | 11.58 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 9.77 | 12.43 | 25.04 | 8.70 | 88.08 | 50.08 | 6.93 | 4.62 | 0.00 | 205.64 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 194.86 | 584.58 | 974.30 | 1948.60 | 1948.60 | 1948.60 | 1461.45 | 487.15 | 194.86 | 9743.00 |
| Epan (in) | 6.51 | 5.88 | 4.78 | 4.50 | 4.50 | 3.64 | 3.63 | 3.49 | 3.96 | 4.60 | 4.07 | 5.22 | 54.78 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.55 | 0.70 | 1.27 | 0.63 | 1.22 | 1.39 | 1.61 | 1.42 | 0.02 | 8.81 |
| AElake(in) | 4.88 | 4.41 | 3.59 | 3.38 | 3.38 | 2.73 | 2.72 | 2.62 | 2.97 | 3.45 | 3.05 | 3.92 | 41.09 |
| Qelake(af) | 25.41 | 34.79 | 28.28 | 29.29 | 38.29 | 35.82 | 37.67 | 36.61 | 41.09 | 46.97 | 38.23 | 46.83 | 439.29 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 2.40 | 2.40 | 1.18 | 0.02 | 6.13 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 2.40 | 2.40 | 1.18 | 0.02 | 0.00 | 6.13 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.34 | 1.43 | 0.00 | 0.00 | 0.00 | 2.77 |
| Qtotal (af) | -25.41 | -34.79 | -28.28 | 170.34 | 554.23 | 956.98 | 1917.71 | 1986.41 | 1952.15 | 1419.79 | 452.18 | 148.03 | **9469.34** |
| Water Elev (ft) | 45.35 | 43.20 | 43.10 | 43.00 | 48.10 | 53.20 | 54.35 | 55.50 | 54.95 | 54.40 | 52.70 | 51.00 | |
| Surface area (acres) | 62.46 | 94.67 | 94.67 | 104.16 | 136.15 | 157.43 | 166.03 | 167.86 | 166.03 | 163.36 | 150.27 | 143.55 | |

ATTACHMENT 5
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
RiverPark B Reworked Gravel Pits with UWCD Diversions
1979-80 to 1998-99 Water Years
(No stormwater runoff in Gravel Pits)
(Land Bridge between Brigham and Vickers/Small Woolsey at 50 Feet)

| Water Year 1994-1995 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.18 | 0.39 | 1.63 | 0.97 | 14.23 | 1.08 | 8.16 | 0.58 | 0.78 | 0.34 | 28.34 |
| Qprec (af) | 0.00 | 0.00 | 3.20 | 6.93 | 28.95 | 17.23 | 252.70 | 19.18 | 144.91 | 10.30 | 13.85 | 6.04 | 503.27 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 276.92 | 830.76 | 1384.60 | 2769.20 | 2769.20 | 2769.20 | 2076.90 | 692.30 | 276.92 | 13846.00 |
| Epan (in) | 5.58 | 5.84 | 4.64 | 4.27 | 3.84 | 2.60 | 1.64 | 2.53 | 3.64 | 5.25 | 4.65 | 4.98 | 49.46 |
| AEsoil (in) | 0.02 | 0.00 | 0.18 | 0.39 | 1.34 | 0.91 | 0.57 | 0.89 | 1.27 | 1.84 | 1.63 | 0.64 | 9.67 |
| AElake(in) | 4.19 | 4.38 | 3.48 | 3.20 | 2.88 | 1.95 | 1.23 | 1.90 | 2.73 | 3.94 | 3.49 | 3.74 | 37.10 |
| Qelake(af) | 42.36 | 22.80 | 18.11 | 29.05 | 29.01 | 22.65 | 17.02 | 26.69 | 38.81 | 54.48 | 45.67 | 47.92 | 394.57 |
| SM1 (in) | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 0.35 | 2.40 | 2.40 | 2.40 | 1.14 | 0.30 | 9.29 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 0.35 | 2.40 | 2.40 | 2.40 | 1.14 | 0.30 | 0.00 | 9.27 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.60 | 0.19 | 6.89 | 0.00 | 0.00 | 0.00 | 18.68 |
| Qtotal (af) | -42.36 | -22.80 | -17.18 | 251.41 | 818.17 | 1373.22 | 2994.58 | 2758.42 | 2870.78 | 2030.45 | 656.84 | 233.36 | **13904.89** |
| Water Elev (ft) | 48.20 | 45.40 | 45.00 | 44.60 | 45.80 | 47.00 | 48.74 | 50.49 | 52.23 | 53.98 | 55.72 | 57.46 | |
| Surface area (acres) | 121.45 | 62.46 | 62.46 | 108.85 | 120.88 | 139.36 | 166.03 | 168.78 | 170.60 | 166.03 | 157.16 | 153.96 | |

| Water Year 1995-1996 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 1.99 | 1.24 | 7.59 | 1.40 | 0.60 | 0.11 | 0.00 | 13.04 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 0.00 | 1.95 | 35.34 | 22.02 | 134.79 | 24.86 | 10.66 | 1.95 | 0.00 | 231.57 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 195.18 | 585.54 | 975.90 | 1951.80 | 1951.80 | 1951.80 | 1463.85 | 487.95 | 195.18 | 9759.00 |
| Epan (in) | 5.83 | 6.20 | 4.90 | 4.67 | 3.20 | 2.88 | 3.02 | 2.41 | 3.74 | 5.56 | 6.06 | 5.40 | 53.87 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 1.16 | 0.00 | 7.44 |
| AElake(in) | 4.37 | 4.65 | 3.68 | 3.50 | 2.40 | 2.16 | 2.27 | 1.81 | 2.81 | 4.17 | 4.55 | 4.05 | 40.40 |
| Qelake(af) | 55.66 | 59.78 | 48.32 | 47.55 | 34.17 | 32.02 | 35.07 | 28.48 | 44.71 | 65.71 | 67.37 | 56.20 | 575.04 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 1.17 | 2.40 | 2.40 | 1.05 | 0.00 | 8.00 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 1.17 | 2.40 | 2.40 | 1.05 | 0.00 | 0.00 | 8.00 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.51 | 0.09 | 0.00 | 0.00 | 0.00 | 5.60 |
| Qtotal (af) | -55.66 | -59.78 | -48.32 | 147.63 | 552.94 | 973.38 | 1935.93 | 2053.95 | 1929.57 | 1407.60 | 422.21 | 138.98 | **9398.42** |
| Water Elev (ft) | 59.21 | 60.95 | 62.69 | 64.44 | 66.18 | 67.93 | 69.67 | 71.41 | 73.16 | 74.90 | 70.65 | 66.40 | |
| Surface area (acres) | 152.75 | 154.27 | 157.79 | 162.92 | 170.83 | 177.87 | 185.81 | 189.09 | 191.27 | 189.09 | 177.87 | 166.52 | |

| Water Year 1996-1997 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.00 | 1.18 | 2.63 | 5.50 | 4.45 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 13.82 |
| Qprec (af) | 0.00 | 0.00 | 0.00 | 20.95 | 46.70 | 97.67 | 79.02 | 1.07 | 0.00 | 0.00 | 0.00 | 0.00 | 245.42 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 183.68 | 551.04 | 918.40 | 1836.80 | 1836.80 | 1836.80 | 1377.60 | 459.20 | 183.68 | 9184.00 |
| Epan (in) | 5.91 | 5.65 | 4.94 | 4.85 | 4.25 | 3.58 | 2.41 | 4.35 | 5.53 | 6.93 | 7.31 | 6.40 | 62.11 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 1.18 | 1.49 | 1.25 | 0.84 | 1.52 | 0.94 | 0.00 | 0.00 | 0.00 | 7.22 |
| AElake(in) | 4.43 | 4.24 | 3.71 | 3.64 | 3.19 | 2.69 | 1.81 | 3.26 | 4.15 | 5.20 | 5.48 | 4.80 | 46.58 |
| Qelake(af) | 56.98 | 52.87 | 45.29 | 44.50 | 39.50 | 31.53 | 25.15 | 47.96 | 61.54 | 77.04 | 73.05 | 60.03 | 615.45 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.14 | 2.40 | 2.40 | 0.94 | 0.00 | 0.00 | 0.00 | 6.88 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.14 | 2.40 | 2.40 | 0.94 | 0.00 | 0.00 | 0.00 | 0.00 | 6.88 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.99 | 3.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.60 |
| Qtotal (af) | -56.98 | -52.87 | -45.29 | 153.61 | 544.13 | 969.44 | 1887.43 | 1789.72 | 1775.26 | 1300.56 | 386.15 | 123.65 | **8774.81** |
| Water Elev (ft) | 60.00 | 57.74 | 55.48 | 53.22 | 50.96 | 48.70 | 55.30 | 61.90 | 63.70 | 65.50 | 60.60 | 55.70 | |
| Surface area (acres) | 154.27 | 149.72 | 146.69 | 146.82 | 148.71 | 140.91 | 166.95 | 176.42 | 178.05 | 177.87 | 159.88 | 150.08 | |

ATTACHMENT 5
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
RiverPark B Reworked Gravel Pits with UWCD Diversions
1979-80 to 1998-99 Water Years
(No stormwater runoff in Gravel Pits)
(Land Bridge between Brigham and Vickers/Small Woolsey at 50 Feet)

| Water Year 1997-1998 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.04 | 0.00 | 2.21 | 6.54 | 3.06 | 18.64 | 3.17 | 1.55 | 2.74 | 0.02 | 37.97 |
| Qprec (af) | 0.00 | 0.00 | 0.71 | 0.00 | 39.25 | 116.14 | 54.34 | 331.02 | 56.29 | 27.53 | 48.66 | 0.36 | 674.28 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 106.08 | 318.24 | 530.40 | 1060.80 | 1060.80 | 1060.80 | 795.60 | 265.20 | 106.08 | 5304.00 |
| Epan (in) | 6.61 | 6.43 | 6.09 | 6.53 | 3.61 | 4.24 | 2.72 | 2.99 | 4.92 | 5.66 | 6.41 | 6.63 | 62.84 |
| AEsoil (in) | 0.00 | 0.00 | 0.04 | 0.00 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 2.32 | 13.05 |
| AElake(in) | 4.96 | 4.82 | 4.57 | 4.90 | 2.71 | 3.18 | 2.04 | 2.24 | 3.69 | 4.25 | 4.81 | 4.97 | 47.13 |
| Qelake(af) | 56.32 | 25.10 | 23.77 | 42.40 | 24.57 | 29.59 | 22.07 | 29.13 | 49.86 | 58.40 | 65.76 | 69.35 | 496.33 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 | 2.40 | 2.40 | 2.40 | 2.40 | 1.97 | 2.40 | 14.92 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 | 2.40 | 2.40 | 2.40 | 2.40 | 1.97 | 2.40 | 0.10 | 15.02 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.60 | 2.11 | 17.59 | 1.45 | 0.00 | 0.07 | 0.00 | 24.82 |
| Qtotal (af) | -56.32 | -25.10 | -23.57 | 63.68 | 313.73 | 592.12 | 1086.46 | 1357.70 | 1059.92 | 758.52 | 237.18 | 37.01 | **5401.34** |
| Water Elev (ft) | 50.75 | 45.80 | 45.45 | 45.10 | 43.65 | 42.20 | 46.75 | 51.30 | 56.20 | 61.10 | 64.20 | 67.30 | |
| Surface area (acres) | 136.33 | 62.46 | 62.46 | 103.89 | 108.90 | 111.67 | 129.81 | 155.87 | 162.13 | 165.10 | 164.15 | 167.36 | |

| Water Year 1998-1999 | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pg (in) | 0.00 | 0.00 | 0.11 | 0.11 | 0.85 | 0.63 | 1.91 | 0.80 | 2.79 | 2.48 | 0.03 | 0.24 | 9.95 |
| Qprec (af) | 0.00 | 0.00 | 1.95 | 1.95 | 15.09 | 11.19 | 33.92 | 14.21 | 49.55 | 44.04 | 0.53 | 4.26 | 176.70 |
| Qrunoff-UWCD (af) | 0.00 | 0.00 | 0.00 | 67.84 | 203.52 | 339.20 | 678.40 | 678.40 | 678.40 | 508.80 | 169.60 | 67.84 | 3392.00 |
| Epan (in) | 7.37 | 7.28 | 5.24 | 5.68 | 3.71 | 4.10 | 3.89 | 3.78 | 4.63 | 5.87 | 5.94 | 6.51 | 64.00 |
| AEsoil (in) | 0.10 | 0.00 | 0.11 | 0.11 | 0.85 | 0.63 | 1.36 | 1.32 | 1.62 | 2.05 | 1.65 | 0.24 | 10.05 |
| AElake(in) | 5.53 | 5.46 | 3.93 | 4.26 | 2.78 | 3.08 | 2.92 | 2.84 | 3.47 | 4.40 | 4.46 | 4.88 | 48.00 |
| Qelake(af) | 75.85 | 74.93 | 53.25 | 56.86 | 38.61 | 44.20 | 43.25 | 42.02 | 52.16 | 65.55 | 64.13 | 68.09 | 678.91 |
| SM1 (in) | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.03 | 1.20 | 1.62 | 0.00 | 3.49 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.03 | 1.20 | 1.62 | 0.00 | 0.00 | 3.39 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | -75.85 | -74.93 | -51.76 | 12.45 | 176.70 | 304.05 | 663.47 | 648.24 | 668.15 | 480.18 | 105.91 | 3.09 | **2859.69** |
| Water Elev (ft) | 66.90 | 66.50 | 65.15 | 63.80 | 66.10 | 68.40 | 69.55 | 70.70 | 71.20 | 71.70 | 69.65 | 67.60 | |
| Surface area (acres) | 164.68 | 164.68 | 162.61 | 160.16 | 166.52 | 172.51 | 177.87 | 177.87 | 180.26 | 178.67 | 172.73 | 167.36 | |

# ATTACHMENT 6
# POST-PROJECT CONDITIONS WATER BALANCE
## Riverpark A and B Irrigated Areage

RiverPark Irrigated Pervious Area = 446.1 acres

Demand Factor Applied to Park Land Use = 1,500 gal/acre/day = 0.004602 AF/acre/day

% Area of Park Land Use Considered Pervious = 77%

Demand Factor Applied to Pervious Irrigated Area = 0.004602 / .77 * 365 = 2.1815 AF/acre/year

(Reference: Pervious/Impervious Areas, Riverpark Draft Specific Plan Summary, AC Martin Partners, Inc., May 8, 2001
and Proposed Land Use Program, Riverpark Draft Specific Plan, 2000)

| **Pervious Irrigated Area** | **Pervious Area Water Demand** | **Average Total Annual Demand** | **80% Consumptive Use** | **20% Recharge to GW** |
|---|---|---|---|---|
| (acres) | (AF/acre/year) | (AF) | (AF) | (AF) |
| | | | | |
| 446.10 | 2.1815 | 973.17 | 778.53 | **194.63** |

| Date | Daily Precipitation | Date | Daily Precipitation | Date | Daily Precipitation | Date | Daily Precipitation |
|---|---|---|---|---|---|---|---|
| 12/6/97 | 4.98 | 3/2/81 | 1.45 | 12/11/84 | 1.05 | 3/5/95 | 0.75 |
| 2/17/80 | 2.94 | 4/12/99 | 1.45 | 3/27/91 | 1.03 | 9/26/82 | 0.74 |
| 2/15/86 | 2.81 | 3/1/81 | 1.44 | 1/19/83 | 1.02 | 2/4/89 | 0.73 |
| 3/26/93 | 2.77 | 2/13/92 | 1.44 | 1/6/92 | 1.02 | 2/7/92 | 0.73 |
| 1/5/95 | 2.69 | 2/15/80 | 1.42 | 3/15/82 | 1 | 2/26/81 | 0.72 |
| 1/23/83 | 2.67 | 2/4/98 | 1.41 | 2/26/93 | 1 | 12/22/82 | 0.72 |
| 2/20/96 | 2.54 | 1/5/86 | 1.4 | 2/20/94 | 1 | 1/29/98 | 0.72 |
| 2/28/91 | 2.5 | 1/8/93 | 1.4 | 11/9/84 | 0.99 | 11/25/84 | 0.71 |
| 12/7/92 | 2.5 | 3/4/81 | 1.39 | 2/12/92 | 0.99 | 1/4/87 | 0.71 |
| 12/11/96 | 2.48 | 11/18/86 | 1.38 | 2/14/87 | 0.98 | 12/17/87 | 0.71 |
| 1/11/80 | 2.45 | 1/25/95 | 1.38 | 3/9/86 | 0.97 | 5/28/90 | 0.71 |
| 2/11/92 | 2.39 | 1/13/93 | 1.34 | 1/14/90 | 0.97 | 12/29/91 | 0.71 |
| 2/19/93 | 2.37 | 1/10/98 | 1.33 | 11/29/85 | 0.96 | 4/20/83 | 0.7 |
| 2/21/96 | 2.28 | 2/24/98 | 1.33 | 2/17/90 | 0.96 | 12/4/83 | 0.7 |
| 2/2/98 | 2.27 | 1/9/80 | 1.31 | 12/23/82 | 0.95 | 12/10/83 | 0.7 |
| 2/18/80 | 2.26 | 1/18/93 | 1.31 | 2/23/98 | 0.94 | 2/19/86 | 0.7 |
| 1/24/95 | 2.2 | 12/4/80 | 1.3 | 12/20/84 | 0.93 | 1/7/93 | 0.7 |
| 3/11/95 | 2.2 | 12/5/87 | 1.28 | 1/25/99 | 0.93 | 3/26/99 | 0.7 |
| 3/3/80 | 2.17 | 1/21/82 | 1.27 | 12/16/88 | 0.92 | 4/24/83 | 0.69 |
| 11/25/85 | 2.13 | 12/8/84 | 1.26 | 1/3/95 | 0.92 | 1/5/87 | 0.69 |
| 12/25/83 | 2.09 | 3/10/86 | 1.25 | 10/23/87 | 0.91 | 3/3/92 | 0.69 |
| 1/30/86 | 2.09 | 2/9/89 | 1.25 | 11/21/96 | 0.91 | 1/20/82 | 0.68 |
| 2/8/93 | 2.09 | 2/17/98 | 1.25 | 12/19/97 | 0.91 | 6/5/93 | 0.68 |
| 3/1/83 | 2.07 | 3/23/92 | 1.24 | 4/12/82 | 0.9 | 2/14/98 | 0.68 |
| 2/7/98 | 2.05 | 2/1/96 | 1.24 | 3/25/94 | 0.9 | 2/1/86 | 0.67 |
| 12/25/79 | 2.02 | 3/6/87 | 1.23 | 1/23/97 | 0.9 | 5/6/98 | 0.67 |
| 2/3/98 | 2 | 2/7/94 | 1.23 | 2/20/98 | 0.9 | 3/21/83 | 0.66 |
| 3/18/91 | 1.91 | 12/13/95 | 1.23 | 2/10/92 | 0.89 | 3/20/91 | 0.66 |
| 2/6/98 | 1.87 | 11/10/82 | 1.21 | 11/2/83 | 0.85 | 2/8/98 | 0.66 |
| 10/1/83 | 1.86 | 11/8/79 | 1.18 | 2/15/92 | 0.85 | 10/29/81 | 0.65 |
| 1/29/80 | 1.82 | 3/3/95 | 1.17 | 2/22/98 | 0.84 | 1/7/95 | 0.64 |
| 3/19/91 | 1.79 | 10/30/96 | 1.15 | 2/20/80 | 0.83 | 10/30/92 | 0.63 |
| 12/10/96 | 1.77 | 2/21/80 | 1.14 | 9/30/83 | 0.83 | 3/25/91 | 0.62 |
| 1/10/95 | 1.75 | 2/8/83 | 1.13 | 2/23/93 | 0.83 | 12/23/95 | 0.62 |
| 3/6/95 | 1.74 | 11/10/94 | 1.13 | 1/4/95 | 0.83 | 4/12/98 | 0.62 |
| 12/28/91 | 1.71 | 1/17/88 | 1.12 | 3/13/96 | 0.83 | 3/15/99 | 0.62 |
| 3/1/91 | 1.7 | 1/16/93 | 1.12 | 8/20/83 | 0.82 | 1/9/95 | 0.61 |
| 2/13/86 | 1.67 | 3/20/94 | 1.12 | 11/25/83 | 0.82 | 1/12/95 | 0.61 |
| 11/22/96 | 1.67 | 3/21/95 | 1.12 | 2/27/83 | 0.81 | 12/30/81 | 0.6 |
| 2/26/83 | 1.65 | 3/21/92 | 1.11 | 4/7/86 | 0.8 | 1/9/85 | 0.59 |
| 2/20/93 | 1.64 | 1/28/81 | 1.1 | 1/18/88 | 0.8 | 3/28/93 | 0.59 |
| 3/25/98 | 1.64 | 9/25/86 | 1.09 | 12/12/93 | 0.8 | 2/4/94 | 0.59 |
| 2/15/98 | 1.54 | 5/13/98 | 1.09 | 12/25/94 | 0.8 | 4/1/82 | 0.58 |
| 11/30/82 | 1.53 | 12/30/91 | 1.08 | 1/26/97 | 0.79 | 2/3/83 | 0.58 |
| 2/9/85 | 1.53 | 2/9/81 | 1.07 | 3/24/83 | 0.77 | 3/1/88 | 0.58 |
| 1/11/95 | 1.51 | 11/28/81 | 1.07 | 12/21/88 | 0.76 | 1/13/90 | 0.57 |
| 1/27/83 | 1.47 | 3/17/82 | 1.07 | 2/16/80 | 0.75 | 2/14/95 | 0.57 |
| 3/16/86 | 1.47 | 3/20/81 | 1.06 | 11/19/82 | 0.75 | 3/26/98 | 0.57 |
| 4/20/88 | 1.47 | 1/29/83 | 1.06 | 12/12/83 | 0.75 | 2/22/96 | 0.56 |
| 2/17/94 | 1.47 | 4/18/83 | 1.05 | 11/1/87 | 0.75 | 3/20/99 | 0.56 |

Note: Only non-zero data reported.

| Date | Daily Precipitation | Date | Daily Precipitation | Date | Daily Precipitation | Date | Daily Precipitation |
|---|---|---|---|---|---|---|---|
| 11/27/81 | 0.55 | 3/23/95 | 0.42 | 1/10/91 | 0.34 | 10/7/83 | 0.25 |
| 11/11/83 | 0.55 | 11/11/97 | 0.42 | 3/26/80 | 0.33 | 3/15/87 | 0.25 |
| 10/11/93 | 0.55 | 5/5/98 | 0.42 | 5/4/98 | 0.33 | 4/18/96 | 0.25 |
| 4/16/95 | 0.55 | 1/31/99 | 0.42 | 1/28/83 | 0.32 | 4/29/80 | 0.24 |
| 4/29/83 | 0.54 | 1/24/83 | 0.41 | 4/6/86 | 0.32 | 4/24/84 | 0.24 |
| 12/16/87 | 0.52 | 11/20/90 | 0.41 | 1/24/89 | 0.32 | 11/28/84 | 0.24 |
| 10/5/83 | 0.51 | 3/6/92 | 0.41 | 1/6/93 | 0.32 | 1/19/93 | 0.24 |
| 11/12/83 | 0.51 | 1/17/96 | 0.41 | 2/3/96 | 0.32 | 11/11/93 | 0.24 |
| 2/14/86 | 0.51 | 12/28/96 | 0.41 | 3/14/96 | 0.32 | 1/28/96 | 0.24 |
| 1/3/97 | 0.51 | 1/5/98 | 0.41 | 4/7/99 | 0.32 | 11/13/97 | 0.24 |
| 2/8/89 | 0.5 | 11/8/98 | 0.41 | 3/23/83 | 0.31 | 3/26/82 | 0.23 |
| 11/26/89 | 0.5 | 11/9/82 | 0.4 | 2/25/87 | 0.31 | 10/31/92 | 0.23 |
| 11/30/97 | 0.5 | 1/15/90 | 0.4 | 2/29/88 | 0.31 | 5/7/94 | 0.23 |
| 2/14/80 | 0.49 | 1/5/82 | 0.39 | 2/18/90 | 0.31 | 2/9/95 | 0.23 |
| 11/13/84 | 0.49 | 4/30/83 | 0.39 | 1/5/92 | 0.31 | 12/23/96 | 0.23 |
| 12/16/84 | 0.49 | 3/27/85 | 0.39 | 1/15/93 | 0.31 | 1/13/98 | 0.23 |
| 5/15/95 | 0.49 | 12/2/85 | 0.39 | 2/9/93 | 0.31 | 1/19/98 | 0.23 |
| 11/16/97 | 0.49 | 11/14/88 | 0.39 | 2/9/99 | 0.31 | 11/28/98 | 0.23 |
| 12/1/97 | 0.49 | 12/15/93 | 0.39 | 1/30/81 | 0.3 | 11/14/81 | 0.22 |
| 4/1/98 | 0.49 | 1/22/97 | 0.39 | 3/14/83 | 0.3 | 3/11/86 | 0.22 |
| 12/29/92 | 0.48 | 1/12/80 | 0.38 | 3/17/83 | 0.3 | 3/20/92 | 0.22 |
| 3/19/94 | 0.48 | 3/3/83 | 0.38 | 10/17/84 | 0.3 | 12/19/93 | 0.22 |
| 3/28/98 | 0.48 | 11/26/85 | 0.38 | 3/12/86 | 0.3 | 3/6/94 | 0.22 |
| 9/30/79 | 0.47 | 12/30/87 | 0.38 | 12/18/92 | 0.3 | 1/15/95 | 0.22 |
| 10/20/79 | 0.47 | 12/8/92 | 0.38 | 11/8/94 | 0.3 | 3/11/99 | 0.22 |
| 1/7/87 | 0.47 | 2/10/99 | 0.38 | 1/29/85 | 0.29 | 3/16/99 | 0.22 |
| 1/25/94 | 0.47 | 3/18/83 | 0.37 | 12/3/85 | 0.29 | 10/1/81 | 0.21 |
| 1/13/97 | 0.47 | 12/8/91 | 0.37 | 2/18/86 | 0.29 | 12/6/86 | 0.21 |
| 11/29/82 | 0.46 | 1/21/95 | 0.37 | 3/25/89 | 0.29 | 11/6/87 | 0.21 |
| 3/2/89 | 0.46 | 1/31/96 | 0.37 | 12/28/92 | 0.29 | 12/18/88 | 0.21 |
| 2/1/98 | 0.46 | 1/2/97 | 0.37 | 4/26/94 | 0.29 | 3/2/92 | 0.21 |
| 1/14/80 | 0.45 | 12/2/98 | 0.37 | 5/16/95 | 0.29 | 2/24/93 | 0.21 |
| 3/12/82 | 0.45 | 1/15/80 | 0.36 | 12/12/96 | 0.29 | 1/23/95 | 0.21 |
| 2/10/87 | 0.44 | 10/31/82 | 0.36 | 11/26/97 | 0.29 | 1/26/95 | 0.21 |
| 1/15/97 | 0.44 | 2/2/88 | 0.36 | 2/16/86 | 0.28 | 4/2/96 | 0.21 |
| 2/5/98 | 0.44 | 2/28/88 | 0.36 | 3/22/87 | 0.28 | 6/2/99 | 0.21 |
| 1/10/80 | 0.43 | 11/25/88 | 0.36 | 3/4/83 | 0.27 | 3/16/82 | 0.2 |
| 1/23/81 | 0.43 | 3/25/93 | 0.36 | 1/6/89 | 0.27 | 3/2/83 | 0.2 |
| 3/2/82 | 0.43 | 2/28/96 | 0.36 | 1/14/93 | 0.27 | 3/17/84 | 0.2 |
| 2/4/90 | 0.43 | 2/28/83 | 0.35 | 2/18/94 | 0.27 | 9/11/84 | 0.2 |
| 1/4/91 | 0.43 | 3/28/85 | 0.35 | 2/8/95 | 0.27 | 1/4/86 | 0.2 |
| 1/8/92 | 0.43 | 4/15/88 | 0.35 | 6/17/95 | 0.27 | 1/31/86 | 0.2 |
| 11/30/93 | 0.43 | 3/5/91 | 0.35 | 4/5/98 | 0.27 | 1/6/88 | 0.2 |
| 4/6/99 | 0.43 | 3/26/91 | 0.35 | 1/29/81 | 0.26 | 12/23/88 | 0.2 |
| 1/25/83 | 0.42 | 2/8/94 | 0.35 | 2/6/83 | 0.26 | 10/4/94 | 0.2 |
| 10/22/85 | 0.42 | 3/12/95 | 0.35 | 3/14/86 | 0.26 | 11/26/94 | 0.2 |
| 10/29/87 | 0.42 | 3/6/98 | 0.35 | 1/5/88 | 0.26 | 1/21/97 | 0.2 |
| 4/24/88 | 0.42 | 2/19/80 | 0.34 | 2/6/92 | 0.26 | 3/5/80 | 0.19 |
| 12/25/88 | 0.42 | 3/18/82 | 0.34 | 3/27/92 | 0.26 | 4/11/82 | 0.19 |
| 12/4/92 | 0.42 | 11/11/85 | 0.34 | 1/22/83 | 0.25 | 2/13/83 | 0.19 |

Note: Only non-zero data reported.

| Date | Daily Precipitation | Date | Daily Precipitation | Date | Daily Precipitation | Date | Daily Precipitation |
|---|---|---|---|---|---|---|---|
| 1/17/84 | 0.19 | 4/17/96 | 0.14 | 1/27/97 | 0.09 | 7/16/87 | 0.05 |
| 11/24/88 | 0.19 | 11/27/97 | 0.14 | 5/3/98 | 0.09 | 11/4/87 | 0.05 |
| 12/30/92 | 0.19 | 12/6/98 | 0.14 | 9/3/98 | 0.09 | 11/18/87 | 0.05 |
| 10/5/94 | 0.19 | 1/1/82 | 0.13 | 10/22/89 | 0.08 | 2/27/88 | 0.05 |
| 3/2/95 | 0.19 | 3/6/83 | 0.13 | 2/16/92 | 0.08 | 9/16/89 | 0.05 |
| 3/14/84 | 0.18 | 5/1/83 | 0.13 | 4/9/94 | 0.08 | 1/9/91 | 0.05 |
| 1/2/93 | 0.18 | 8/15/83 | 0.13 | 9/23/94 | 0.08 | 4/1/92 | 0.05 |
| 2/28/93 | 0.18 | 11/20/83 | 0.13 | 9/24/94 | 0.08 | 2/19/94 | 0.05 |
| 1/20/99 | 0.18 | 10/28/87 | 0.13 | 12/22/96 | 0.08 | 3/24/95 | 0.05 |
| 3/9/99 | 0.18 | 11/5/87 | 0.13 | 12/18/97 | 0.08 | 1/22/96 | 0.05 |
| 5/22/80 | 0.17 | 12/7/87 | 0.13 | 3/21/99 | 0.08 | 3/4/96 | 0.05 |
| 2/11/82 | 0.17 | 2/5/89 | 0.13 | 3/28/83 | 0.07 | 5/16/96 | 0.05 |
| 4/19/83 | 0.17 | 3/3/89 | 0.13 | 9/12/84 | 0.07 | 12/31/96 | 0.05 |
| 11/13/83 | 0.17 | 3/14/98 | 0.13 | 3/18/85 | 0.07 | 11/20/97 | 0.05 |
| 2/2/85 | 0.17 | 1/18/80 | 0.12 | 2/26/87 | 0.07 | 12/7/97 | 0.05 |
| 2/8/92 | 0.17 | 11/15/81 | 0.12 | 10/31/87 | 0.07 | 1/16/98 | 0.05 |
| 12/11/92 | 0.17 | 2/24/83 | 0.12 | 1/2/90 | 0.07 | 2/8/99 | 0.05 |
| 2/27/93 | 0.17 | 12/3/84 | 0.12 | 1/4/92 | 0.07 | 4/11/99 | 0.05 |
| 12/13/94 | 0.17 | 3/7/85 | 0.12 | 1/10/93 | 0.07 | 2/28/81 | 0.04 |
| 11/29/98 | 0.17 | 12/20/88 | 0.12 | 6/16/95 | 0.07 | 1/27/82 | 0.04 |
| 3/25/99 | 0.17 | 2/18/93 | 0.12 | 1/16/97 | 0.07 | 3/19/82 | 0.04 |
| 3/4/80 | 0.16 | 4/8/99 | 0.12 | 1/9/98 | 0.07 | 3/27/82 | 0.04 |
| 4/26/89 | 0.16 | 11/17/84 | 0.11 | 1/8/80 | 0.06 | 9/15/82 | 0.04 |
| 10/27/91 | 0.16 | 1/7/85 | 0.11 | 1/28/80 | 0.06 | 12/29/82 | 0.04 |
| 1/3/92 | 0.16 | 11/30/85 | 0.11 | 3/23/81 | 0.06 | 12/29/87 | 0.04 |
| 10/22/92 | 0.16 | 2/15/87 | 0.11 | 4/2/82 | 0.06 | 12/31/88 | 0.04 |
| 1/17/93 | 0.16 | 3/5/87 | 0.11 | 11/23/82 | 0.06 | 4/25/89 | 0.04 |
| 1/27/99 | 0.16 | 5/11/89 | 0.11 | 4/6/83 | 0.06 | 2/14/92 | 0.04 |
| 9/29/79 | 0.15 | 10/23/89 | 0.11 | 12/18/84 | 0.06 | 1/8/95 | 0.04 |
| 4/22/80 | 0.15 | 3/22/92 | 0.11 | 1/8/85 | 0.06 | 3/28/96 | 0.04 |
| 12/26/83 | 0.15 | 1/11/93 | 0.11 | 12/30/85 | 0.06 | 11/23/96 | 0.04 |
| 3/8/86 | 0.15 | 11/1/95 | 0.11 | 9/24/86 | 0.06 | 1/12/97 | 0.04 |
| 1/1/89 | 0.15 | 3/5/96 | 0.11 | 7/17/87 | 0.06 | 1/25/97 | 0.04 |
| 1/5/91 | 0.15 | 4/4/98 | 0.11 | 4/19/88 | 0.06 | 11/10/97 | 0.04 |
| 3/10/95 | 0.15 | 10/25/98 | 0.11 | 12/17/88 | 0.06 | 11/14/97 | 0.04 |
| 2/2/96 | 0.15 | 1/17/80 | 0.1 | 3/2/91 | 0.06 | 5/2/98 | 0.04 |
| 12/27/96 | 0.15 | 4/18/81 | 0.1 | 7/13/92 | 0.06 | 11/11/98 | 0.04 |
| 1/26/99 | 0.15 | 12/21/81 | 0.1 | 5/17/96 | 0.06 | 1/21/99 | 0.04 |
| 3/3/81 | 0.14 | 5/25/93 | 0.1 | 1/5/97 | 0.06 | 1/13/80 | 0.03 |
| 3/14/82 | 0.14 | 3/7/94 | 0.1 | 2/11/97 | 0.06 | 5/21/80 | 0.03 |
| 2/7/83 | 0.14 | 2/25/96 | 0.1 | 4/2/98 | 0.06 | 1/11/81 | 0.03 |
| 10/2/83 | 0.14 | 5/12/98 | 0.1 | 1/16/80 | 0.05 | 4/19/81 | 0.03 |
| 11/12/85 | 0.14 | 12/1/98 | 0.1 | 5/1/80 | 0.05 | 3/29/82 | 0.03 |
| 3/17/86 | 0.14 | 4/9/99 | 0.1 | 2/16/82 | 0.05 | 3/30/82 | 0.03 |
| 1/17/90 | 0.14 | 11/17/79 | 0.09 | 3/11/82 | 0.05 | 10/26/82 | 0.03 |
| 11/26/90 | 0.14 | 3/5/81 | 0.09 | 9/9/82 | 0.05 | 3/19/83 | 0.03 |
| 3/14/91 | 0.14 | 2/8/82 | 0.09 | 9/16/82 | 0.05 | 12/19/84 | 0.03 |
| 11/18/91 | 0.14 | 12/10/82 | 0.09 | 8/16/84 | 0.05 | 12/27/84 | 0.03 |
| 12/14/95 | 0.14 | 2/8/86 | 0.09 | 1/10/85 | 0.05 | 5/31/86 | 0.03 |
| 1/19/96 | 0.14 | 1/31/90 | 0.09 | 3/13/86 | 0.05 | 12/20/86 | 0.03 |

Note: Only non-zero data reported.

| Date | Daily Precipitation | Date | Daily Precipitation | Date | Daily Precipitation | Date | Daily Precipitation |
|---|---|---|---|---|---|---|---|
| 3/13/87 | 0.03 | 1/13/95 | 0.02 | 7/23/86 | 0.01 | | |
| 6/6/87 | 0.03 | 1/14/95 | 0.02 | 6/7/87 | 0.01 | | |
| 10/12/87 | 0.03 | 3/4/95 | 0.02 | 11/2/87 | 0.01 | | |
| 2/10/89 | 0.03 | 1/25/96 | 0.02 | 2/3/88 | 0.01 | | |
| 9/17/89 | 0.03 | 2/16/96 | 0.02 | 11/11/88 | 0.01 | | |
| 4/4/90 | 0.03 | 2/19/96 | 0.02 | 11/26/88 | 0.01 | | |
| 7/12/92 | 0.03 | 3/29/96 | 0.02 | 2/1/90 | 0.01 | | |
| 11/23/93 | 0.03 | 1/24/97 | 0.02 | 1/3/91 | 0.01 | | |
| 4/17/95 | 0.03 | 9/26/97 | 0.02 | 2/20/92 | 0.01 | | |
| 3/22/96 | 0.03 | 12/8/97 | 0.02 | 3/26/92 | 0.01 | | |
| 10/31/96 | 0.03 | 1/3/98 | 0.02 | 4/3/92 | 0.01 | | |
| 12/30/96 | 0.03 | 6/17/98 | 0.02 | 10/24/92 | 0.01 | | |
| 1/1/97 | 0.03 | 9/4/98 | 0.02 | 12/5/92 | 0.01 | | |
| 1/14/97 | 0.03 | 12/4/98 | 0.02 | 5/18/94 | 0.01 | | |
| 1/19/99 | 0.03 | 3/12/99 | 0.02 | 2/10/95 | 0.01 | | |
| 2/1/99 | 0.03 | 3/24/99 | 0.02 | 1/26/96 | 0.01 | | |
| 2/5/99 | 0.03 | 10/26/79 | 0.01 | 11/18/96 | 0.01 | | |
| 5/23/99 | 0.03 | 11/4/79 | 0.01 | 12/13/96 | 0.01 | | |
| 6/3/99 | 0.03 | 12/21/79 | 0.01 | 9/2/97 | 0.01 | | |
| 2/13/80 | 0.02 | 3/22/80 | 0.01 | 9/25/97 | 0.01 | | |
| 5/2/80 | 0.02 | 3/19/81 | 0.01 | 12/15/97 | 0.01 | | |
| 5/10/80 | 0.02 | 3/21/81 | 0.01 | 4/13/99 | 0.01 | | |
| 12/5/80 | 0.02 | 4/24/81 | 0.01 | | | | |
| 2/10/81 | 0.02 | 10/22/81 | 0.01 | | | | |
| 3/22/81 | 0.02 | 1/29/82 | 0.01 | | | | |
| 4/20/81 | 0.02 | 2/15/82 | 0.01 | | | | |
| 4/25/81 | 0.02 | 9/24/82 | 0.01 | | | | |
| 10/23/81 | 0.02 | 9/27/82 | 0.01 | | | | |
| 12/8/81 | 0.02 | 10/25/82 | 0.01 | | | | |
| 2/10/82 | 0.02 | 12/1/82 | 0.01 | | | | |
| 3/31/82 | 0.02 | 12/30/82 | 0.01 | | | | |
| 10/27/82 | 0.02 | 3/7/83 | 0.01 | | | | |
| 3/25/83 | 0.02 | 3/8/83 | 0.01 | | | | |
| 9/29/83 | 0.02 | 5/26/83 | 0.01 | | | | |
| 11/17/83 | 0.02 | 6/8/83 | 0.01 | | | | |
| 12/28/84 | 0.02 | 8/14/83 | 0.01 | | | | |
| 1/6/86 | 0.02 | 11/1/83 | 0.01 | | | | |
| 4/30/87 | 0.02 | 11/18/83 | 0.01 | | | | |
| 10/24/87 | 0.02 | 12/17/83 | 0.01 | | | | |
| 9/20/88 | 0.02 | 2/16/84 | 0.01 | | | | |
| 1/4/89 | 0.02 | 4/6/84 | 0.01 | | | | |
| 8/13/91 | 0.02 | 10/8/84 | 0.01 | | | | |
| 2/9/92 | 0.02 | 11/29/84 | 0.01 | | | | |
| 4/2/92 | 0.02 | 12/4/84 | 0.01 | | | | |
| 10/21/92 | 0.02 | 3/6/85 | 0.01 | | | | |
| 1/9/93 | 0.02 | 9/26/85 | 0.01 | | | | |
| 1/23/94 | 0.02 | 10/6/85 | 0.01 | | | | |
| 4/27/94 | 0.02 | 2/12/86 | 0.01 | | | | |
| 5/8/94 | 0.02 | 3/1/86 | 0.01 | | | | |
| 9/29/94 | 0.02 | 4/12/86 | 0.01 | | | | |

Note: Only non-zero data reported.

# ATTACHMENT 8
# POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
## Juvenile Justice Complex Detention Basin
## Water Years 1979-1980 through 1998-1999

### Data used for calculations:

Soil Evaporation Depth: 30 inches

Soil Moisture Holding Capacity: 5.40 inches (0.18 in/in * 30 in)

Total Detention Basin Area: 1.12 acres

Total Area of JJC Contributing Runoff into Detention Basin: 37.68 acres (JJC Hydrol. Exhibit B, Jensen Design)

Runoff Factor: 0.5

Soil Factor on Pan Evaporation: 0.35

### Definition of terms:

Pg = Precipitation (inches). Station 239E El Rio - UWCD (7/1/79 - 6/30/99)

Qrunoff = Water yield generated from JJC area runoff draining into detention basin (acre-feet). Qrunoff = (Pg*.42/12)*47.08

Epan = Pan Evaporation (inches) at El Rio from 1985-1999. Monthly averages used for 1979-1985.

PEsoil = Potential soil evaporation (inches). Epan * 0.35

AEsoil = Actual soil evaporation (inches).

If (Pg + Qrunoff*12/1.12 + SM1 - PEsoil) > 0; AEsoil = PEsoil.

If (Pg + Qrunoff*12/1.12 + SM1 - PEsoil) $\leq$ 0; AEsoil = Pg + Qrunoff*12/1.12 + SM1.

SM1 = Soil moisture at the beginning of the month (inches). SM1 = SM2 from previous month

SM2 = Soil moisture at end of the month (inches).

If (Pg + Qrunoff*12/1.12 + SM1 - AEsoil) < 5.4; SM2 = Pg + Qrunoff*12/1.12 + SM1 - AEsoil.

If (Pg + Qrunoff*12/1.12 + SM1 - AEsoil) $\geq$ 5.4; SM2 = 5.4.

If (Pg + Qrunoff*12/1.12 + SM1 - AEsoil) $\leq$ 0; SM2 = 0.0.

Qsoil = Groundwater Recharge (inches).

If (Pg + Qrunoff*12/1.12 - AEsoil - (SM2 - SM1) > 0; Qsoil = Pg + Qrunoff*12/1.12 + AEsoil - SM2 - SM1).

If (Pg + Qrunoff*12/1.12 - AEsoil - (SM2 - SM1) $\leq$ 0; Qsoil = 0

Qtotal = Total groundwater recharge from detention basin (acre-feet).

Qtotal = (Qsoil/12) * Total Detention Basin Area

| **Water Year 1979-1980** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **TOTAL** |
| **Pg (in)** | 0.00 | 0.00 | 0.62 | 0.48 | 1.28 | 2.03 | 7.62 | 10.19 | 2.86 | 0.39 | 0.29 | 0.00 | 25.76 |
| **Qrunoff (af)** | 0.00 | 0.00 | 0.97 | 0.75 | 2.01 | 3.19 | 11.96 | 16.00 | 4.49 | 0.61 | 0.46 | 0.00 | 40.44 |
| **Epan (in)** | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| **PEsoil(in)** | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| **AEsoil (in)** | 0.00 | 0.00 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 16.62 |
| **SM1 (in)** | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 48.60 |
| **SM2 (in)** | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.24 | 51.84 |
| **Qsoil (in)** | 0.00 | 0.00 | 3.76 | 6.83 | 21.31 | 34.85 | 134.63 | 180.37 | 49.43 | 5.01 | 3.05 | 0.00 | 439.23 |
| **Qtotal (af)** | 0.00 | 0.00 | 0.35 | 0.64 | 1.99 | 3.25 | 12.57 | 16.83 | 4.61 | 0.47 | 0.28 | 0.00 | **40.99** |
| **Water Year 1980-1981** | | | | | | | | | | | | | |
| | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **TOTAL** |
| **Pg (in)** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 2.12 | 1.85 | 5.67 | 0.18 | 0.00 | 0.00 | 11.14 |
| **Qrunoff (af)** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.07 | 3.33 | 2.90 | 8.90 | 0.28 | 0.00 | 0.00 | 17.49 |
| **Epan (in)** | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| **PEsoil(in)** | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| **AEsoil (in)** | 2.33 | 0.90 | 0.00 | 0.00 | 0.00 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 14.73 |
| **SM1 (in)** | 3.24 | 0.90 | 0.00 | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.28 | 34.42 |
| **SM2 (in)** | 0.90 | 0.00 | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.28 | 1.12 | 32.30 |
| **Qsoil (in)** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 16.80 | 36.61 | 31.74 | 99.50 | 1.27 | 0.00 | 0.00 | 185.92 |
| **Qtotal (af)** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.57 | 3.42 | 2.96 | 9.29 | 0.12 | 0.00 | 0.00 | **17.35** |

ATTACHMENT 8
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Detention Basin
Water Years 1979-1980 through 1998-1999

| Water Year 1981-1982 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.89 | 1.96 | 0.72 | 2.52 | 0.34 | 4.07 | 1.73 | 0.00 | 0.00 | 12.23 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 1.40 | 3.08 | 1.13 | 3.96 | 0.53 | 6.39 | 2.72 | 0.00 | 0.00 | 19.20 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 1.12 | 0.00 | 0.00 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 15.84 |
| SM1 (in) | 1.12 | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.28 | 42.20 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.28 | 1.12 | 42.20 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 8.73 | 33.43 | 11.51 | 43.74 | 4.83 | 70.99 | 28.89 | 0.00 | 0.00 | 202.12 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.81 | 3.12 | 1.07 | 4.08 | 0.45 | 6.63 | 2.70 | 0.00 | 0.00 | **18.86** |
| **Water Year 1982-1983** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.90 | 0.42 | 4.41 | 1.82 | 7.62 | 5.23 | 5.90 | 3.60 | 0.14 | 0.01 | 30.05 |
| Qrunoff (af) | 0.00 | 0.00 | 1.41 | 0.66 | 6.92 | 2.86 | 11.96 | 8.21 | 9.26 | 5.65 | 0.22 | 0.02 | 47.18 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 1.12 | 0.00 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 17.73 |
| SM1 (in) | 1.12 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 49.72 |
| SM2 (in) | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.42 | 52.02 |
| Qsoil (in) | 0.00 | 0.00 | 8.75 | 5.76 | 77.09 | 31.11 | 134.63 | 91.98 | 103.60 | 62.22 | 0.37 | 0.00 | 515.50 |
| Qtotal (af) | 0.00 | 0.00 | 0.82 | 0.54 | 7.19 | 2.90 | 12.57 | 8.58 | 9.67 | 5.81 | 0.03 | 0.00 | **48.11** |
| **Water Year 1983-1984** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.96 | 0.85 | 2.76 | 3.07 | 4.40 | 0.19 | 0.01 | 0.38 | 0.25 | 0.00 | 0.00 | 12.87 |
| Qrunoff (af) | 0.00 | 1.51 | 1.33 | 4.33 | 4.82 | 6.91 | 0.30 | 0.02 | 0.60 | 0.39 | 0.00 | 0.00 | 20.21 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| SM1 (in) | 3.42 | 1.08 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 4.35 | 5.40 | 5.40 | 3.28 | 55.32 |
| SM2 (in) | 1.08 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 4.35 | 5.40 | 5.40 | 3.28 | 1.12 | 53.03 |
| Qsoil (in) | 0.00 | 10.53 | 13.25 | 47.46 | 53.21 | 77.09 | 2.21 | 0.00 | 4.18 | 2.52 | 0.00 | 0.00 | 210.45 |
| Qtotal (af) | 0.00 | 0.98 | 1.24 | 4.43 | 4.97 | 7.20 | 0.21 | 0.00 | 0.39 | 0.23 | 0.00 | 0.00 | **19.64** |
| **Water Year 1984-1985** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.05 | 0.27 | 0.31 | 2.55 | 4.00 | 1.10 | 1.70 | 0.94 | 0.00 | 0.00 | 0.00 | 10.92 |
| Qrunoff (af) | 0.00 | 0.08 | 0.42 | 0.49 | 4.00 | 6.28 | 1.73 | 2.67 | 1.48 | 0.00 | 0.00 | 0.00 | 17.14 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.81 | 4.74 | 4.96 | 5.72 | 7.17 | 7.96 | 65.92 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 2.00 | 2.51 | 2.79 | 23.07 |
| AEsoil (in) | 1.12 | 0.89 | 1.89 | 1.73 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 2.00 | 2.51 | 0.89 | 18.59 |
| SM1 (in) | 1.12 | 0.00 | 0.00 | 2.92 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.40 | 0.89 | 40.72 |
| SM2 (in) | 0.00 | 0.00 | 2.92 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.40 | 0.89 | 0.00 | 39.60 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 1.31 | 43.94 | 69.96 | 18.27 | 28.64 | 15.02 | 0.00 | 0.00 | 0.00 | 177.14 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.12 | 4.10 | 6.53 | 1.71 | 2.67 | 1.40 | 0.00 | 0.00 | 0.00 | **16.53** |

ATTACHMENT 8
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Detention Basin
Water Years 1979-1980 through 1998-1999

| Water Year 1985-1986 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.01 | 0.43 | 4.06 | 0.74 | 3.91 | 7.03 | 4.82 | 1.13 | 0.03 | 0.00 | 22.16 |
| Qrunoff (af) | 0.00 | 0.00 | 0.02 | 0.68 | 6.37 | 1.16 | 6.14 | 11.04 | 7.57 | 1.77 | 0.05 | 0.00 | 34.79 |
| Epan (in) | 8.32 | 7.86 | 7.17 | 6.35 | 4.21 | 4.49 | 4.12 | 3.35 | 4.26 | 5.99 | 5.93 | 5.76 | 67.81 |
| PEsoil(in) | 2.91 | 2.75 | 2.51 | 2.22 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 2.08 | 2.02 | 23.73 |
| AEsoil (in) | 0.00 | 0.00 | 0.18 | 2.22 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 2.08 | 2.02 | 15.74 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.86 | 41.66 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.86 | 1.84 | 43.50 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.04 | 70.88 | 11.62 | 68.24 | 124.11 | 84.41 | 18.04 | 0.00 | 0.00 | 377.34 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 6.62 | 1.08 | 6.37 | 11.58 | 7.88 | 1.68 | 0.00 | 0.00 | **35.22** |
| **Water Year 1986-1987** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.01 | 0.00 | 1.15 | 0.00 | 1.38 | 0.24 | 1.87 | 1.91 | 1.90 | 0.02 | 0.00 | 0.04 | 8.52 |
| Qrunoff (af) | 0.02 | 0.00 | 1.81 | 0.00 | 2.17 | 0.38 | 2.94 | 3.00 | 2.98 | 0.03 | 0.00 | 0.06 | 13.38 |
| Epan (in) | 7.34 | 6.66 | 5.38 | 4.98 | 4.48 | 3.82 | 3.55 | 4.21 | 4.54 | 5.64 | 5.59 | 5.75 | 61.94 |
| PEsoil(in) | 2.57 | 2.33 | 1.88 | 1.74 | 1.57 | 1.34 | 1.24 | 1.47 | 1.59 | 1.97 | 1.96 | 2.01 | 21.68 |
| AEsoil (in) | 2.02 | 0.00 | 1.88 | 1.74 | 1.57 | 1.34 | 1.24 | 1.47 | 1.59 | 1.97 | 1.96 | 2.01 | 18.80 |
| SM1 (in) | 1.84 | 0.00 | 0.00 | 5.40 | 3.66 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.78 | 1.83 | 43.51 |
| SM2 (in) | 0.00 | 0.00 | 5.40 | 3.66 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.78 | 1.83 | 0.53 | 42.19 |
| Qsoil (in) | 0.00 | 0.00 | 13.21 | 0.00 | 21.28 | 2.94 | 32.08 | 32.57 | 32.27 | 0.00 | 0.00 | 0.00 | 134.36 |
| Qtotal (af) | 0.00 | 0.00 | 1.23 | 0.00 | 1.99 | 0.27 | 2.99 | 3.04 | 3.01 | 0.00 | 0.00 | 0.00 | **12.54** |
| **Water Year 1987-1988** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.11 | 0.00 | 0.00 | 1.58 | 1.20 | 3.06 | 2.38 | 1.09 | 0.58 | 2.30 | 0.00 | 0.00 | 12.30 |
| Qrunoff (af) | 0.17 | 0.00 | 0.00 | 2.48 | 1.88 | 4.80 | 3.74 | 1.71 | 0.91 | 3.61 | 0.00 | 0.00 | 19.31 |
| Epan (in) | 6.58 | 6.92 | 5.79 | 4.71 | 4.66 | 3.37 | 4.03 | 5.15 | 7.20 | 6.02 | 8.56 | 7.46 | 70.45 |
| PEsoil(in) | 2.30 | 2.42 | 2.03 | 1.65 | 1.63 | 1.18 | 1.41 | 1.80 | 2.52 | 2.11 | 3.00 | 2.61 | 24.66 |
| AEsoil (in) | 2.30 | 0.18 | 0.00 | 1.65 | 1.63 | 1.18 | 1.41 | 1.80 | 2.52 | 2.11 | 3.00 | 2.40 | 20.19 |
| SM1 (in) | 0.53 | 0.18 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 2.40 | 40.91 |
| SM2 (in) | 0.18 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 2.40 | 0.00 | 40.39 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 21.11 | 19.75 | 53.35 | 41.00 | 17.62 | 7.82 | 38.88 | 0.00 | 0.00 | 199.54 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 1.97 | 1.84 | 4.98 | 3.83 | 1.64 | 0.73 | 3.63 | 0.00 | 0.00 | **18.62** |
| **Water Year 1988-1989** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.96 | 2.73 | 0.76 | 2.64 | 0.88 | 0.20 | 0.11 | 0.00 | 8.30 |
| Qrunoff (af) | 0.00 | 0.00 | 0.03 | 0.00 | 1.51 | 4.29 | 1.19 | 4.14 | 1.38 | 0.31 | 0.17 | 0.00 | 13.03 |
| Epan (in) | 6.82 | 7.17 | 6.49 | 4.77 | 4.16 | 4.99 | 4.10 | 3.32 | 4.34 | 6.01 | 6.36 | 6.03 | 64.56 |
| PEsoil(in) | 2.39 | 2.51 | 2.27 | 1.67 | 1.46 | 1.75 | 1.44 | 1.16 | 1.52 | 2.10 | 2.23 | 2.11 | 22.60 |
| AEsoil (in) | 0.00 | 0.00 | 0.36 | 0.00 | 1.46 | 1.75 | 1.44 | 1.16 | 1.52 | 2.10 | 2.23 | 2.11 | 14.11 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.13 | 37.53 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.13 | 3.02 | 40.56 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 10.25 | 46.91 | 12.11 | 45.89 | 14.16 | 1.46 | 0.00 | 0.00 | 130.78 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.96 | 4.38 | 1.13 | 4.28 | 1.32 | 0.14 | 0.00 | 0.00 | **12.21** |

ATTACHMENT 8
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Detention Basin
Water Years 1979-1980 through 1998-1999

| Water Year 1989-1990 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.08 | 0.19 | 0.50 | 0.00 | 2.24 | 1.71 | 0.00 | 0.03 | 0.71 | 0.00 | 5.46 |
| Qrunoff (af) | 0.00 | 0.00 | 0.13 | 0.30 | 0.79 | 0.00 | 3.52 | 2.68 | 0.00 | 0.05 | 1.11 | 0.00 | 8.57 |
| Epan (in) | 6.83 | 5.96 | 5.35 | 4.58 | 5.12 | 4.71 | 3.86 | 3.42 | 4.37 | 4.45 | 6.21 | 6.47 | 61.33 |
| PEsoil(in) | 2.39 | 2.09 | 1.87 | 1.60 | 1.79 | 1.65 | 1.35 | 1.20 | 1.53 | 1.56 | 2.17 | 2.26 | 21.47 |
| AEsoil (in) | 2.39 | 0.63 | 1.43 | 1.60 | 1.79 | 1.65 | 1.35 | 1.20 | 1.53 | 1.56 | 2.17 | 2.26 | 19.57 |
| SM1 (in) | 3.02 | 0.63 | 0.00 | 0.00 | 1.78 | 5.40 | 3.75 | 5.40 | 5.40 | 3.87 | 2.85 | 5.40 | 37.51 |
| SM2 (in) | 0.63 | 0.00 | 0.00 | 1.78 | 5.40 | 3.75 | 5.40 | 5.40 | 3.87 | 2.85 | 5.40 | 3.14 | 37.62 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 3.50 | 0.00 | 36.92 | 29.28 | 0.00 | 0.00 | 7.93 | 0.00 | 77.63 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 3.45 | 2.73 | 0.00 | 0.00 | 0.74 | 0.00 | **7.25** |
| **Water Year 1990-1991** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.98 | 2.50 | 8.61 | 0.00 | 0.00 | 0.00 | 12.64 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 | 0.00 | 1.54 | 3.93 | 13.52 | 0.00 | 0.00 | 0.00 | 19.84 |
| Epan (in) | 7.48 | 6.45 | 5.61 | 5.27 | 4.90 | 4.42 | 3.35 | 2.81 | 3.45 | 5.52 | 6.52 | 5.78 | 61.56 |
| PEsoil(in) | 2.62 | 2.26 | 1.96 | 1.84 | 1.72 | 1.55 | 1.17 | 0.98 | 1.21 | 1.93 | 2.28 | 2.02 | 21.55 |
| AEsoil (in) | 2.62 | 0.52 | 0.00 | 0.00 | 1.72 | 1.55 | 1.17 | 0.98 | 1.21 | 1.93 | 2.28 | 1.19 | 15.16 |
| SM1 (in) | 3.14 | 0.52 | 0.00 | 0.00 | 0.00 | 5.40 | 3.85 | 5.40 | 5.40 | 5.40 | 3.47 | 1.19 | 33.76 |
| SM2 (in) | 0.52 | 0.00 | 0.00 | 0.00 | 5.40 | 3.85 | 5.40 | 5.40 | 5.40 | 3.47 | 1.19 | 0.00 | 30.62 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 2.69 | 0.00 | 14.75 | 43.57 | 152.24 | 0.00 | 0.00 | 0.00 | 213.24 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 1.38 | 4.07 | 14.21 | 0.00 | 0.00 | 0.00 | **19.90** |
| **Water Year 1991-1992** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.02 | 0.00 | 0.16 | 0.14 | 3.87 | 1.99 | 7.87 | 4.26 | 0.08 | 0.00 | 0.00 | 18.39 |
| Qrunoff (af) | 0.00 | 0.03 | 0.00 | 0.25 | 0.22 | 6.08 | 3.12 | 12.36 | 6.69 | 0.13 | 0.00 | 0.00 | 28.87 |
| Epan (in) | 5.96 | 5.45 | 4.31 | 3.97 | 4.38 | 2.92 | 3.63 | 3.10 | 3.02 | 4.54 | 4.45 | 5.83 | 51.56 |
| PEsoil(in) | 2.09 | 1.91 | 1.51 | 1.39 | 1.53 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 1.56 | 2.04 | 18.05 |
| AEsoil (in) | 0.00 | 0.36 | 0.00 | 1.39 | 1.53 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 1.56 | 2.04 | 12.90 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 1.46 | 2.42 | 5.40 | 5.40 | 5.40 | 5.40 | 5.24 | 3.68 | 34.40 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 1.46 | 2.42 | 5.40 | 5.40 | 5.40 | 5.40 | 5.24 | 3.68 | 1.64 | 36.04 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 64.97 | 34.19 | 139.17 | 74.86 | 0.00 | 0.00 | 0.00 | 313.20 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.06 | 3.19 | 12.99 | 6.99 | 0.00 | 0.00 | 0.00 | **29.23** |
| **Water Year 1992-1993** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.09 | 0.00 | 0.00 | 1.05 | 0.00 | 4.74 | 7.55 | 8.92 | 3.72 | 0.00 | 0.10 | 0.68 | 26.85 |
| Qrunoff (af) | 0.14 | 0.00 | 0.00 | 1.65 | 0.00 | 7.44 | 11.85 | 14.00 | 5.84 | 0.00 | 0.16 | 1.07 | 42.15 |
| Epan (in) | 6.26 | 6.66 | 5.08 | 4.05 | 5.19 | 3.22 | 2.52 | 2.98 | 3.61 | 5.34 | 5.73 | 6.50 | 57.14 |
| PEsoil(in) | 2.19 | 2.33 | 1.78 | 1.42 | 1.82 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 2.01 | 2.28 | 20.00 |
| AEsoil (in) | 2.19 | 1.05 | 0.00 | 1.42 | 1.82 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 2.01 | 2.28 | 16.94 |
| SM1 (in) | 1.64 | 1.05 | 0.00 | 0.00 | 5.40 | 3.58 | 5.40 | 5.40 | 5.40 | 5.40 | 3.53 | 3.31 | 40.11 |
| SM2 (in) | 1.05 | 0.00 | 0.00 | 5.40 | 3.58 | 5.40 | 5.40 | 5.40 | 5.40 | 3.53 | 3.31 | 5.40 | 43.87 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 11.90 | 0.00 | 81.53 | 133.67 | 157.92 | 65.03 | 0.00 | 0.00 | 7.75 | 457.80 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 1.11 | 0.00 | 7.61 | 12.48 | 14.74 | 6.07 | 0.00 | 0.00 | 0.72 | **42.73** |

ATTACHMENT 8
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Detention Basin
Water Years 1979-1980 through 1998-1999

| Water Year 1993-1994 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.55 | 0.70 | 1.41 | 0.49 | 4.96 | 2.82 | 0.39 | 0.26 | 0.00 | 11.58 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 0.86 | 1.10 | 2.21 | 0.77 | 7.79 | 4.43 | 0.61 | 0.41 | 0.00 | 18.18 |
| Epan (in) | 6.51 | 5.88 | 4.78 | 4.50 | 4.50 | 3.64 | 3.63 | 3.49 | 3.96 | 4.60 | 4.07 | 5.22 | 54.78 |
| PEsoil(in) | 2.28 | 2.06 | 1.67 | 1.58 | 1.58 | 1.27 | 1.27 | 1.22 | 1.39 | 1.61 | 1.42 | 1.83 | 19.17 |
| AEsoil (in) | 2.28 | 2.06 | 1.06 | 1.58 | 1.58 | 1.27 | 1.27 | 1.22 | 1.39 | 1.61 | 1.42 | 1.83 | 18.56 |
| SM1 (in) | 5.40 | 3.12 | 1.06 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 52.79 |
| SM2 (in) | 3.12 | 1.06 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.57 | 50.96 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 2.83 | 10.90 | 23.85 | 7.46 | 87.17 | 48.87 | 5.34 | 3.21 | 0.00 | 189.64 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.26 | 1.02 | 2.23 | 0.70 | 8.14 | 4.56 | 0.50 | 0.30 | 0.00 | **17.70** |
| **Water Year 1994-1995** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.18 | 0.39 | 1.63 | 0.97 | 14.23 | 1.08 | 8.16 | 0.58 | 0.78 | 0.34 | 28.34 |
| Qrunoff (af) | 0.00 | 0.00 | 0.28 | 0.61 | 2.56 | 1.52 | 22.34 | 1.70 | 12.81 | 0.91 | 1.22 | 0.53 | 44.49 |
| Epan (in) | 5.58 | 5.84 | 4.64 | 4.27 | 3.84 | 2.60 | 1.64 | 2.53 | 3.64 | 5.25 | 4.65 | 4.98 | 49.46 |
| PEsoil(in) | 1.95 | 2.04 | 1.62 | 1.49 | 1.34 | 0.91 | 0.57 | 0.89 | 1.27 | 1.84 | 1.63 | 1.74 | 17.31 |
| AEsoil (in) | 1.95 | 1.62 | 1.62 | 1.49 | 1.34 | 0.91 | 0.57 | 0.89 | 1.27 | 1.84 | 1.63 | 1.74 | 16.89 |
| SM1 (in) | 3.57 | 1.62 | 0.00 | 1.58 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 49.98 |
| SM2 (in) | 1.62 | 0.00 | 1.58 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 51.80 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 1.64 | 27.70 | 16.38 | 253.02 | 18.36 | 144.15 | 8.50 | 12.27 | 4.32 | 486.35 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.15 | 2.59 | 1.53 | 23.62 | 1.71 | 13.45 | 0.79 | 1.15 | 0.40 | **45.39** |
| **Water Year 1995-1996** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 1.99 | 1.24 | 7.59 | 1.40 | 0.60 | 0.11 | 0.00 | 13.04 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | 3.12 | 1.95 | 11.92 | 2.20 | 0.94 | 0.17 | 0.00 | 20.47 |
| Epan (in) | 5.83 | 6.20 | 4.90 | 4.67 | 3.20 | 2.88 | 3.02 | 2.41 | 3.74 | 5.56 | 6.06 | 5.40 | 53.87 |
| PEsoil(in) | 2.04 | 2.17 | 1.72 | 1.63 | 1.12 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 2.12 | 1.89 | 18.85 |
| AEsoil (in) | 2.04 | 2.17 | 1.19 | 0.00 | 1.12 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 2.12 | 1.89 | 16.69 |
| SM1 (in) | 5.40 | 3.36 | 1.19 | 0.00 | 0.00 | 0.84 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.24 | 43.03 |
| SM2 (in) | 3.36 | 1.19 | 0.00 | 0.00 | 0.84 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.24 | 3.35 | 40.98 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 29.90 | 21.04 | 134.42 | 23.64 | 8.75 | 0.00 | 0.00 | 217.75 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.79 | 1.96 | 12.55 | 2.21 | 0.82 | 0.00 | 0.00 | **20.32** |
| **Water Year 1996-1997** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 1.18 | 2.63 | 5.50 | 4.45 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 13.82 |
| Qrunoff (af) | 0.00 | 0.00 | 0.00 | 1.85 | 4.13 | 8.64 | 6.99 | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 | 21.70 |
| Epan (in) | 5.91 | 5.65 | 4.94 | 4.85 | 4.25 | 3.58 | 2.41 | 4.35 | 5.53 | 6.93 | 7.31 | 6.40 | 62.11 |
| PEsoil(in) | 2.07 | 1.98 | 1.73 | 1.70 | 1.49 | 1.25 | 0.84 | 1.52 | 1.94 | 2.43 | 2.56 | 2.24 | 21.74 |
| AEsoil (in) | 2.07 | 1.28 | 0.00 | 1.70 | 1.49 | 1.25 | 0.84 | 1.52 | 1.94 | 2.43 | 0.59 | 0.00 | 15.10 |
| SM1 (in) | 3.35 | 1.28 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 4.95 | 3.01 | 0.59 | 0.00 | 34.77 |
| SM2 (in) | 1.28 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 4.95 | 3.01 | 0.59 | 0.00 | 0.00 | 31.42 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 13.93 | 45.38 | 96.76 | 78.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 234.54 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 1.30 | 4.24 | 9.03 | 7.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **21.89** |

ATTACHMENT 8
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Detention Basin
Water Years 1979-1980 through 1998-1999

| Water Year 1997-1998 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.04 | 0.00 | 2.21 | 6.54 | 3.06 | 18.64 | 3.17 | 1.55 | 2.74 | 0.02 | 37.97 |
| Qrunoff (af) | 0.00 | 0.00 | 0.06 | 0.00 | 3.47 | 10.27 | 4.80 | 29.26 | 4.98 | 2.43 | 4.30 | 0.03 | 59.61 |
| Epan (in) | 6.61 | 6.43 | 6.09 | 6.53 | 3.61 | 4.24 | 2.72 | 2.99 | 4.92 | 5.66 | 6.41 | 6.63 | 62.84 |
| PEsoil(in) | 2.31 | 2.25 | 2.13 | 2.29 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 2.32 | 21.99 |
| AEsoil (in) | 0.00 | 0.00 | 0.71 | 0.00 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 2.32 | 13.73 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 37.80 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.44 | 41.24 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 32.72 | 115.07 | 53.58 | 331.14 | 54.77 | 25.64 | 46.59 | 0.00 | 659.52 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 3.05 | 10.74 | 5.00 | 30.91 | 5.11 | 2.39 | 4.35 | 0.00 | **61.56** |
| **Water Year 1998-1999** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.11 | 0.11 | 0.85 | 0.63 | 1.91 | 0.80 | 2.79 | 2.48 | 0.03 | 0.24 | 9.95 |
| Qrunoff (af) | 0.00 | 0.00 | 0.17 | 0.17 | 1.33 | 0.99 | 3.00 | 1.26 | 4.38 | 3.89 | 0.05 | 0.38 | 15.62 |
| Epan (in) | 7.37 | 7.28 | 5.24 | 5.68 | 3.71 | 4.10 | 3.89 | 3.78 | 4.63 | 5.87 | 5.94 | 6.51 | 64.00 |
| PEsoil(in) | 2.58 | 2.55 | 1.83 | 1.99 | 1.30 | 1.44 | 1.36 | 1.32 | 1.62 | 2.05 | 2.08 | 2.28 | 22.40 |
| AEsoil (in) | 2.58 | 0.86 | 1.83 | 1.99 | 1.30 | 1.44 | 1.36 | 1.32 | 1.62 | 2.05 | 2.08 | 2.28 | 20.71 |
| SM1 (in) | 3.44 | 0.86 | 0.00 | 0.13 | 0.10 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.86 | 40.77 |
| SM2 (in) | 0.86 | 0.00 | 0.13 | 0.10 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 3.86 | 5.40 | 42.74 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 8.55 | 9.79 | 32.68 | 12.93 | 48.10 | 42.14 | 0.00 | 0.45 | 154.65 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.80 | 0.91 | 3.05 | 1.21 | 4.49 | 3.93 | 0.00 | 0.04 | **14.43** |

ATTACHMENT 9
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Dormant Agricultural Land
Water Years 1979-1980 through 1998-1999

**Data used for calculations:**

Soil Evaporation Depth: 30 inches

Soil moisture holding capacity: 2.40 inches (0.08 in/in * 30 in)

Total Open Space Area: 9.4 acres

Runoff Factor: 0.11

**Definition of terms:**

Pg = Precipitation (inches). Station 239E El Rio - UWCD (7/1/79 - 6/30/99)

Pg-runoff = Precipitation minus runoff leaving open space area. Pg-runoff = Pg - Pg*0.11

Epan = Pan Evaporation (inches) at El Rio from 1985-1999. Monthly averages used for 1979-1985.

PEsoil = Potential soil evaporation (inches). Epan * 0.35

AEsoil = Actual soil evaporation (inches). If (Pg-runoff + SM1 - PEsoil) > 0; AEsoil = PEsoil.
If (Pg-runoff + SM1 - PEsoil) $\leq$ 0; AEsoil = Pg-runoff + SM1.

SM1 = Soil moisture at the beginning of the month (inches). SM1 = SM2 from previous month

SM2 = Soil moisture at end of the month (inches). If Pg-runoff + SM1 - AEsoil < 2.40; SM2 = Pg-runoff + SM1 - AEsoil.
If (Pg-runoff + SM1 - AEsoil) $\geq$ 2.4; SM2 = 2.4.

Qsoil = Water yield (inches).
If Pg-runoff - AEsoil - (SM2 - SM1) > 0; Qsoil = Pg-runoff - AEsoil - (SM2 - SM1).
If Pg-runoff - AEsoil - (SM2 - SM1) $\leq$ 0; Qsoil = 0.

Qtotal = Total groundwater recharge from dormant agricultural land (acre-feet) = Qsoil/12 * 9.4.

ATTACHMENT 9
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Dormant Agricultural Land
Water Years 1979-1980 through 1998-1999

| Water Year 1979-1980 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.62 | 0.48 | 1.28 | 2.03 | 7.62 | 10.19 | 2.86 | 0.39 | 0.29 | 0.00 | 25.76 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.55 | 0.43 | 1.14 | 1.81 | 6.80 | 9.09 | 2.55 | 0.35 | 0.26 | 0.00 | 22.98 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.00 | 0.55 | 0.43 | 1.14 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 1.07 | 0.00 | 10.40 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 2.40 | 2.40 | 2.40 | 0.81 | 0.00 | 8.50 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 2.40 | 2.40 | 2.40 | 0.81 | 0.00 | 0.00 | 8.50 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.71 | 7.86 | 1.01 | 0.00 | 0.00 | 0.00 | 12.58 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.91 | 6.16 | 0.79 | 0.00 | 0.00 | 0.00 | **9.86** |
| **Water Year 1980-1981** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 2.12 | 1.85 | 5.67 | 0.18 | 0.00 | 0.00 | 11.14 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.18 | 1.89 | 1.65 | 5.06 | 0.16 | 0.00 | 0.00 | 9.94 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.18 | 1.17 | 1.23 | 1.54 | 1.94 | 0.62 | 0.00 | 7.68 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.72 | 1.14 | 2.40 | 0.62 | 0.00 | 4.88 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.72 | 1.14 | 2.40 | 0.62 | 0.00 | 0.00 | 4.88 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.25 | 0.00 | 0.00 | 0.00 | 2.25 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.77 | 0.00 | 0.00 | 0.00 | **1.77** |
| **Water Year 1981-1982** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.89 | 1.96 | 0.72 | 2.52 | 0.34 | 4.07 | 1.73 | 0.00 | 0.00 | 12.23 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.79 | 1.75 | 0.64 | 2.25 | 0.30 | 3.63 | 1.54 | 0.00 | 0.00 | 10.91 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.79 | 1.51 | 0.64 | 1.17 | 0.30 | 1.54 | 1.54 | 0.00 | 0.00 | 7.50 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.24 | 1.32 | 1.32 | 2.40 | 2.40 | 2.40 | 10.32 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.24 | 1.32 | 1.32 | 2.40 | 2.40 | 2.40 | 2.40 | 12.72 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.01 | 0.00 | 0.00 | 0.00 | 1.01 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.79 | 0.00 | 0.00 | 0.00 | **0.79** |
| **Water Year 1982-1983** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.90 | 0.42 | 4.41 | 1.82 | 7.62 | 5.23 | 5.90 | 3.60 | 0.14 | 0.01 | 30.05 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.80 | 0.37 | 3.93 | 1.62 | 6.80 | 4.67 | 5.26 | 3.21 | 0.12 | 0.01 | 26.80 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 2.33 | 0.07 | 0.80 | 0.37 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 0.41 | 14.82 |
| SM1 (in) | 2.40 | 0.07 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 0.40 | 17.27 |
| SM2 (in) | 0.07 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 0.40 | 0.00 | 14.87 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.30 | 5.62 | 3.44 | 3.72 | 1.27 | 0.00 | 0.00 | 14.38 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.24 | 4.41 | 2.69 | 2.91 | 1.00 | 0.00 | 0.00 | **11.27** |

ATTACHMENT 9
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Dormant Agricultural Land
Water Years 1979-1980 through 1998-1999

| Water Year 1983-1984 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.96 | 0.85 | 2.76 | 3.07 | 4.40 | 0.19 | 0.01 | 0.38 | 0.25 | 0.00 | 0.00 | 12.87 |
| Pg-runoff(in) | 0.00 | 0.86 | 0.76 | 2.46 | 2.74 | 3.92 | 0.17 | 0.01 | 0.34 | 0.22 | 0.00 | 0.00 | 11.48 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.35 | 3.51 | 4.41 | 5.54 | 6.06 | 6.18 | 60.61 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 1.54 | 1.94 | 2.12 | 2.16 | 21.21 |
| AEsoil (in) | 0.00 | 0.86 | 0.76 | 1.73 | 1.51 | 1.32 | 1.17 | 1.23 | 0.52 | 0.22 | 0.00 | 0.00 | 9.31 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.73 | 1.97 | 2.40 | 1.40 | 0.18 | 0.00 | 0.00 | 0.00 | 6.67 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.73 | 1.97 | 2.40 | 1.40 | 0.18 | 0.00 | 0.00 | 0.00 | 0.00 | 6.67 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.17 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **1.70** |
| **Water Year 1984-1985** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.05 | 0.27 | 0.31 | 2.55 | 4.00 | 1.10 | 1.70 | 0.94 | 0.00 | 0.00 | 0.00 | 10.92 |
| Pg-runoff(in) | 0.00 | 0.04 | 0.24 | 0.28 | 2.27 | 3.57 | 0.98 | 1.52 | 0.84 | 0.00 | 0.00 | 0.00 | 9.74 |
| Epan (in) | 6.67 | 6.46 | 5.41 | 4.94 | 4.30 | 3.78 | 3.81 | 4.74 | 4.96 | 5.72 | 7.17 | 7.96 | 65.92 |
| PEsoil(in) | 2.33 | 2.26 | 1.89 | 1.73 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 2.00 | 2.51 | 2.79 | 23.07 |
| AEsoil (in) | 0.00 | 0.04 | 0.24 | 0.28 | 1.51 | 1.32 | 1.33 | 1.66 | 1.74 | 1.01 | 0.00 | 0.00 | 9.13 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.77 | 2.40 | 2.05 | 1.91 | 1.01 | 0.00 | 0.00 | 8.13 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.77 | 2.40 | 2.05 | 1.91 | 1.01 | 0.00 | 0.00 | 0.00 | 8.13 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.61 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.48 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.48** |
| **Water Year 1985-1986** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.01 | 0.43 | 4.06 | 0.74 | 3.91 | 7.03 | 4.82 | 1.13 | 0.03 | 0.00 | 22.16 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.01 | 0.38 | 3.62 | 0.66 | 3.49 | 6.27 | 4.30 | 1.01 | 0.03 | 0.00 | 19.77 |
| Epan (in) | 8.32 | 7.86 | 7.17 | 6.35 | 4.21 | 4.49 | 4.12 | 3.35 | 4.26 | 5.99 | 5.93 | 5.76 | 67.81 |
| PEsoil(in) | 2.91 | 2.75 | 2.51 | 2.22 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 2.08 | 2.02 | 23.73 |
| AEsoil (in) | 0.00 | 0.00 | 0.01 | 0.38 | 1.47 | 1.57 | 1.44 | 1.17 | 1.49 | 2.10 | 1.34 | 0.00 | 10.98 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.15 | 1.24 | 2.40 | 2.40 | 2.40 | 1.31 | 0.00 | 11.90 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 2.15 | 1.24 | 2.40 | 2.40 | 2.40 | 1.31 | 0.00 | 0.00 | 11.90 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.88 | 5.10 | 2.81 | 0.00 | 0.00 | 0.00 | 8.79 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.69 | 3.99 | 2.20 | 0.00 | 0.00 | 0.00 | **6.88** |
| **Water Year 1986-1987** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.01 | 0.00 | 1.15 | 0.00 | 1.38 | 0.24 | 1.87 | 1.91 | 1.90 | 0.02 | 0.00 | 0.04 | 8.52 |
| Pg-runoff(in) | 0.01 | 0.00 | 1.03 | 0.00 | 1.23 | 0.21 | 1.67 | 1.70 | 1.69 | 0.02 | 0.00 | 0.04 | 7.60 |
| Epan (in) | 7.34 | 6.66 | 5.38 | 4.98 | 4.48 | 3.82 | 3.55 | 4.21 | 4.54 | 5.64 | 5.59 | 5.75 | 61.94 |
| PEsoil(in) | 2.57 | 2.33 | 1.88 | 1.74 | 1.57 | 1.34 | 1.24 | 1.47 | 1.59 | 1.97 | 1.96 | 2.01 | 21.68 |
| AEsoil (in) | 0.01 | 0.00 | 1.03 | 0.00 | 1.23 | 0.21 | 1.24 | 1.47 | 1.59 | 0.78 | 0.00 | 0.04 | 7.60 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 0.66 | 0.76 | 0.00 | 0.00 | 1.84 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 0.66 | 0.76 | 0.00 | 0.00 | 0.00 | 1.84 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |

ATTACHMENT 9
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Dormant Agricultural Land
Water Years 1979-1980 through 1998-1999

| Water Year 1987-1988 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.11 | 0.00 | 0.00 | 1.58 | 1.20 | 3.06 | 2.38 | 1.09 | 0.58 | 2.30 | 0.00 | 0.00 | 12.30 |
| Pg-runoff(in) | 0.10 | 0.00 | 0.00 | 1.41 | 1.07 | 2.73 | 2.12 | 0.97 | 0.52 | 2.05 | 0.00 | 0.00 | 10.97 |
| Epan (in) | 6.58 | 6.92 | 5.79 | 4.71 | 4.66 | 3.37 | 4.03 | 5.15 | 7.20 | 6.02 | 8.56 | 7.46 | 70.45 |
| PEsoil(in) | 2.30 | 2.42 | 2.03 | 1.65 | 1.63 | 1.18 | 1.41 | 1.80 | 2.52 | 2.11 | 3.00 | 2.61 | 24.66 |
| AEsoil (in) | 0.10 | 0.00 | 0.00 | 1.41 | 1.07 | 1.18 | 1.41 | 1.80 | 1.95 | 2.05 | 0.00 | 0.00 | 10.97 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.55 | 2.26 | 1.43 | 0.00 | 0.00 | 0.00 | 5.24 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.55 | 2.26 | 1.43 | 0.00 | 0.00 | 0.00 | 0.00 | 5.24 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| **Water Year 1988-1989** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.96 | 2.73 | 0.76 | 2.64 | 0.88 | 0.20 | 0.11 | 0.00 | 8.30 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.86 | 2.44 | 0.68 | 2.35 | 0.78 | 0.18 | 0.10 | 0.00 | 7.40 |
| Epan (in) | 6.82 | 7.17 | 6.49 | 4.77 | 4.16 | 4.99 | 4.10 | 3.32 | 4.34 | 6.01 | 6.36 | 6.03 | 64.56 |
| PEsoil(in) | 2.39 | 2.51 | 2.27 | 1.67 | 1.46 | 1.75 | 1.44 | 1.16 | 1.52 | 2.10 | 2.23 | 2.11 | 22.60 |
| AEsoil (in) | 0.00 | 0.00 | 0.02 | 0.00 | 0.86 | 1.75 | 1.37 | 1.16 | 1.52 | 0.64 | 0.10 | 0.00 | 7.40 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.69 | 0.00 | 1.19 | 0.46 | 0.00 | 0.00 | 2.34 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.69 | 0.00 | 1.19 | 0.46 | 0.00 | 0.00 | 0.00 | 2.34 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| **Water Year 1989-1990** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.08 | 0.19 | 0.50 | 0.00 | 2.24 | 1.71 | 0.00 | 0.03 | 0.71 | 0.00 | 5.46 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.07 | 0.17 | 0.45 | 0.00 | 2.00 | 1.53 | 0.00 | 0.03 | 0.63 | 0.00 | 4.87 |
| Epan (in) | 6.83 | 5.96 | 5.35 | 4.58 | 5.12 | 4.71 | 3.86 | 3.42 | 4.37 | 4.45 | 6.21 | 6.47 | 61.33 |
| PEsoil(in) | 2.39 | 2.09 | 1.87 | 1.60 | 1.79 | 1.65 | 1.35 | 1.20 | 1.53 | 1.56 | 2.17 | 2.26 | 21.47 |
| AEsoil (in) | 0.00 | 0.00 | 0.07 | 0.17 | 0.45 | 0.00 | 1.35 | 1.20 | 0.98 | 0.03 | 0.63 | 0.00 | 4.87 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.65 | 0.98 | 0.00 | 0.00 | 0.00 | 1.62 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.65 | 0.98 | 0.00 | 0.00 | 0.00 | 0.00 | 1.62 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| **Water Year 1990-1991** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.98 | 2.50 | 8.61 | 0.00 | 0.00 | 0.00 | 12.64 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 0.00 | 0.87 | 2.23 | 7.68 | 0.00 | 0.00 | 0.00 | 11.27 |
| Epan (in) | 7.48 | 6.45 | 5.61 | 5.27 | 4.90 | 4.42 | 3.35 | 2.81 | 3.45 | 5.52 | 6.52 | 5.78 | 61.56 |
| PEsoil(in) | 2.62 | 2.26 | 1.96 | 1.84 | 1.72 | 1.55 | 1.17 | 0.98 | 1.21 | 1.93 | 2.28 | 2.02 | 21.55 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 0.00 | 0.87 | 0.98 | 1.21 | 1.93 | 0.47 | 0.00 | 5.96 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.25 | 2.40 | 0.47 | 0.00 | 4.11 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.25 | 2.40 | 0.47 | 0.00 | 0.00 | 4.11 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.32 | 0.00 | 0.00 | 0.00 | 5.32 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.17 | 0.00 | 0.00 | 0.00 | **4.17** |

ATTACHMENT 9
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Dormant Agricultural Land
Water Years 1979-1980 through 1998-1999

| Water Year 1991-1992 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.02 | 0.00 | 0.16 | 0.14 | 3.87 | 1.99 | 7.87 | 4.26 | 0.08 | 0.00 | 0.00 | 18.39 |
| Pg-runoff(in) | 0.00 | 0.02 | 0.00 | 0.14 | 0.12 | 3.45 | 1.78 | 7.02 | 3.80 | 0.07 | 0.00 | 0.00 | 16.40 |
| Epan (in) | 5.96 | 5.45 | 4.31 | 3.97 | 4.38 | 2.92 | 3.63 | 3.10 | 3.02 | 4.54 | 4.45 | 5.83 | 51.56 |
| PEsoil(in) | 2.09 | 1.91 | 1.51 | 1.39 | 1.53 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 1.56 | 2.04 | 18.05 |
| AEsoil (in) | 0.00 | 0.02 | 0.00 | 0.14 | 0.12 | 1.02 | 1.27 | 1.09 | 1.06 | 1.59 | 0.88 | 0.00 | 7.19 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.88 | 0.00 | 10.48 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.88 | 0.00 | 0.00 | 10.48 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.50 | 5.94 | 2.74 | 0.00 | 0.00 | 0.00 | 9.21 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.40 | 4.65 | 2.15 | 0.00 | 0.00 | 0.00 | **7.22** |
| **Water Year 1992-1993** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.09 | 0.00 | 0.00 | 1.05 | 0.00 | 4.74 | 7.55 | 8.92 | 3.72 | 0.00 | 0.10 | 0.68 | 26.85 |
| Pg-runoff(in) | 0.08 | 0.00 | 0.00 | 0.94 | 0.00 | 4.23 | 6.73 | 7.96 | 3.32 | 0.00 | 0.09 | 0.61 | 23.95 |
| Epan (in) | 6.26 | 6.66 | 5.08 | 4.05 | 5.19 | 3.22 | 2.52 | 2.98 | 3.61 | 5.34 | 5.73 | 6.50 | 57.14 |
| PEsoil(in) | 2.19 | 2.33 | 1.78 | 1.42 | 1.82 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 2.01 | 2.28 | 20.00 |
| AEsoil (in) | 0.08 | 0.00 | 0.00 | 0.94 | 0.00 | 1.13 | 0.88 | 1.04 | 1.26 | 1.87 | 0.62 | 0.61 | 8.43 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.53 | 0.00 | 10.13 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 2.40 | 2.40 | 0.53 | 0.00 | 0.00 | 10.13 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.70 | 5.85 | 6.91 | 2.05 | 0.00 | 0.00 | 0.00 | 15.52 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 4.58 | 5.42 | 1.61 | 0.00 | 0.00 | 0.00 | **12.16** |
| **Water Year 1993-1994** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.55 | 0.70 | 1.41 | 0.49 | 4.96 | 2.82 | 0.39 | 0.26 | 0.00 | 11.58 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.49 | 0.62 | 1.26 | 0.44 | 4.42 | 2.52 | 0.35 | 0.23 | 0.00 | 10.33 |
| Epan (in) | 6.51 | 5.88 | 4.78 | 4.50 | 4.50 | 3.64 | 3.63 | 3.49 | 3.96 | 4.60 | 4.07 | 5.22 | 54.78 |
| PEsoil(in) | 2.28 | 2.06 | 1.67 | 1.58 | 1.58 | 1.27 | 1.27 | 1.22 | 1.39 | 1.61 | 1.42 | 1.83 | 19.17 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.49 | 0.62 | 1.26 | 0.44 | 1.22 | 1.39 | 1.61 | 1.37 | 0.00 | 8.40 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 1.14 | 0.00 | 5.94 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 2.40 | 1.14 | 0.00 | 0.00 | 5.94 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.80 | 1.13 | 0.00 | 0.00 | 0.00 | 1.93 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 0.88 | 0.00 | 0.00 | 0.00 | **1.51** |
| **Water Year 1994-1995** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.18 | 0.39 | 1.63 | 0.97 | 14.23 | 1.08 | 8.16 | 0.58 | 0.78 | 0.34 | 28.34 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.16 | 0.35 | 1.45 | 0.87 | 12.69 | 0.96 | 7.28 | 0.52 | 0.70 | 0.30 | 25.28 |
| Epan (in) | 5.58 | 5.84 | 4.64 | 4.27 | 3.84 | 2.60 | 1.64 | 2.53 | 3.64 | 5.25 | 4.65 | 4.98 | 49.46 |
| PEsoil(in) | 1.95 | 2.04 | 1.62 | 1.49 | 1.34 | 0.91 | 0.57 | 0.89 | 1.27 | 1.84 | 1.63 | 1.74 | 17.31 |
| AEsoil (in) | 0.00 | 0.00 | 0.16 | 0.35 | 1.34 | 0.91 | 0.57 | 0.89 | 1.27 | 1.84 | 1.63 | 0.45 | 9.41 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.07 | 2.40 | 2.40 | 2.40 | 1.08 | 0.15 | 8.60 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.07 | 2.40 | 2.40 | 2.40 | 1.08 | 0.15 | 0.00 | 8.60 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.78 | 0.08 | 6.00 | 0.00 | 0.00 | 0.00 | 15.87 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.66 | 0.06 | 4.70 | 0.00 | 0.00 | 0.00 | **12.43** |

ATTACHMENT 9
POST-PROJECT CONDITIONS MONTHLY WATER BALANCE
Juvenile Justice Complex Dormant Agricultural Land
Water Years 1979-1980 through 1998-1999

| Water Year 1995-1996 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 1.99 | 1.24 | 7.59 | 1.40 | 0.60 | 0.11 | 0.00 | 13.04 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 1.78 | 1.11 | 6.77 | 1.25 | 0.54 | 0.10 | 0.00 | 11.63 |
| Epan (in) | 5.83 | 6.20 | 4.90 | 4.67 | 3.20 | 2.88 | 3.02 | 2.41 | 3.74 | 5.56 | 6.06 | 5.40 | 53.87 |
| PEsoil(in) | 2.04 | 2.17 | 1.72 | 1.63 | 1.12 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 2.12 | 1.89 | 18.85 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 1.01 | 1.06 | 0.84 | 1.31 | 1.95 | 1.03 | 0.00 | 7.29 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.77 | 0.82 | 2.40 | 2.34 | 0.93 | 0.00 | 7.25 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.77 | 0.82 | 2.40 | 2.34 | 0.93 | 0.00 | 0.00 | 7.25 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.34 | 0.00 | 0.00 | 0.00 | 0.00 | 4.34 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | **3.40** |
| **Water Year 1996-1997** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.00 | 1.18 | 2.63 | 5.50 | 4.45 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 13.82 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.00 | 1.05 | 2.35 | 4.91 | 3.97 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 12.33 |
| Epan (in) | 5.91 | 5.65 | 4.94 | 4.85 | 4.25 | 3.58 | 2.41 | 4.35 | 5.53 | 6.93 | 7.31 | 6.40 | 62.11 |
| PEsoil(in) | 2.07 | 1.98 | 1.73 | 1.70 | 1.49 | 1.25 | 0.84 | 1.52 | 1.94 | 2.43 | 2.56 | 2.24 | 21.74 |
| AEsoil (in) | 0.00 | 0.00 | 0.00 | 1.05 | 1.49 | 1.25 | 0.84 | 1.52 | 0.93 | 0.00 | 0.00 | 0.00 | 7.09 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 | 2.40 | 2.40 | 0.93 | 0.00 | 0.00 | 0.00 | 6.59 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 | 2.40 | 2.40 | 0.93 | 0.00 | 0.00 | 0.00 | 0.00 | 6.59 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.11 | 3.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.24 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.65 | 2.45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **4.10** |
| **Water Year 1997-1998** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.04 | 0.00 | 2.21 | 6.54 | 3.06 | 18.64 | 3.17 | 1.55 | 2.74 | 0.02 | 37.97 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.04 | 0.00 | 1.97 | 5.83 | 2.73 | 16.63 | 2.83 | 1.38 | 2.44 | 0.02 | 33.87 |
| Epan (in) | 6.61 | 6.43 | 6.09 | 6.53 | 3.61 | 4.24 | 2.72 | 2.99 | 4.92 | 5.66 | 6.41 | 6.63 | 62.84 |
| PEsoil(in) | 2.31 | 2.25 | 2.13 | 2.29 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 2.32 | 21.99 |
| AEsoil (in) | 0.00 | 0.00 | 0.04 | 0.00 | 1.26 | 1.48 | 0.95 | 1.05 | 1.72 | 1.98 | 2.24 | 2.02 | 12.75 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.71 | 2.40 | 2.40 | 2.40 | 2.40 | 1.80 | 2.00 | 14.11 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.71 | 2.40 | 2.40 | 2.40 | 2.40 | 1.80 | 2.00 | 0.00 | 14.11 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.66 | 1.78 | 15.58 | 1.11 | 0.00 | 0.00 | 0.00 | 21.12 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.08 | 1.39 | 12.20 | 0.87 | 0.00 | 0.00 | 0.00 | **16.54** |
| **Water Year 1998-1999** | | | | | | | | | | | | | |
| | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
| Pg (in) | 0.00 | 0.00 | 0.11 | 0.11 | 0.85 | 0.63 | 1.91 | 0.80 | 2.79 | 2.48 | 0.03 | 0.24 | 9.95 |
| Pg-runoff(in) | 0.00 | 0.00 | 0.10 | 0.10 | 0.76 | 0.56 | 1.70 | 0.71 | 2.49 | 2.21 | 0.03 | 0.21 | 8.88 |
| Epan (in) | 7.37 | 7.28 | 5.24 | 5.68 | 3.71 | 4.10 | 3.89 | 3.78 | 4.63 | 5.87 | 5.94 | 6.51 | 64.00 |
| PEsoil(in) | 2.58 | 2.55 | 1.83 | 1.99 | 1.30 | 1.44 | 1.36 | 1.32 | 1.62 | 2.05 | 2.08 | 2.28 | 22.40 |
| AEsoil (in) | 0.00 | 0.00 | 0.10 | 0.10 | 0.76 | 0.56 | 1.36 | 1.06 | 1.62 | 2.05 | 1.05 | 0.21 | 8.88 |
| SM1 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.00 | 0.87 | 1.03 | 0.00 | 2.24 |
| SM2 (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.00 | 0.87 | 1.03 | 0.00 | 0.00 | 2.24 |
| Qsoil (in) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Qtotal (af) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |

ATTACHMENT 10
POST-PROJECT CONDITIONS WATER BALANCE
Juvenile Justice Complex Pervious Irrigated Area

JJC Irrigated Pervious Area = 18.94 acres (JJC Hydrol. Exhibit B, Jensen Design)

Demand Factor Applied to Park Land Use = 1,500 gal/acre/day = 0.004602 AF/acre/day

% Area of Park Land Use Considered Pervious = 77%

Demand Factor Applied to Pervious Irrigated Area = 0.004602 / .77 * 365 = 2.1815 AF/acre/year

(References: Proposed Land Use Program, Riverpark Draft Specific Plan, 2000 and Master Plan Land Use 2.4.4.3 Water Demands Section)

| **Pervious Irrigated Area** | **Pervious Area Water Demand** | **Total Annual Demand** | **80% Consumptive Use** | **20% Recharge to GW** |
|---|---|---|---|---|
| (acres) | (AF/acre/year) | (AF) | (AF) | (AF) |
| | | | | |
| 18.94 | 2.1815 | 41.32 | 33.05 | **8.26** |

# APPENDIX 4.5-4

## Los Angeles Regional Water Quality Control Board
## TMDL Request Letter

# California Regional Water Quality Control Board

## Los Angeles Region

Winston H. Hickox
Secretary for
Environmental
Protection

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640
Internet Address: http://www.swrcb.ca.gov/~rwqcb4

Gray Davis
Governor

RECEIVED
MAY 25 2000
PLANNING DIVISION
CITY OF OXNARD

Gary Sugano
Senior Associate Planner
City of Oxnard
Planning and Environmental Services
305 West Third Street
Oxnard, CA 93030

Dear Mr. Sugano,

Re: Response to Notice of Preparation of a Draft Environmental Impact Report Oxnard River Park Specific Plan (SCH# 2000051046)

We appreciate the opportunity to comment on the above mentioned project. For your information a list of permitting requirements and Regional Board Contacts is provided in Attachment A hereto.

The project site lies in the Santa Clara watershed that was listed as being impaired pursuant to Section 303 (d) of the Clean Water Act. Impairments listed in reaches downstream from the proposed project include nutrients and their effects, salts, coliform bacteria, and historic pesticides. The Los Angeles Regional Water Quality Control Board will be developing Total Maximum Daily Loads (TMDLs) for the watershed, but the proposed project is expected to proceed before applicable TMDLs are adopted. In the interim, the Regional Board must carefully evaluate the potential impacts of new projects that may discharge to impaired waterbodies. Please provide the following additional information for both the construction and operational phases of the project.

- For each constituent listed above, please provide an estimate of the concentration (ppb) and load (lbs/day) from non-point and point source discharges.
- Estimates of the amount of additional runoff generated by the project during wet and dry seasons.
- Estimate of the amount of increased or decreased percolation due to the project.
- Estimates of the net change in cubic feet per second of groundwater and surface water contributions under historic drought conditions (as compiled by local water purveyors, the Department of Water Resources, and others), and 10-year 50-year and 100-year flood conditions.

If you have any questions please call Elizabeth Erickson at (213) 576 6683.

Sincerely,

Melinda Merryfield-Becker
Chief, TMDL Unit
Los Angeles Regional Water Quality Control Board
State Clearinghouse

EE:mmb
Attachments (1)
cc: file

**ATTACHMENT A**

✓ If the **proposed project** is subject to a **federal** license or **permit**, and will result in a **discharge (dredge or fill) into a surface water**, including a dry streambed, the project may require a *Section 401 Water Quality Certification*, or waiver thereof. For further information, please contact:

Alex Fu at (213) 576-6682 or Anthony Klecha at (213) 576-6785, Nonpoint Source Unit

✓ If the project involves **inland disposal of nonhazardous contaminated soils and materials**, the proposed project may be subject to *Waste Discharge Requirements*. For further information, please contact:

Rodney Nelson, Landfills & Cleanup Unit, at (213) 576-6719

✓ If the **overall project area is larger than five acres**, the proposed project may be subject to the State Board's *General Construction Activity Storm Water Permit*. For further information, please contact:

Wayne Chiou, Los Angeles Inland Unit, at (213) 576-6664,
Los Angeles County watersheds draining to Long Beach and San Pedro

Carlos Urrunaga, Los Angeles Coastal Unit, at (213) 576-6655
Los Angeles County watersheds draining to Santa Monica Bay and Palos Verdes Peninsula
Ventura County watersheds draining to Malibu Creek watershed

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657
Watersheds draining to Ventura County coastline

✓ If the project involves a **facility** that is proposing to discharge storm water associated with industrial activity (e.g., manufacturing, recycling and transportation facilities, etc.), the facility may be subject to the State Board's *General Industrial Activities Storm Water Permit*. For further information, please contact:

Robert Tom, Nonpoint Source Unit, at (213) 576-6789
Watersheds draining to Los Angeles County coastline

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657,
Watersheds draining to Ventura County coastline

✓ If the proposed project involves any construction and/or **groundwater dewatering to be discharged to surface waters or storm drains**, including dry streambeds, the project may be subject to *NPDES/Waste Discharge Requirements*. For further information, please contact:

Wayne Chiou, Los Angeles Inland Unit, at (213) 576-6664
Los Angeles County watersheds draining to Long Beach and San Pedro

Mazhar Ali, Los Angeles Coastal Unit, at (213) 576-6652:
Los Angeles County watersheds draining to Santa Monica Bay and Palos Verdes Peninsula
Ventura County watersheds draining to Malibu Creek watershed

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657:
Watersheds draining to Ventura County coastline

✓ If the proposed project involves any construction and/or **groundwater dewatering to be discharged to land or groundwater**, the project may be subject to *Waste Discharge Requirements*. For further information, please contact:

Jau Ren Chen, Los Angeles Coastal Unit, at (213) 576-6656:
Watersheds draining to Los Angeles County coastline

Mark Pumford, Ventura Coastal Unit, at (213) 576-6657
Watersheds draining to Ventura County coastline

✓ The **proposed project** shall also comply with the local regulations associated with the **applicable Regional Board stormwater permit**:

| | |
|---|---|
| Los Angeles County and co-permittees | Ventura County and co-permittees |
| NPDES No. CAS614001 | NPDES No. CAS063339 |
| Waste Discharge Requirements Order No. 96-054 | Waste Discharge Requirements Order No. 94-082 |

Revised 12/13/99

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**Estimates of RiverPark Pollutant Load to Santa Clara River**

**Hydraulic Load:**

| Parameter: | Existing | Project |
|---|---|---|
| Drainage Area (ac) | 350 | 1004 |
| Avg. Annual Precip (in/yr) | 15.9 | 15.9 |
| Fraction Agricultural | 71% | 38% |
| Fraction Commercial | 14% | 21% |
| Fraction Industrial | 0% | 22% |
| Fraction Residential | 15% | 19% |
| Total Hydraulic Load (AF/yr) | 334 | 947 |

**Land-Use Runoff Coefficients and Mean EMCs:**

| Parameter: | Agriculture | Commercial | Industrial | Residential |
|---|---|---|---|---|
| Runoff Coeff. | 0.76 | 0.59 | 0.80 | 0.65 |

**Pollutant Load:**

| Pollutant | Units | | Existing Conditions | | Project Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Raw Runoff | | Treated Runoff | |
| | EMC | Load | EMC | Load | EMC | Load | EMC | Load |
| Total Coliform | MPN/100ml | MPN/day | 209,180 | 2.35E+12 | 143,819 | 4.59E+12 | 25,918 | 8.27E+11 |
| Fecal Coliform | MPN/100ml | MPN/day | 26,150 | 2.94E+11 | 19,653 | 6.27E+11 | 2,027 | 6.47E+10 |
| Fecal Streptococci | MPN/100ml | MPN/day | 70,085 | 7.88E+11 | 51,992 | 1.66E+12 | 8,653 | 2.76E+11 |
| Total Susp. Solids | mg/L | lb/day | 885 | 2.19E+03 | 649 | 4.56E+03 | 70 | 4.92E+02 |
| ChemA | ug/L | lb/day | ND | --- | ND | --- | ND | --- |
| Toxaphene | ug/L | lb/day | ND | --- | ND | --- | ND | --- |

**Anticipated Stormater Event Mean Concentration Data Source:**
Integrated Water Resources. September 2000. Design and Technical Analysis of Stormwater Quality Treatment System for RiverPark.

**Definition of Terms:**
**"Existing Conditions"** are such that the existing agricultural and urban areas immediately north of Hwy. 101 drain to the River.
**"Project Conditions"** is the drainage scheme of the Project as described in the Water Resources Section of the RiverPark EIR.
**"Raw Runoff"** is the stormwater which drains directly from the drainage area prior to any treatment via BMPs.
**"Treated Runoff"** is the stormwater which drains from the drainage area subsequent to treatment via BMPs.
**"MPN"** = most probable number

**Estimates of RiverPark Hydrologic Load to Santa Clara River**

Rational Method: Q = CIA

**10/50/100-Year Storm Event Rainfall Intensities:**

| | |
|---|---|
| $I_{10}$ (in/hr) | 2.5 |
| $I_{50}$ (in/hr) | 3.25 |
| $I_{100}$ (in/hr) | 3.61 |

**Avg. Annual Precip. (in/yr):**

| | |
|---|---|
| Wet Year | 46.1 |
| Avg. Year | 15.9 |
| Dry Year | 5.0 |

**Cumulative Annual Runoff to River from Project:**

| Conditions | Area (ac) | C | Wet Year Q (AF/yr) | Avg. Year Q (AF/yr) | Dry Year Q (AF/yr) |
|---|---|---|---|---|---|
| Existing Conditions | 350 | 0.35 | 471 | 162 | 51 |
| Baseline Project | 255 | 0.70 | 686 | 237 | 74 |
| 10/10 Plan | 255 | 0.70 | 686 | 237 | 74 |
| Bypass Plan | 755 | 0.50 | 1450 | 500 | 157 |

**10/50/100-Year Storm Event Peak Flows from Project to River:**

| Conditions | Area (ac) | C | $Q_{10}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | % Change |
|---|---|---|---|---|---|---|
| Existing Conditions | 350 | 0.35 | 306 | 398 | 442 | 0% |
| Baseline Project | 255 | 0.70 | 446 | 580 | 644 | 46% |
| 10/10 Plan | 255 | 0.70 | 446 | 580 | 644 | 46% |
| Bypass Plan | 755 | 0.50 | 944 | 1,227 | 1,363 | 208% |

**Notes:**

Annual precipitation data from Ventura County Flood Control District for El Rio County Yards Station.
Storm event precipitation intensities from Ventura County Hydrology Manual.

# APPENDIX 4.5-5

## Design and Technical Analysis of the Proposed Stormwater Quality Treatment System for RiverPark

# DESIGN AND TECHNICAL ANALYSIS OF THE PROPOSED STORMWATER QUALITY TREATMENT SYSTEM FOR RIVERPARK

November 12, 2001

# Table of Contents

**EXECUTIVE SUMMARY** ..... **1**
**INTRODUCTION** ..... **3**
Stormwater Management Goals ..... 3
Proposed Stormwater Quality Treatment System Overview ..... 3
Anticipated Treatment Results ..... 5
**PROPOSED STORMWATER QUALITY TREATMENT SYSTEM** ..... **6**
Existing Drainage Conditions ..... 6
Drainage Area #1 ..... 6
Drainage Area #2 ..... 6
Drainage Area #3 ..... 6
Drainage Area #4 ..... 6
Proposed Drainage Improvements ..... 7
Drainage Area #1 ..... 7
Drainage Area #2a ..... 7
Drainage Area #2b ..... 8
Drainage Area #3a ..... 8
Drainage Area #3b ..... 8
Drainage Area #4 ..... 9
Treatment System Design ..... 9
Pretreatment Dry Swale Design ..... 9
Detention Basin Design ..... 11
Structural BMP's ..... 12
Facilities Maintenance ..... 12
Soil Types and Estimated Permeabilities ..... 13
**STORMWATER TREATMENT BENEFITS OF PROPOSED SYSTEM** ..... **15**
State of the Science ..... 15
Stormwater Water Quality Literature Review ..... 15
Anticipated Raw Stormwater Quality ..... 17
Data used for Drainage Areas #1 and #2 ..... 18
Data Used for Drainage Areas #3 and #4 ..... 19
Water Quality Data Management and Processing ..... 20
Anticipated Raw Stormwater Constituent Concentrations ..... 20
BMP Removal Efficiencies ..... 24
BMP Treatment for Drainage Area #1 ..... 24
BMP Treatment for Drainage Areas #2, #3 and #4 ..... 25
Supplementary Water Quality Improvement in Pits ..... 27
Thresholds of Significance ..... 28
Stormwater Quality Assessment: Standard Stormwater Constituents ..... 30
Stormwater Quality Assessment: Other Constituents of Concern ..... 33
Pesticides ..... 33
Pathogens ..... 35
Chromium-VI ..... 38
MTBE ..... 39
Regulatory Considerations ..... 43
**REFERENCES** ..... **44**

**APPENDIX A: SAT LITERATURE REVIEW** ..... **50**
History of SAT ..... 50
Summary of SAT Removal Mechanisms ..... 50
Sediments and Organics ..... 51
Nutrients ..... 53
Pathogens ..... 54
Metals ..... 56
Summary of Vadose Zone Treatment ..... 57

# EXECUTIVE SUMMARY

The proposed RiverPark development consists of the existing Oxnard Town Center area and adjacent land to the north currently owned by Hanson Aggregates Company. The Town Center area is located immediately north of the Ventura Freeway (California State Highway 101) and adjacent to the east bank of the Santa Clara River. This southern portion is known as RiverPark "A". The Hanson Aggregates portion, known as RiverPark "B", has been used over the past several decades for gravel mining and cement batch processing. A legacy of Hanson's mining is three large pits, which have been mined deeper than the typical depth to the local groundwater table. The water which is visible in the pits much of the time, therefore, is exposed groundwater. Because of the significant use of this groundwater resource by the local community, this analysis conducts careful evaluation of potential impacts, mitigation measures and project alternatives. Because runoff of stormwater into the pits represents a potential pathway for a variety of entrained constituents to directly enter the groundwater system, a carefully designed stormwater treatment and conveyance system is developed as a fundamental component of the RiverPark development. This stormwater treatment system will capture, treat and convey stormwater runoff for the vast majority of storm events to the Santa Clara River, and thereby prevent direct contact with the local groundwater present in and adjacent to the gravel pits. Only stormflows generated during the later stages of larger, less frequent events (greater than the 10-year storm event) discharge into the pit. Fundamental to the overall design of the treatment system is the concept that these excess flows are known to be of better quality than the smaller, more frequent stormflows.

The stormwater treatment system will employ several Best Management Practice ("BMP") treatment devices including grass-lined pretreatment "dry" swales, detention basins and selected structural devices. These facilities are commonly used for the proposed purposes and are recommended for such use in the Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan. The natural treatment processes that occur within these types of stormwater BMP's" are known to effectively treat a wide range of constituents commonly present in stormflows from the land uses within and tributary to the project area.

The proposed system includes separate conveyance and treatment systems for the stormwater runoff from each of the four primary drainage areas associated with RiverPark (see Figure 1). For the RiverPark A commercial area, all stormwater is conveyed by a dry swale and a series of stormdrains into a master stormdrain which connects to the existing Stroube stormdrain which, in turn, daylights at the Santa Clara River. Both a dry swale and a series of structural BMP's such as catch basin inserts, centrifugal separator units and pervious pavement (for selected parking areas) are included for stormwater treatment within this drainage network. For the RiverPark B residential area and the two offsite areas that are tributary to the project site (i.e., the industrial area to the north and the agricultural area to the east), natural BMP's—including dry swales and detention basins—are included to convey, detain and treat runoff from up to the 10-year storm event. Treated flows discharge to the Santa Clara River via dedicated stormdrains. Stormflows exceeding the capacity of the

proposed stormwater quality treatment system bypass this system and are conveyed through overflow facilities to one of the adjacent pre-existing gravel pits (referred to in this report as "Water Storage/Recharge Basins"). The Water Storage/Recharge Basins have the collective capacity to store the cumulative runoff volume from up to the 100-year event of the tributary drainage areas, assuming the precondition of historic high groundwater levels in the Basins and 1 foot of reserved freeboard.

The pretreatment dry swales and detention basins provide runoff detention and contaminant removal before discharge to the river. These BMP's provide the benefit of controlling the peak stormwater discharge rates, thereby maintaining downstream erosion and protecting stream habitat. In addition, the BMP's provide numerous mechanisms of contaminant removal, including vegetative and subsurface filtration during dry swale overland flow and infiltration, and sedimentation of suspended solids during detention basin storage. Natural BMP's also aesthetically enrich the development by providing open space while meeting the overall design goal of creating an environmentally conscious community.

The dry swales and detention basins significantly reduce raw stormwater constituent concentrations. Storm events that exceed the 10-year event capacity of the treatment systems will be sufficiently diluted such that their stormflows will not require the extent of treatment provided for the smaller than 10-year event storms. The proposed system exceeds the minimum regulatory and design requirements established by the Ventura County Stormwater Quality Urban Impact Mitigation Plan ("SQUIMP") for stormwater BMP's for new developments. The proposed stormwater quality treatment system also includes considerations of the criteria included in the recently promulgated resolutions of United Water Conservation District and Fox Canyon Groundwater Management Agency regarding stormwater discharges.

This report describes the existing and proposed drainage conditions for the RiverPark tributary drainage areas, describes the conceptual design of the proposed stormwater quality treatment system, summarizes the scientific underpinnings of the treatment approach and evaluates the raw and post-treatment stormwater quality for both existing and post-development conditions relative to the EIR water quality impact thresholds adopted for the project. Based on these stormwater quality evaluations, significant impacts are identified despite the considerable improvement of discharged project stormwater quality relative to the existing and raw project stormwater quality. These impacts are limited to fecal coliform for project stormwater discharges to the Santa Clara River (for stormflows resulting from storms smaller than or equal to the 10-year event); and iron, manganese and nickel for project stormwater discharges to the Water Storage/Recharge Basins (for stormflows resulting from storms that exceed the 10-year event). Stormwater discharge constituent concentrations to the Water Storage/Recharge Basins do not exceed any primary or secondary drinking water standards or Maximum Contaminant levels ("MCL's").

# INTRODUCTION

## Stormwater Management Goals

The goals of the RiverPark stormwater management program are as follows:

- To employ natural treatment systems to control, convey and treat stormwater generated on-site within the specific plan area of RiverPark and to control, convey and treat the stormwater that has historically flowed onto the RiverPark Specific Plan area from offsite, tributary areas;
- To meet the regulatory and design requirements established by the Ventura County Stormwater Quality Urban Impact Mitigation Plan ("SQUIMP"), the Los Angeles Regional Water Quality Control Board ("RWQCB") Water Quality Control Plan, California Department of Health Services ("DHS") drinking water regulations and the U.S. Environmental Protection Agency ("EPA") National Pollution Discharge Elimination System ("NPDES");
- To consider criteria included in recent resolutions adopted by United Water Conservation District ("UWCD") and Fox Canyon Groundwater Management Agency ("FCGMA") regarding stormwater discharges; and
- To minimize or avoid impacts to Santa Clara River water quality or Montalvo Forebay aquifer water quality as determined by evaluating anticipated pre- and post-development stormwater quality in comparison with water quality impact thresholds adopted for the project's Environmental Impact Report ("EIR").

## Proposed Stormwater Quality Treatment System Overview

Stormwater flows generated within the RiverPark Specific Plan Area and those generated from offsite areas that have historically drained into the Specific Plan Area are conveyed to either the Santa Clara River (subsequent to treatment through the BMP's) or, during storms larger than the 10-year event, to the pre-existing gravel pits (referred to as "Water Storage/Recharge Basins"). The destination of the stormwater flows depends upon the magnitude of the rainfall event and location of the individual drainage area. Six (6) distinct drainage areas will utilize independent collection and conveyance systems to manage their respective stormflows. These six areas (shown in Figure 1) tributary to the Specific Plan Area are delineated as follows:

| | |
|---|---|
| Drainage Area 1. | Southern commercial areas of RiverPark "A"; |
| Drainage Area 2a. | Western RiverPark "B" along the Santa Clara River and a small northwestern residential area of RiverPark "A"; |
| Drainage Area 2b. | Eastern RiverPark "B" adjacent to the Brigham-Vickers Water Storage/Recharge Basin; |
| Drainage Area 3a. | Northernmost off-site industrial area including Beedy Street and the proposed Juvenile Justice Center area (formerly occupied by Giacapuzzi agricultural land); |
| Drainage Area 3b. | Southern portion of off-site industrial area, including Montgomery and Lambert Streets; |

Drainage Area 4. Existing agricultural area east of Vineyard Avenue and northeast of the RiverPark Specific Plan Area, in addition to a small industrial area along Carnegie Street.

The stormwater conveyance and treatment Best Management Practices ("BMP's") proposed for these separate areas are individually described and illustrated in this report. For Drainage Area 1, all stormflows are collected in a backbone storm drain system that discharges into the existing Stroube Drain which, in turn, discharges into the Santa Clara River. Catch basin inserts, pervious pavement (for selected parking areas) and manhole-accessible centrifugal separator units are additional structural BMP features incorporated into the stormwater management plan for this drainage area.

For Drainage Areas 2, 3 and 4 pretreatment dry swales and lined detention basins are utilized. Stormflows are detained in the basins, thereby allowing for sediment and sediment-associated constituents to settle-out of suspension, and then be conveyed to the Santa Clara River via dedicated stormdrains. Stormflows exceeding the 10-year event peak flow bypass the BMP's and are conveyed directly to a nearby Water Storage/Recharge Basin. Considering the large influence of dilution, the water quality of these rare, intense storm flows—which do not occur until the latter stages of each storm event—are greatly improved over the quality of flows from the smaller and more regular storm events.

The detention basins and dry swales provide runoff retention and contaminant removal before discharge to the river. These BMP's provide the benefit of controlling post-development peak stormwater discharge rates, thereby controlling downstream erosion, protecting stream habitat, and providing components of multiple treatment barrier protection of water resources. In addition, the BMP's provide numerous mechanisms of contaminant removal, including:

- Vegetative filtration during overland flow through the dry swale channels;
- Subsurface adsorption/filtration during dry swale infiltration and subsurface transport; and,
- Sedimentation of suspended solids during detention basin containment.

Benefits of employing these systems for the treatment and control of stormwater runoff from the site include:

- Natural systems are used for the conveyance and treatment of design storm events;
- Flows through the system are entirely gravity driven;
- Flood control benefits associated with ample storage capacity and pervious coverage;
- Aesthetic enrichment of the development due to the expansive open space they afford; and,
- Consistency with overall design goals of creating an environmentally conscious community.

**Anticipated Treatment Results**

As described and documented in the following sections of this report, natural filtration and detention facilities, such as those included in the proposed system, remove substantial percentages of suspended solids, microorganisms, hydrocarbons, metals and nutrients which may be present in stormwater from the types of land uses present on and tributary to RiverPark. Post-treatment constituent concentrations are calculated, based upon anticipated concentrations of individual constituents determined to be present in each drainage area's stormwater runoff, and the anticipated treatment via the stormwater BMP's utilized. These represent the anticipated stormwater constituent concentrations that may reach the Santa Clara River at the Stroube Drain outfall. Additionally, an analysis is conducted demonstrating the water quality of stormwater discharged to and infiltrated through the exposed groundwater of the Water Storage/Recharge Basins during storm events exceeding the 10-year event.

As documented in this report, the proposed treatment system will significantly reduce the concentrations for all constituents of concern to the project and substantially reduce any potentially significant impacts to the water quality of the Santa Clara River or the Montalvo Forebay aquifer resulting from proposed stormwater discharges. Based on these stormwater quality evaluations, several significant impacts are identified despite the considerable improvement of discharged project stormwater quality relative to the existing and raw project stormwater quality. These impacts are limited to fecal coliform for project stormwater discharges to the Santa Clara River (for stormflows resulting from storms smaller than or equal to the 10-year event), and iron, manganese and nickel for project stormwater discharges to the pits (for stormflows resulting from storms that exceed the 10-year event). Stormwater discharge constituent concentrations to the pits will not exceed any primary or secondary drinking water standards or Maximum Contaminant levels ("MCL's").

# PROPOSED STORMWATER QUALITY TREATMENT SYSTEM

## Existing Drainage Conditions

The RiverPark Specfic Plan area is primarily agricultural and mining land. There is also a small industrial area along the southern boundary known as the "Oxnard Town Center". The lay of the land for the site roughly follows gradient of the Santa Clara River to the southwest at a slope of generally less than 0.5%. The project site lies within Rainfall Zone K and is composed of soil group Numbers 3, 5 and 7 based on the Oxnard and Saticoy Hydrologic Maps. The following discussion serves to summarize the existing drainage conditions at the on- and off-site project drainage areas.

### *Drainage Area #1*

There currently exists a 10-foot wide by 8-foot high reinforced concrete box constructed in conjunction with the Town Center development. This facility is commonly referred to as the "Stroube Stormdrain" and currently discharges through the levee to the Santa Clara River north of the 101 freeway bridge. The County Drainage Master Plan indicates extension of this drain to Stroube Avenue east of Vineyard Avenue to alleviate flooding that occasionally occurs in that area. RiverPark development plans include installation of a stormdrain north of this proposed alignment for collection and conveyance of the Drainage Area #1 runoff. No stormwater BMP's are currently used to detain or treat stormflows from this drainage area before river discharge.

### *Drainage Area #2*

SP Milling Company's concrete batch plant and active sand and gravel mining operations currently occupy the proposed RiverPark B site area. These stormflows are entirely contained on-site—i.e., stormwater infiltrates into the ground, evaporates to the atmosphere, or drains into a nearby gravel pit.

### *Drainage Area #3*

Stormwater from the Montgomery, Lambert, and Beedy Street industrial and agricultural areas currently drains directly to the existing Large Woolsey mining pit. These existing drainage systems are comprised of limited pipeline and overland drainage systems. No stormwater BMP's currently exist to detain or treat stormflows from this drainage area before discharge to the existing gravel pits.

### *Drainage Area #4*

Drainage Area #4 consists of a large off-site agricultural drainage area northeast of and tributary to the project site area. This drainage area is primarily occupied by the Jones Strawberry fields. The County has constructed an extensive drainage system that includes two infiltration basins to accommodate this off-site runoff. The first such facility, Ventura County Drainage Basin No. 1—also referred to as the El Rio Basin No.

1—is a 10-acre infiltration basin located adjacent the west side of Vineyard Avenue north of Simon Way. The second, located north of the existing El Rio neighborhood on the west-side of Vineyard Avenue, is a 65-acre depression referred to as El Rio Basin No. 2, or the Campbell Basin. Stormwater from Drainage Area #4 is collected in a 78-inch RCP pipeline near Lemar and Vineyard Avenues and is discharged into Ventura County Drainage Basin No. 1. There is an 84-inch RCP pipeline outlet from the southwest corner of this basin which drains to El Rio Basin No. 2, where the majority of high flow events are stored. These basins have the combined capacity to store and infiltrate the cumulative volume of the 100-year storm event. Flows into these basins either percolate into the unconfined aquifer below or evaporate to the atmosphere. The elevations of the bottoms of these basins are relatively deep as compared to local historic high groundwater levels, resulting in the presence of a thin vadose zone. This thin vadose zone allows only minimal natural water quality improvement before contact with the underlying unconfined aquifer.

## Proposed Drainage Improvements

The following discussion serves to summarize the proposed drainage improvements at the on-site and off-site project drainage areas as depicted in Figure 1. These improvements are consistent and integrated with the Drainage Master Plan work currently in preparation by Hawks Engineers of Ventura for the City of Oxnard.

### *Drainage Area #1*

Stormwater drainage from the southern (primarily commercial) areas of RiverPark A will be treated by a dry swale located in the median of Santa Clara River Boulevard and conveyed in an underlying stormdrain pipeline. This stormdrain pipeline discharges to the existing Stroube stormdrain that, in turn, discharges through the levee to the Santa Clara River. This stormdrain design will accommodate up to the 100-year peak flow event. Catch basin inserts and manhole-accessible centrifugal separator units, with the potential addition of other structural BMP's, are incorporated into the storm drain system to meet Ventura County and City of Oxnard requirements for stormwater discharge.

PRC Toups Corp. prepared a Master Plan of Drainage in 1979 noting several problem areas near RiverPark, particularly along the US 101 frontage and at Stroube Street at Vineyard Avenue. Considering that only a portion of the stormdrain facilities recommended by the Master Plan has been constructed, it is unlikely that these flooding problems have been alleviated.

### *Drainage Area #2a*

Stormdrains from this residential area will discharge to either the North Detention Basin or a pretreatment dry swale located between the eastern side of the Santa Clara River levee and the western border of the RiverPark B residential area. Flows from these storm drains will join with stormflows from Drainage Area #3, which also are routed through the North Detention Basin and the dry swale along the river. This swale will convey stormflows southward to a discharge point to the Santa Clara River located at

approximately the RiverPark A-B boundary. Stormflows that exceed the 10-year event peak flow will overtop the swale and be detained in the surrounding cottonwood forest. This riparian buffer strip will therefore serve as a detention basin or floodplain to alleviate flooding during very large stormflow events.

***Drainage Area #2b***

Storm drains from this residential drainage area either discharge to the South Detention Basin or the pretreatment dry swale located between the eastern side of the RiverPark B residential area and the western edge of the Brigham-Vickers Water Storage/Recharge Basin. The swale will convey stormflows southward to the South Detention Basin, which then drains to a large capacity pipeline for conveyance to the Drainage Area #1 stormdrain pipeline and ultimately to the Santa Clara River. Stormflows that exceed the 10-year event peak flow will bypass directly to the Brigham-Vickers Water Storage/Recharge Basin.

The combined storage volume of the Water Storage/Recharge Basins is slightly larger than a 100-year storm event from all the on-site and off-site tributary drainage areas (Haslinger, 2001). This storage capacity estimate assumes a historic high groundwater elevation of 78 feet and allows for 1 foot of freeboard.

***Drainage Area #3a***

Stormdrains from this industrial drainage area discharge to a dry swale located between the eastern edge of the Large Woolsey Water Storage/Recharge Basin and the western border of the Beedy Street/JJC area. The swale conveys storm flows southward to a large capacity stormdrain that discharges to the North Detention Basin, located on the northern edge of RiverPark B. This north detention basin drains to the Drainage Area #2a dry swale located adjacent to the western edge of the RiverPark B residential area. The swale will convey stormflows southward to a large capacity stormdrain which outlets to the Santa Clara River.. Stormflows exceeding the 10-year event peak flow bypass the treatment system via flow bifurcation structures located at the catch basins, and flow directly to the adjacent Large Woolsey Water Storage/Recharge Basin.

***Drainage Area #3b***

Storm drains from this industrial drainage area will discharge to a large capacity storm drain pipeline located between the eastern edge of the Large Woolsey Water Storage/Recharge Basin and the western border of the Montgomery/Lambert Street area. A pretreatment swale is not included here because of insufficient width between the western edge of the industrial area at Lambert Street and the eastern edge of Large Woolsey pit. The stormdrain discharges to the North Detention Basin. The North Detention Basin drains to the Drainage Area #2a dry swale that runs adjacent to the western edge of the RiverPark B residential area. The swale conveys stormflows southward to a large capacity storm drain pipeline which outlets to the Santa Clara River. Stormflows exceeding the 10-year event peak flow bypass the treatment system via flow bifurcation structures located at the catch basins, and flow directly to the adjacent Large Woolsey Water Storage/Recharge Basin.

### *Drainage Area #4*

Stormflows generated from the agricultural area tributary to the project site are conveyed via existing drainage channels into a dry swale located at the drainage area's southern boundary. The swale conveys storm flows westward and across Vineyard Avenue to the East Detention Basin adjacent to the Brigham-Vickers Water Storage/Recharge Basin. Stormflows from the Carnegie Street industrial area (a relatively minor contribution) discharge directly to the East Detention Basin. This detention basin drains to a large capacity stormdrain which discharges into the Drainage Area #1 stormdrain, and ultimately to the Santa Clara River. Stormflows that exceed the 10-year event peak flow will bypass the swale via an existing drainage ditch and discharge directly to the Brigham-Vickers Water Storage/Recharge Basin.

## Treatment System Design

The following discussion summarizes design of BMP's for the proposed stormwater quality treatment system for RiverPark. The natural BMP's convey and store up to the 10-year storm event. As evidence of the ability of this stormwater treatment system to treat the majority of stormflow events, implementation of this system would have prevented stormwater discharge to the pits during the past 20 years, based upon daily precipitation data as analyzed by Todd Engineers.

### *Pretreatment Dry Swale Design*

As illustrated in Figure 1, five (5) pretreatment dry swales are incorporated into the stormwater quality treatment system for RiverPark, as follows:

1. within Santa Clara River Boulevard in Drainage Area #1,
2. along the western boundary of Drainage Area #2a,
3. along the eastern boundary of Drainage Area #2b,
4. along the western edge of Drainage Area #3a, and
5. along the southern edge of Drainage Area #4.

These pretreatment dry swales ("dry" because they remain dry most of the year) are designed to convey and treat stormflows from their tributary drainage areas. They are sized to detain and convey up to the 10-year peak flow, while reserving 1 foot of freeboard (see Figure 2).

The dry swales consist of a 4 to 6 inch layer of topsoil underlain by a 3 to 6 foot layer of moderately permeable soil containing a high level of organic matter (Natural Resource Conservation Service soil types ML, SM, or SC). A thick soil layer produces greater water treatment due to the soil's ability to adsorb/filter contaminants from the percolating stormwater. A 6 to 12 inch layer of 3/8-inch gravel comprises the base layer, and surrounds a perforated pipe underdrain collection system. The soil/gravel interface can either consist of a permeable filter fabric or a 6-inch roto-tilled mixing zone of fine sand, soil, and gravel to augment the filtering capability of the system. Underdrain pipe

diameters are sized to accommodate anticipated flows through the various sections of the dry swales.

During runoff-generating storm events, stormwater will discharge from local stormdrains to the dry swales at the stormdrain outfalls via bifurcation structures. Flows up to the 10-year event peak flows are directed into each dry swale via flared outlets and energy dissipation structures (for erosion control), while flows greater than the 10-year event peak flows are conveyed to an adjacent Water Storage/Recharge Basin. Storm water discharged into each dry swale spreads across the surface of the swale and subsequently either percolates through the swale's permeable soil layers or flows over the channel's surface. Subsurface flows are collected within the swale's gravel base layer by gravity-flow pipe underdrains. Both surface (channel) and underdrain flows deliver treated water to an outflow structure discharging to either a detention basin or large capacity stormdrain. Although the swales are not lined, minimal infiltration to the groundwater will occur because the gravel and underdrain base layer is will rapidly collect percolated stormflows and convey them to the swale outlet.

Swale side-slopes will be 3:1 for ease of maintenance (mowing), as well as for providing supplementary pretreatment (flow retardation and vegetative filtration) for lateral flows into the swales. The swales' longitudinal slopes will be approximately 0.2%, or 0.002 ft/ft. The cross sections of the swales can be trapezoidal or U-shaped, with widths of 60 to 90 feet and depths of 5 to 6 feet. One perforated pipe underdrain is included for approximately every 15 feet of width at the swale's base. In an effort to control sediment loads from the off-site agricultural area to the East Detention Basin, the dry swale serving Drainage Area #4 includes several energy dissipation or check structures along its length to induce sedimentation of the anticipated entrained sediment load. Additional swale design information is provided in Table 1 below.

As previously stated, stormwater bifurcation structures located at the catch basins will divert excess flows (i.e., flows which exceed the 10-year peak flow) directly to an adjacent Water Storage/Recharge Basin. In the case of the swale located along the western boundary of Drainage Area #2a, a cottonwood buffer strip will serve as a floodplain for temporary storage of stormwater during very large storm events. Because a detention basin outlet drain feeds this swale, this connection pipe will be routed under the dry swale for a distance until the pipe is day-lighted into the swale.

**Table 1. Dry Swale Dimensions and Hydraulic Capacities**

| **Drainage Area** | **#1** | **#2a** | **#2b** | **#3a** | **#4** |
|---|---|---|---|---|---|
| Swale Width (ft) | 40 | 90 | 70 | 60 | 90 |
| Swale Depth (ft), incl. 1 ft free board | 5 | 6 | 6 | 5 | 6 |
| Swale Length (ft) | 2,000 | 3,200 | 1,600 | 1,000 | 1,800 |
| Swale Flow Capacity (cfs) | 65 | 246 | 167 | 102 | 246 |

Bermuda grass (*Cynodon dactylon*) or alkali sacaton (*Sporobolus airoides*) is planted along the length of the dry swales based on their known tolerances for periodic inundation/drought, warmer climates, and higher shear stresses (which are associated with the larger flow events). The longitudinal profile of the swale allows for slight undulations, thereby encouraging temporary ponding subsequent to storm events, and hence, more likely visitation/habitat-formation of native waterfowl and amphibian species. Further design of vegetation planning along the swales' edges will be conducted by RiverPark landscape architects and biologists.

Because particulate filtering is such a dominant removal mechanism for metals in grass swales, Wang *et. al.* (1980) concluded that it may be necessary to remove the contaminated soils and replant the grass periodically to prevent dislodging of the deposited polluted sediments. In consideration of these findings, a provision for BMP floor scraping and sediment disposal has been included in the "Facilities Maintenance" section of this report.

***Detention Basin Design***

As shown in Figure 1, three detention basins are incorporated into the proposed stormwater quality treatment system for RiverPark: the North Detention Basin located north of Drainage Area #2a; the South Detention Basin located along the southern boundary of the Brigham-Vickers Water Storage/Recharge Basin; and, the East Detention Basin located along eastern edge of the Brigham-Vickers Water Storage/Recharge Basin. These latter two detention basins are hydraulically-linked. These basins are lined with impermeable material and provide sufficient capacity to store the cumulative runoff volume from the 10-year storm event for the tributary drainage areas. The basins detain stormflows for a sufficient period to allow suspended solids to settle and to delay the time of concentration for stormflows from the various drainage areas to prevent exceeding the capacity of the stormdrain pipelines. The lined basin bottoms will prevent stormwater from infiltrating through the basins' floors to the aquifer below. A typical detention basin cross-section is provided in Figure 3. The lining material will be a plastic material, such as PVC, or compacted soil that meets all standards for impermeability that apply to this project.

The Drainage Area #2a dry swale will discharge to a pipeline which daylights at the Stroube drain. All other dry swales—both underdrain and overland flows—will discharge to a detention basin via a flared outlet and energy dissipation structure (for erosion control). Each basin will then drain via a low elevation (invert located approximately 1 foot above basin floor), low capacity culvert outlet to a large capacity storm drain pipeline (or in the case of the North Detention Basin, to the dry swale in Drainage Area #2a). A medium elevation broad-crested weir is included to direct stormflow volumes exceeding the 10-year cumulative runoff volume to an adjacent Water Storage/Recharge Basin. Finally, a high elevation (invert located approximately at freeboard elevation, 1 foot below basin crest), high capacity emergency bypass weir is included to augment this diversion capacity during the most intense storm events to prevent flooding of the surrounding areas.

Each basin varies between 8 and 10 feet deep, allowing for 1 foot freeboard, with side slopes of 3:1 or steeper in order to maximize retention capacity. The basins' bottom elevations allow for a minimum of 1 foot above local historic high groundwater levels to ensure that elevated groundwater levels do not compromise basin holding capacity or pit slope stability. Average areas of the three basins range from approximately 4 to 11 acres, thereby allowing between 28 and 99 AF of storage in each. The basins' storage capacities and outlet drain designs allow for minimum hydraulic retention times of several hours to encourage suspended sediments and sediment-associated constituents to settle out. A brief overview of the basins' characteristics is provided in Table 2.

**Table 2. Detention Basin Dimensions and Hydraulic Capacities**

| Basin | North | South | East |
|---|---|---|---|
| Basin Top Elevation (ft) | 80 | 81 | 90 |
| Basin Bottom Elevation (ft) | 72 | 73 | 80 |
| Basin Depth (ft), incl. 1 ft free board | 8 | 8 | 10 |
| Basin Average Area (ac) | 9 | 4 | 11 |
| Basin Volume Capacity (ac-ft) | 63 | 28 | 99 |

In addition to grass-lining, the basins may be vegetated at the discretion of the landscape architects, planners and biologists. Buffer strips are included for park space, walkpaths, benches, trees or other visual amenities. For pit slope stabilization reasons, a minimum 20 foot buffer is included between each detention basin or dry swale and the adjacent Water Storage/Recharge Basin top of slope. 39-foot buffer strips are maintained for the East and North Detention Basins as walkpaths alongside the Water Storage/Recharge Basins.

Because the accumulation of metals in detention basins receiving urban stormwater has been observed during various studies (e.g., Van Loon *et. al.*, 2000), a provision for detention basin scraping and sediment disposal is included in the "Facilities Maintenance" section of this report. Implementation of this procedure will occur if the basin soils are observed to contain unacceptable levels of metals.

### *Structural BMP's*

Catch basin inserts, manhole-accessible centrifugal separator units, and pervious pavement (for selected parking areas) are some of the structural BMP's that will be used in RiverPark A. These structural BMP's are prebuilt and are installed and maintained according to their manufacturers' specifications. These BMP's will serve to fulfill the NPDES requirements for stormwater BMP's within this drainage area.

## Facilities Maintenance

Inlets, outlets and bypass structures shall be inspected weekly during the winter and spring for trash and debris. Swales and basins shall be mowed and irrigated at the

landscaper's discretion in order to maintain healthy vegetation and aesthetics. The dry swales' drain outlets shall be examined after all large storms to ensure on-going flow viability through the underdrain collection and conveyance systems. Depending upon rate of clogging and sediment build-up, the swales shall be excavated every three (3) to seven (7) years for underdrain and filter media inspection. Detention basins may require cleaning of approximately every five (5) years, depending upon the rate of accumulation of bottom sediments. Depending on constituent concentrations in the excavated sediment, special disposal considerations may have to be used.

**Soil Types and Estimated Permeabilities**

Native undisturbed earth materials in the RiverPark B area generally consist of sand with variable amounts of gravel. Artificial fill materials encountered at the western end of RiverPark B generally consist of fine sands with varying amounts of silt and clayey silt that were discarded from the aggregate mining process. Similar artificial fill materials are likely in the previously excavated area located immediately southwest of the Large Woolsey pit. These fill materials are anticipated to be finer-grained (i.e., silty fine sand) than the native materials encountered in the adjacent plant area located immediately to the southwest.

The permeabilities for native and artificial fill materials located near the East and North Detention Basins are estimated based on the soil types anticipated in those areas. The permeability of the earth materials below the East Detention Basin, assuming native undisturbed materials, should be on the order of about 1 to $10^{-1}$ cm/sec. That permeability range is generally consistent with the rates measured for similar type materials encountered in the Stockpile area and from the Ferro pit area on the adjacent Vulcan Materials Plant property (Fugro, 1997). The permeability of the native materials at the North Detention Basin are likely to be similar to those estimated above for native materials, while the permeability of the fill materials (located roughly on the eastern _ of the basin footprint) are expected to be $10^{-1}$ to $10^{-2}$ cm/sec, assuming sand with silt to silty sand fill materials.

The permeability of the artificial fill materials near the South Detention Basin in Drainage Area #2 (i.e., the former "Stockpile" area) probably ranges between roughly $10^{-2}$ and $10^{-7}$ cm/sec, assuming a variety of fill materials ranging from sand with silt to clayey silt to clay. For the upper 3 feet of earth materials (silty sand to sandy silt) below an assumed basin bottom elevation of about El. 73 feet, a rough estimate of the permeability is about $10^{-3}$ cm/sec. Additionally, in proximity to this residential detention basin, an approximately _-foot thick clayey silt layer was encountered at about El. 72 feet, nearly even with the basin's floor. The estimated permeability of the clayey silt is on the order of about $10^{-6}$ cm/sec. The artificial fill materials in the Stockpile area will be removed down to native materials and replaced as compacted fill during the mass-grading of the RiverPark project. Through this process, distinct clay layers will be eliminated down to the bottom of the artificial fill.

In Drainage Area #2, clayey fill materials generally were encountered about 10 to 20 feet below the proposed North Detention Basin bottom. For example, in the vicinity of the North Detention Basin, and about 14 feet below the assumed basin bottom of El. 80 feet,

about 20 feet of clayey silt was encountered. West of that area, clay (with an estimated permeability on the order of about $10^{-7}$ cm/sec) to clayey silt layers were encountered at about El. 60 to 65 feet. Those clayey layers were typically greater than about 10 feet thick, however the extent of the clayey layers below the exploration depths is not known.

# STORMWATER TREATMENT BENEFITS OF PROPOSED SYSTEM

## State of the Science

Over the past several decades, many investigations have been conducted attempting to quantify typical stormwater constituent concentrations from various land uses. In general, these studies have resulted in two significant findings:

a) Stormwater constituent concentrations vary over wide ranges and require actual monitoring data and/or local studies of analogous hydrologic and land use conditions for accurate estimation; and
b) In some cases, stormwater constituent loads from urbanized drainage areas (i.e., nonpoint sources) can represent significant contributions of conventional constituents to receiving water bodies.

Therefore, urban planners and water quality professionals need to consider source control and/or treatment BMP strategies to ensure that adequate water quality is achieved for stormwater discharges. Based upon these considerations, monitoring data from several local studies have been summarized and analyzed in the following sections of this report to quantify the anticipated stormwater constituent loads from the project site for the purposes of BMP evaluation and environmental impact analysis.

### *Stormwater Water Quality Literature Review*

In an effort to provide maximum water quality improvement to the stormflows from the drainage areas of the project, an investigation was conducted on the potential changes in stormwater constituent loads that may coincide with increasing storm size. Intuitively, it seems likely that the relative concentration of entrained contaminants would be high during small rainfall events, or the early part of a larger event, and progressively lessen during larger and more long-lasting storm events. In this context, the following section presents a review of technical literature that clarifies the current understanding of both anticipated water quality from various types of land uses and the water quality changes that are likely to occur with increasing storm size.

Many recent evaluations of stormwater flows have referred to the "first flush" concept, the concentrated stormwater constituent load that occurs during the first storm following an extended dry period. Over the past decade or so, many studies have addressed this concept. Many studies have provided good documentation of the concept, although others have identified other controlling factors. The following paragraphs review the salient studies and establish the anticipated first flush effects related to the proposed drainage conditions at RiverPark.

One of the early studies that documented the first flush concept was conducted in 1990 by the Environmental and Conservation Services Department of the City of Austin, Texas. In this study, 74-83% of the average annual constituent load (which included suspended solids, organic carbon, phosphate, ammonia, organic nitrogen, nitrate, copper,

iron, lead, zinc and fecal bacteria indicators) for a 70% impervious cover watershed was shown to be associated with the initial 0.5-inches of runoff.

More recently, numerous other researchers have further investigated the first flush concept, both in the United States and overseas. Although each investigation has determined different levels of association regarding the first flush concept, and each has defined the concept differently, all have noted that stormwater constituent *concentrations* are consistently elevated during the initial stages of storm events, particularly subsequent to extended antecedent dry conditions. In addition, proportionally greater fractions of the cumulative constituent *load* have been shown to be delivered during the initial stages of the hydrograph event relative to the cumulative hydraulic load. Sansalone *et. al.* (1997) has observed this phenomenon for metals in runoff from urban Cincinnati roadways, and has shown this phenomenon to be most pronounced for the metals' dissolved—and therefore, bioavailable—fractions. In two separate European investigations, Deletec (1998) and Bertrand-Kraiewski *et. al.* (1998) have observed similar first flush effects for suspended solids in urban stormwaters, although each investigator noted the effects as being relatively minor. Larsen *et. al.* (1998), on the other hand, noted the first flush effect to be "significant" for both suspended solids and nutrients in a similar study conducted in Denmark. Finally, in a recent Korean stormwater investigation, Lee *et. al.* (2000) has observed the first flush effect to be most pronounced during large storms in small, highly impervious drainage areas. This is essentially the case for much of the proposed RiverPark development.

Perhaps the most sample-intensive stormwater quality study yet performed in California is a USGS study (Oltmann and Shulters, 1989) of four urban land-use catchments in Fresno, California. Detailed stormwater quality monitoring was conducted during dozens of storms between 1981 and 1983, and results were thoroughly analyzed. There are three very significant findings of this study pertinent to the design of the proposed stormwater treatment system for RiverPark:

- Dissolved constituent concentrations in stormwaters (e.g., nutrients, minerals and dissolved metal fractions) consistently behaved in accordance with the first flush concept; that is, their concentrations asymptotically decreased over the course of the storm event.
- Particle-bound constituent (e.g., TSS, particulate metals and bacteria) concentrations in stormwaters consistently exhibited time-series trends that mimicked the hydrograph; that is, their concentrations increased with discharge, so that concentrations were greatest during mid-event stormwater peak flows.
- Event mean concentrations ("EMC's") consistently decreased with increasing antecedent dry period for both dissolved and particle-bound constituents.
- EMC's consistently decreased with increasing cumulative storm volume—and therefore decreasing storm frequency—for both dissolved and particle-bound constituents.

Based upon the studies referenced above, the RiverPark project stormwater discharges to the Water Storage/Recharge Basins (which would occur only during the latter portion of consecutive large storm events or during the latter portion of storm events larger than the 10-year event) will likely contain the lowest concentrations of constituents determined from analog studies, particularly those problematic dissolved constituents such as nitrate,

TDS and *dissolved* metals (the most bioavailable metal form). A significant fraction of RiverPark's cumulative stormwater constituent load will be treated and delivered to the Santa Clara River during the first flush of the first significant rainfall event following an extended antecedent dry period. Although the first flush volume is typically on the order of a 2-year storm event, to ensure that a robust and conservative approach is selected for stormwater treatment, the BMP's proposed for RiverPark are sized to treat and detain the stormwater from storms as large as the 10-year event, and from the initial flows of storms larger (i.e., less frequent) than the 10-year event.

**Anticipated Raw Stormwater Quality**

For the purposes of this analysis, anticipated raw stormwater constituent concentrations are calculated based upon reports and studies summarizing results from several areas with analogous land uses and hydrologic conditions to RiverPark. The referenced reports include stormwater quality monitoring studies from Ventura County, Los Angeles, Santa Monica and Fresno, California. In addition to these analogs, this analysis utilizes local stormwater sampling results as collected by Hanson Aggregates for the industrial area (Drainage Area #3) and by United Water Conservation District ("UWCD") for the Jones Strawberry fields (Drainage Area #4). Because many of the studies did not analyze the comprehensive list of constituents considered in this EIR, in some cases anticipated concentrations for a given drainage area's constituents were selected from more than one data source.

The constituents selected for analysis include the following:

- General Minerals: Sulfate, Chloride, Total Dissolved Solids.
- Solids: Total Suspended Solids
- Nutrients: Nitrate, Ammonia
- Metals: Arsenic, Beryllium, Cadmium, Chromium (III and VI), Copper, Iron, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Zinc
- Pesticides: ChemA, Lannate
- Hydrocarbons: 'Oil & Grease', MTBE
- Microorganisms: Total Coliform, Fecal Coliform, Fecal Streptococci, Giardia, Cryptosporidium

Most of these constituents are either regularly sampled and analyzed by local agencies or are considered in analog studies referenced in this report. These constituents represent a comprehensive list for stormwater runoff analysis and include the complete set of stormwater constituents having the potential to cause significant impacts to the receiving waters of the project; i.e., RWQCB Reach #2 of the Santa Clara River and the unconfined aquifer of the Montalvo Forebay. Additional discussion of selected constituents of concern for which quantitative regional information is limited or unavailable—including pesticides, pathogens, chromium-VI and MTBE—is also provided in this report.

There are limited data available for stormwater constituent concentrations during rare, intense storm events, such as those that would result in stormwater discharges to the pits. However, it is qualitatively understood that there is a substantial dilution effect during

these rare, larger storms, which results in decreased constituent concentrations. It is only during the later, peak stages of these large events, when the concentrations of many constituents will be relatively low, that stormflows are diverted to the pits. As discussed previously, for some constituents (particularly the dissolved constituents), concentrations are elevated during the earlier stages of storm events, and rapidly decrease as the event progresses.

***Data used for Drainage Areas #1 and #2***

Drainage Areas #1 and #2 represent the commercial and residential areas, respectively, of the proposed RiverPark development. Since these areas are not yet developed, historic monitoring data is not available. Therefore, stormwater quality data from monitoring studies of local, analogous land uses must be fully relied upon to estimate the water quality of stormwater discharges from these proposed project drainage areas.

A Ventura County study (VCSWMP, 1999) investigated stormwater quality from 6 drainage areas of various land-uses during 28 different storm events between 1993 and 1998. Both the hydrologic and land-use conditions of this study are analogous to those of the project site. Therefore, for average storm events (i.e., those in which stormwater is directed through the proposed treatment system and discharged to the river), the stormwater quality data provided in this study is considered most appropriate as an approximation of the anticipated stormwater constituent concentrations from the post-development RiverPark project site.

A Los Angeles County study (LACDPW, 2000) includes a compilation of stormwater quality monitoring data from 1994 through 1999. Although this is an extensive dataset with large sample sizes, the hydrologic and land-use conditions of Los Angeles are not completely analogous to those of the project site in Oxnard, California. Therefore, for average storm events, stormwater constituent concentrations provided by this study are only used to substitute for values absent from the Ventura County study.

A Santa Monica study (Woodward-Clyde, 1998) investigated stormwater quality from 2 small residential and 2 small commercial drainage areas in Santa Monica. 7 storm events in 1997 were studied, with 1-3 stormwater samples taken at each land-use drain during each runoff-producing event. Due to the relatively small size of the drainage areas and the relatively small number of samples taken, this study is of limited application to the purposes of stormwater quality estimation for the RiverPark development. Therefore, for average storm events, the constituent concentration data provided by this study are only used to substitute for values absent from either the Ventura County or the Los Angeles County studies.

The USGS Fresno study (Oltmann and Shulters, 1989) is an extremely thorough investigation of stormwater quality for urban land uses in the Fresno, California area. Numerous storms and land-uses were extensively studied between 1981 and 1983, and a large dataset was accumulated for analysis purposes. However, because of the differing hydrologic conditions of the Fresno area (average annual precipitation is just 10 inches compared to 16 for the Oxnard area), this study is the analogous to those conditions of the RiverPark site. Therefore, for average storm events, the data provided by this study

are only used to substitute for values absent from either the Ventura County, the Los Angeles County or the Santa Monica studies.

To account for the effects of dilution during those rare, intense storm events in which stormwater discharges to the pits may occur (i.e., when stormflows exceed the 10-year event peak flows), the *minimum* constituent concentration value was taken from among the average values reported by the Ventura County, Los Angeles County and Santa Monica studies. These reported average stormwater constituent concentration values were determined almost exclusively based on sampling conducted during smaller, more frequent storm events, not during extreme events corresponding with greater dilution and therefore lower constituent concentrations. To clarify the anticipated frequency of these potential discharges to the pits, the Ventura County study reviewed 28 recent storm events of which *none* would have generated stormflows sufficient to exceed the capacity of the stormwater treatment and river discharge facilities proposed for RiverPark.

***Data Used for Drainage Areas #3 and #4***

Drainage Areas #3 and #4 represent the off-site industrial and agricultural areas, respectively, which are tributary to proposed RiverPark development. Since these areas will remain unchanged as a result of the project, historic monitoring data can be relied upon to estimate raw stormwater quality. Therefore, stormwater quality data from monitoring studies of local, analogous land uses (studies described in previous section) are used in addition to any historic monitoring data from these existing drainage areas to estimate the water quality of stormwater discharges from these off-site project drainage areas.

The Hanson data (Hanson Aggregates, 2000) include stormwater sampling results for two storms (January and April, 2000) at four drainage points in Drainage Area #3. A total of 8 samples are analyzed; one sample taken per storm at each industrial storm drain outlet—Montgomery, Lambert and Beedy Streets—and 1 per storm at a Giacapuzzi farm drain outlet. The UWCD data (UWCD, 1999) include sampling results for four storms (April, May, June and November, 1999) at various drainage locations in Drainage Area #4, therefore totaling just 4 samples analyzed. These two datasets constitute the entirety of the recent stormwater quality monitoring data available for these two off-site locations.

Geometric mean values are calculated for each constituent for each land-use for each of these two datasets. For the purpose of these statistical calculations, results reported as below detection limit were set to their respective detection limits, thus ensuring conservative estimates for those stormwater constituents present at trace levels. Then, as a further effort to be conservative, the *maximum* value for each constituent determined from either the Hanson dataset, the UWCD dataset or the Ventura County study was used to approximate the raw stormwater constituent concentrations from the off-site drainage areas (Drainage Areas #3a, #3b and #4).

To account for the effects of dilution during those rare, intense storm events in which stormwater discharges to the pits may occur (i.e., when stormflows exceed the 10-year event peak flows), the *minimum* value for each constituent from these three datasets is used to approximate raw stormwater constituent concentrations. This is a sufficiently

conservative approach because none of the storm events sampled by these three studies would have resulted in discharges to the pits if the proposed stormwater treatment facilities for RiverPark had already been installed at the time. Therefore, as the average concentrations listed in these studies are representative of average storm event constituent concentrations, by taking the minimum concentration for each constituent as reported by these three studies the most reasonable estimate possible is made for stormwater quality during large flow events. Based upon these criteria, the approach implemented for estimating raw stormwater quality is sufficiently conservative to account for the significant effect of dilution that occurs during storms that exceed the 10-year peak flows.

### *Water Quality Data Management and Processing*

Methods for utilizing non-detect sample results vary for different stormwater monitoring studies. Numerous technical papers address this issue and the uncertainty associated with estimating non-detect results. Essentially, there are 5 options available including: (1) assuming non-detects equal zero (this will bias the average low); (2) assuming non-detects equal _ the detection limit (this will have an uncertain effect on the average); (3) assuming non-detects equal the detection limit (this will bias the average high); (4) neglecting non-detect information altogether (this will bias the average even higher); and (5) using a statistical approach to estimate non-detect values. One such statistical approach to estimating non-detect values is the Helsel method (Helsel, 1990). For this method, a frequency distribution is assumed for the constituent of interest; in general, constituent concentrations in environmental media are best represented by lognormal probability distributions. Next, values for non-detect results are estimated by extrapolating this distribution to the concentrations below the detection limit. Since constituent concentrations in environmental samples are often quite close to their analytical detection limits, the approach selected for dealing with non-detects can have a significant influence on the statistical calculations.

For the Ventura County study, the Helsel method was used to estimate the values for the non-detect analytical results. For the LA County study, statistical approaches were also used (frequency distributions were determined for each constituent). For the Santa Monica study, the approach used to deal with non-detect results was not clarified. For the USGS Fresno study, non-detects were assumed to be equal to detection limits. Non-detects were also set to detection limits for the Hanson and UWCD stormwater sampling datasets, as discussed previously. Finally, for UWCD's ambient water quality data for the River and groundwater—information that was used to establish the water quality impact thresholds for the project—non-detects were also set to detection limits. Therefore, for the processing of most datasets, conservative yet consistent non-detect approaches were applied.

### *Anticipated Raw Stormwater Constituent Concentrations*

The results of the land use-specific stormwater quality data analysis and selection are provided in Tables 3 and 4 below. These tables show anticipated event mean stormwater constituent concentrations for the four primary land uses of concern to the project: industrial, agricultural, residential and commercial. Anticipated constituent concentrations for blended stormwaters discharged to the Santa Clara River (at the

Stroube drain) and the local groundwater (via the Water Storage/Recharge Basins) were then determined based on storm volume-weighted averages of these land use-specific values. For the relative stormwater volume contributions from the various project drainage areas, synthetic hydrographs were used (relative volume contributions were independent of storm event magnitude). These stormwater volume ratios are provided in Table 5.

## Table 3. Anticipated Stormwater Constituent Concentrations vs. Land-Use For Storms Smaller Than 10-Year Event

| Constituent | Units | Stormwater Quality By Land-Use | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Industrial | | Agricultural | | Residential | | Commercial | |
| | | Stormwater Concentration | Data Source | Stormwater Concentration | Data Source | Stormwater Concentration | Data Source | Stormwater Concentration | Data Source |
| **TSS** | mg/l | 436 | Ventura | 1144 | Ventura | 156 | Ventura | 403 | Ventura |
| **Minerals** | | | | | | | | | |
| Sulfate | mg/l | 31 | Hanson | 402 | United | 6 | LA | 34 | LA |
| Chloride | mg/l | 24 | Ventura | 36 | United | 20 | Ventura | 48 | LA |
| TDS | mg/l | 148 | Ventura | 930 | United | 122 | Ventura | 75 | Ventura |
| Boron | mg/l | 0.21 | Hanson | 0.53 | United | 0.19 | LA | 0.18 | LA |
| **Nutrients** | | | | | | | | | |
| Nitrate | mg/l as NO3 | 5 | Hanson | 60.3 | Ventura | 8.1 | Ventura | 1.9 | Ventura |
| Ammonia | mg/l as NH3 | 1.16 | Hanson | 2.79 | Ventura | 0.83 | Ventura | 0.57 | Ventura |
| **Metals** | | | | | | | | | |
| Arsenic | mg/l | 0.010 | Hanson | 0.016 | Ventura | 0.003 | Ventura | 0.004 | Ventura |
| Beryllium | mg/l | 0.001 | Hanson | 0.001 | Hanson | 0.002 | Santa Mon | 0.002 | Santa Mon |
| Cadmium | mg/l | 0.005 | Hanson | 0.005 | Ventura | 0.001 | Ventura | 0.002 | Ventura |
| Chromium | mg/l | 0.016 | Ventura | 0.131 | Ventura | 0.010 | Ventura | 0.016 | Ventura |
| Copper | mg/l | 0.037 | Ventura | 0.093 | Ventura | 0.029 | Ventura | 0.060 | Ventura |
| Iron | mg/l | 1.763 | Hanson | 3.580 | Hanson | 2.051 | LA | 5.319 | LA |
| Lead | mg/l | 0.017 | Ventura | 0.032 | Ventura | 0.026 | Ventura | 0.029 | Ventura |
| Manganese | mg/l | 0.084 | Hanson | 0.225 | Hanson | 0.065 | LA | 0.115 | Santa Mon |
| Mercury | mg/l | 0.000240 | Ventura | 0.000110 | Ventura | 0.000140 | Ventura | 0.000200 | Fresno |
| Nickel | mg/l | 0.032 | Ventura | 0.095 | Ventura | 0.020 | Ventura | 0.026 | Ventura |
| Selenium | mg/l | 0.010 | Hanson | 0.010 | Hanson | 0.001 | Ventura | 0.001 | Ventura |
| Silver | mg/l | 0.010 | Hanson | 0.010 | Hanson | 0.002 | Ventura | 0.001 | Ventura |
| Zinc | mg/l | 0.275 | Hanson | 0.385 | Hanson | 0.168 | Ventura | 0.332 | Ventura |
| **Pesticides** | | | | | | | | | |
| ChemA | mg/l | ND | Hanson | ND | Hanson | NA | NA | NA | NA |
| Lannate | mg/l | NA | NA | NA | NA | NA | NA | NA | NA |
| **Hydrocarbons** | | | | | | | | | |
| Oil/Grease | mg/l | 35 | Hanson | 3 | Hanson | 3 | Ventura | 6 | Ventura |
| MTBE | mg/l | NA | NA | NA | NA | NA | NA | NA | NA |
| **Pathogenic Indicators** | | | | | | | | | |
| Total Coliform | MPN/100ml | 39,300 | Ventura | 261,800 | Ventura | 65,800 | Ventura | 107,000 | Ventura |
| Fecal Coliform | MPN/100ml | 13,500 | Ventura | 32,700 | Ventura | 17,200 | Ventura | 4,530 | Ventura |
| Fecal Streptococci | MPN/100ml | 20,200 | Ventura | 82,800 | Ventura | 48,300 | Ventura | 32,530 | Ventura |
| Giardia | Cysts/100L | NA | NA | NA | NA | NA | NA | NA | NA |
| Cryptosporidium | Oocysts/100L | NA | NA | NA | NA | NA | NA | NA | NA |

**NA**: Data not available.
**ND**: Constituent not detectable.

## Table 4. Anticipated Stormwater Constituent Concentrations vs. Land-Use For Storms Greater Than 10-Year Event

| Constituent | Units | Stormwater Quality By Land-Use | | | |
|---|---|---|---|---|---|
| | | Industrial | Agricultural | Residential | Commercial |

| | | Stormwater Concentration | Data Source | Stormwater Concentration | Data Source | Stormwater Concentration | Data Source | Stormwater Concentration | Data Source |
|---|---|---|---|---|---|---|---|---|---|
| **TSS** | mg/l | 67 | Hanson | 50 | United | 38 | Santa Mon | 52 | Santa Mon |
| **Minerals** | | | | | | | | | |
| Sulfate | mg/l | 31 | Hanson | 253 | Hanson | 6 | LA | 34 | LA |
| Chloride | mg/l | 12 | Hanson | 17 | Ventura | 3 | LA | 48 | LA |
| TDS | mg/l | 131 | Hanson | 530 | Ventura | 50 | LA | 75 | Ventura |
| Boron | mg/l | 0.21 | Hanson | 0.25 | Hanson | 0.19 | LA | 0.18 | LA |
| **Nutrients** | | | | | | | | | |
| Nitrate | mg/l as NO3 | 5 | Ventura | 8.5 | United | 2.2 | LA | 1.9 | Ventura |
| Ammonia | mg/l as NH3 | 0.64 | Ventura | 0.45 | Hanson | 0.60 | LA | 0.57 | Ventura |
| **Heavy Metals** | | | | | | | | | |
| Arsenic | mg/l | 0.006 | Ventura | 0.004 | United | 0.003 | Ventura | 0.004 | Ventura |
| Beryllium | mg/l | 0.001 | Hanson | 0.0002 | United | 0.002 | Santa Mon | 0.002 | Santa Mon |
| Cadmium | mg/l | 0.002 | Ventura | 0.001 | United | 0.001 | Ventura | 0.002 | Ventura |
| Chromium | mg/l | 0.010 | Hanson | 0.003 | United | 0.007 | Santa Mon | 0.007 | Santa Mon |
| Copper | mg/l | 0.029 | Hanson | 0.040 | United | 0.020 | LA | 0.027 | LA |
| Iron | mg/l | 1.763 | Hanson | 1.407 | United | 0.224 | Santa Mon | 0.357 | Santa Mon |
| Lead | mg/l | 0.014 | Hanson | 0.008 | United | 0.009 | Santa Mon | 0.015 | LA |
| Manganese | mg/l | 0.084 | Hanson | 0.205 | United | 0.065 | LA | 0.115 | Santa Mon |
| Mercury | mg/l | 0.000017 | Hanson | 0.000020 | United | 0.00014 | Ventura | 0.00020 | Fresno |
| Nickel | mg/l | 0.011 | Hanson | 0.009 | United | 0.020 | Ventura | 0.011 | LA |
| Selenium | mg/l | 0.001 | Ventura | 0.001 | Ventura | 0.001 | Ventura | 0.001 | Ventura |
| Silver | mg/l | 0.001 | Ventura | 0.001 | United | 0.002 | Ventura | 0.001 | Ventura |
| Zinc | mg/l | 0.205 | Ventura | 0.083 | United | 0.168 | Ventura | 0.241 | LA |
| **Pesticides** | | | | | | | | | |
| ChemA | mg/l | ND | Hanson | ND | United | NA | NA | NA | NA |
| Lannate | mg/l | NA | NA | NA | NA | NA | NA | NA | NA |
| **Hydrocarbons** | | | | | | | | | |
| Oil/Grease | mg/l | 3 | Ventura | 1 | Ventura | 3 | Ventura | 3 | LA |
| MTBE | mg/l | NA | NA | NA | NA | NA | NA | NA | NA |
| **Bacterial Indicators** | | | | | | | | | |
| Total Coliform | MPN/100ml | 39,300 | Ventura | 261,800 | Ventura | 65,800 | Ventura | 107,000 | Ventura |
| Fecal Coliform | MPN/100ml | 13,500 | Ventura | 32,700 | Ventura | 17,200 | Ventura | 4,530 | Ventura |
| Fecal Streptococci | MPN/100ml | 20,200 | Ventura | 82,800 | Ventura | 48,300 | Ventura | 32,530 | Ventura |
| Giardia | Cysts/100L | NA | NA | NA | NA | NA | NA | NA | NA |
| Cryptosporidium | Oocysts/100L | NA | NA | NA | NA | NA | NA | NA | NA |

**NA**: Data not available.
**ND**: Constituent not detectable.

**Table 5. Sources of Stormwater Discharge (Percent Cumulative Storm Volume)**

| Drainage Area | Land Use | Stormwater Discharges to River | Stormwater Discharges to Pits |
|---|---|---|---|
| #1 | Commercial | 21% | 0% |
| #2a/b | Residential | 19% | 15% |
| #3a/b | Industrial | 22% | 31% |
| #4 | Agricultural | 38% | 54% |

## BMP Removal Efficiencies

Removal efficiencies for the BMP's incorporated into the proposed RiverPark stormwater quality treatment system are summarized below. These data are based upon the work of: Wu *et. al.* (1996), Scholze *et. al.* (1993), Vincent (1994), Urbonas (1994) and Pitt *et. al.* (1996). In a later section of this report, these removal estimates are applied to anticipated raw stormwater quality in order to predict post-treatment water quality for RiverPark stormwater discharges to the River. The proposed stormwater quality treatment system for RiverPark utilizes dry swales to treat and convey stormwater from all Drainage Areas. Constituent removal capabilities of dry swales, detention basins, and catch basin inserts, based on averages of reported monitoring data, are discussed in this section, and listed in Table 6 below.

### *BMP Treatment for Drainage Area #1*

The proposed stormwater quality treatment system for Drainage Area #1 utilizes a combination of dry swales and pre-assembled structural BMP's to treat and convey stormwater before discharge into the DA #1 stormdrain. Pre-assembled structural BMP's—which include catch basin inserts, centrifugal separator units and/or pervious pavement (for selected parking fields)—will also be installed as part of the stormwater quality treatment for Drainage Area #1. Catch basin inserts provide a limited degree of sediment, trash and debris removal from storm-generated flows prior to their entering the stormwater collection system. Manhole-accessible centrifugal separator units are effective at removing sediments and sediment-associate constituents from stormflows up to the systems' hydraulic design capacities. Pervious pavement also reduces constituent loads from drainage areas and provides supplementary flood reduction benefits via the increased pervious acreage. The dry swale serves as an additional treatment device, providing supplementary water quality improvement for flows up to the 10-year peak flow. Flows exceeding the design capacity of the dry swale are diverted into the underlying stormdrain for discharge to the Stroube stormdrain and ultimately the Santa Clara River.

Centrifugal separator units will provide a major component of the constituent removal capability for Drainage Area #1. As a conservative assumption, it is assumed that 50% of the total stormflows from this drainage area (for storms smaller than the 10-year event) will be routed through these devices (see Table 6). . The dry swale in this area will also treat a moderate amount of the stormflows. As a conservative assumption, dry swale

treatment benefits are not included in the water quality calculations because of modest amount of stormflows tributary to this device.

***BMP Treatment for Drainage Areas #2, #3 and #4***

The proposed stormwater quality treatment system for RiverPark utilizes dry swales to convey stormwater to or from Drainage Areas #2, #3 and #4 to the South, North, and East Detention Basins, respectively. The swales provide supplementary water quality improvement for flows up to the 10-year peak flow before temporary storage in or discharge from the detention basins. Flows exceeding the design capacity of the proposed stormwater quality treatment system are bypassed to an adjacent Water Storage/Recharge Basin.

Dry swales, via vegetative filtration during overland flow and subsurface adsorption/filtration during infiltration, are efficient at removing a wide range of standard stormwater constituents, including suspended solids, metals, nutrients, pathogens and organics. Additionally, detention basins, via sedimentation of suspended sediments and sediment-associated contaminants, are also effective at removing a wide range of stormwater constituents.

**Table 6. BMP Removal Efficiencies**

| Constituent | Units | Removal Efficiencies | | |
|---|---|---|---|---|
| | | DS | DB | CSU |
| **TSS** | mg/l | 90% | 65% | 40% |
| **Minerals** | | | | |
| Sulfate | mg/l | 20% | 0% | 0% |
| Chloride | mg/l | 0% | 0% | 0% |
| TDS | mg/l | 0% | 0% | 0% |
| Boron | mg/l | 75% | 55% | 20% |
| **Nutrients** | | | | |
| Nitrate | mg/l as NO3 | 75% | 0% | 0% |
| Ammonia | mg/l as NH3 | 20% | 0% | 0% |
| **Heavy Metals** | | | | |
| Arsenic | mg/l | 75% | 55% | 20% |
| Beryllium | mg/l | 75% | 55% | 20% |
| Cadmium | mg/l | 75% | 55% | 20% |
| Chromium | mg/l | 75% | 55% | 20% |
| Copper | mg/l | 75% | 55% | 20% |
| Iron | mg/l | 75% | 55% | 20% |
| Lead | mg/l | 75% | 55% | 20% |
| Manganese | mg/l | 75% | 55% | 20% |
| Mercury | mg/l | 75% | 55% | 20% |
| Nickel | mg/l | 75% | 55% | 20% |
| Selenium | mg/l | 75% | 55% | 20% |
| Silver | mg/l | 75% | 55% | 20% |
| Zinc | mg/l | 75% | 55% | 20% |
| **Pesticides** | | | | |
| ChemA | mg/l | 90% | 65% | 40% |
| Lannate | mg/l | 0% | 0% | 0% |
| **Hydrocarbons** | | | | |
| Oil/Grease | mg/l | 80% | 0% | 40% |
| MTBE | mg/l | 0% | 0% | 0% |
| **Pathogenic Indicators** | | | | |
| Total Coliform | MPN/100ml | 80% | 70% | 20% |
| Fecal Coliform | MPN/100ml | 80% | 70% | 20% |
| Fecal Streptococci | MPN/100ml | 80% | 70% | 20% |
| Giardia | Cysts/100L | 80% | 70% | 20% |
| Cryptosporidium | Oocysts/100L | 80% | 70% | 20% |

**Technical Notes and Assumptions:**

Dry swale removal rates for sulfate and ammonia were estimated based upon an assumption that their behaviors as ionic species are similar to that of nitrate, only perhaps more conservative.

Oil & grease removal rates were estimated based upon an assumption that their behavior is similar to that of sediments because of their affinity for adsorption. Detention basin removal (i.e., via sedimentation processes) is considered negligible because oil & grease are present primarily as a floatable sheen.

ChemA constituents are likely to be entirely associated with sediments given the very high partitioning coefficients of these chlorinated pesticides; therefore, their removal behavior is assumed to be similar to that of sediments.

Centrifugal Separator Unit ("CSU") removal rates based on manufacturer's information which cites 80% TSS removal, and assuming that 50% of Drainage Area #1 stormflows are routed through these devices.

***Supplementary Water Quality Improvement in Pits***

All flows generated during storms smaller than the 10-year event are routed through the proposed stormwater quality treatment system before being discharged to the Santa Clara River. The greater than 10-year event peak flows exceed the capacity of the proposed treatment system and discharge directly to the adjacent Water Storage/Recharge Basins. Stormwaters discharged to these basins will have sufficient time to both mix with the existing Basin water and to allow for sediments and sediment-associated constituent constituents to settle out. In addition, the layers of settled fine-grained material that will serve as a filtration barrier to further protect the surrounding aquifer. Estimation of constituent concentrations that reach the ambient groundwater surrounding the basins therefore includes consideration of the removal mechanisms that occur via sedimentation and floor-filtration. Dilution within the Basins is not considered as part of the removal mechanisms or anticipated constituent concentrations.

To account for these basin removal mechanisms of sedimentation and floor-filtration, the water quality evaluation assumes that only the dissolved fractions of sediment-associated contaminants (i.e., all metal constituents) will reach the surrounding aquifer. The governing assumption here is that sedimentation and floor-filtration will remove 100% of the suspended solids and particulate-phase of the metal constituents. This is anticipated because the detention time will be sufficient for substantial sedimentation to occur and the fine-grained floor sediments—which will continue to thicken over time—provide only very narrow and tortuous travel paths which will effectively filter-out the entrained sediments before contacting underlying vadose zone and aquifer. This latter mechanism is analogous to the particulate filtration and adsorption mechanisms known to occur in recharge basins, an overall process that known as "soil aquifer treatment." The following text serves as a brief discussion of this process, specifically in the context of metals removal, and is excerpted from the publication entitled, "Ground Water Recharge Using Waters of Impaired Quality" (Committee on Groundwater Recharge, 1994):

> "Trace elements present in suspended matter generally are removed during SAT by filtration and do not migrate. [...] Smaller suspended particulates that can move through soil pores without becoming trapped are also attenuated by sorption to mineral surfaces in the soil matrix."

A thorough discussion of the theory behind and current research on these natural treatment processes is provided in Appendix A of this report. Although these pit removal effects have not been applied to pathogens—including viruses, bacterial pathogens, and encysted protozoa ("microparticulates")—for the purposes of this evaluation, they will certainly occur in the pits (in addition to the effects of ultra-violet attenuation during pit detention).

Regional stormwater quality monitoring data were used to determine the dissolved fraction values for the various metals in the project's stormwater, to account for the fact that each metal has a unique affinity for solids, and to account for the relationship of this affinity to water chemistry,. Because the Ventura County stormwater data are sufficiently thorough and adequately represent the project's land uses and hydrology, these data were used to estimate each metal's dissolved fraction (or mean dissolved

concentration divided by mean total concentration). For constituents not included in the Ventura County study, data from the LA County, Santa Monica or USGS Fresno stormwater monitoring studies were used. Table 7 shows the dissolved fraction values used for the purpose of stormwater quality evaluation in this report.

**Table 7. Metal Particulate Fractions**

| Metal | Particulate Fraction | Data Source |
|---|---|---|
| B | 70% | LA County |
| As | 39% | Ventura County |
| Be | 54% | Santa Monica |
| Cd | 44% | Ventura County |
| Ch | 24% | Ventura County |
| Cu | 38% | Ventura County |
| Fe | 16% | LA County |
| Pb | 35% | Ventura County |
| Mn | 36% | Fresno |
| Hg | 2% | Ventura County |
| Ni | 61% | Ventura County |
| Se | 83% | Ventura County |
| Si | 21% | Ventura County |
| Zn | 26% | Ventura County |

## Thresholds of Significance

Thresholds of significance are criteria employed during EIR analysis in order to define significant impacts resulting from a project. The water quality thresholds of significance used to analyze the RiverPark project's impact on water quality are as follows:

**Stormwater Discharges to Santa Clara River**: For stormwater discharges to surface water, this threshold is set to Basin Plan objectives and California Toxics Rule (CTR) aquatic life criteria, applied at the point of contact. The point of contact is established as the Santa Clara River, where stormwater from all project drainage areas will discharge for up to and including the 10-year event. Maximum ambient river concentrations are used for those constituents—including total suspended solids, iron, manganese, total coliform and fecal streptococci—for which neither Basin Plan objectives nor CTR criteria are established.

Ambient Santa Clara River water quality ranges for iron and manganese are based on UWCD data for their Freeman Diversion sampling station. The ambient River range for total suspended solid is based on 1991-1993 USGS data for their Montalvo sampling station. Ambient river data for Giardia and Cryptosporidium are based

upon a single sample collect 500 feet downstream of the Freeman Diversion Dam on November 18, 1996. Because most microbiological constituent data were unavailable for the Santa Clara River, Ventura River data were utilized for total coliform, fecal coliform and fecal streptococci. Ambient Ventura River ranges for these constituents are based on 2001 VCFCD data for their Foster Park sampling station on the Ventura River. The Ventura River is considered sufficiently analogous to the Santa Clara River for the purpose of this water quality evaluation and was recommended by Ventura County staff as an appropriate analog.

This threshold is conservative and is consistent with the following criteria:

- ✓ Beneficial use designations and their associated water quality objectives established for the adjacent and downstream reaches of the Santa Clara River by the LARWQCB Basin Plan.

- ✓ The State Water Resources Control Board ("SWRCB") Anti-Degradation Policy as established by SWRCB Resolution No. 68-16, which requires that any changes to the existing high quality of the State's waters (a) be consistent with maximum benefit to the people of the State, (b) not unreasonably affect present and anticipated beneficial use of such water and (b) not result in water quality less than that prescribed in the policies. In addition, any discharges to these high quality waters must meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.

**Stormwater Discharges to Groundwater**: For stormwater discharges to the Water Storage/Recharge Basins the threshold is the lesser of Basin Plan objectives (which include State drinking water standards by reference) and maximum ambient groundwater concentrations. This threshold is applied at the point of contact with groundwater beneath the pits for all constituents, but with a technical variation included for pathogenic indicators. For most constituents, this point of compliance is no different than the point of contact with exposed pitwater; however, for metals and total suspended solids, this point of compliance allows for the pit removal mechanisms of sedimentation and floor-filtration to be properly accounted for.

Because of the significant concentration reductions that occur to pathogenic indicators during aquifer transport, the point of compliance for these constituents is the downgradient (i.e., in the direction of groundwater flow) RiverPark property boundary. Conservative removal estimates for dilution, die-off and sorption/filtration are applied to anticipated pathogen indicator concentrations for stormwater discharges to the pits to calculate concentrations at the exit point from the RiverPark property. Other constituents are expected to behave conservatively; i.e., their levels will not nearly be as significantly attenuated during saturated zone transport through the aquifer.

Project stormwater discharge constituent concentrations are determined based on volume-weighted averages of the anticipated stormwater constituent concentrations from the various proposed stormdrain outfalls. This approach serves to account for the mixing of stormwaters that would naturally occur in the pits without accounting for the dilution of stormwater with ambient pit waters.

Maximum ambient groundwater concentrations are established as the maximum recorded concentrations in UWCD's database for their 9 El Rio wells. These wells were selected based on the following desirable attributes: proximity to the project site, abundance of available historic water quality data and being representative of a functionally equivalent system (that is, groundwater recharge basins).

This threshold is selected in consideration of California Environmental Quality Act ("CEQA") guidelines indicating that beneficial uses of the applicable receiving waterbodies shall be maintained. This threshold is conservative and is consistent with the following criteria:

- ✓ The most stringent beneficial use designation (i.e., as municipal supply) and its associated water quality objectives, which are established for the Montalvo forebay by the Los Angeles Regional Water Quality Control Board Basin ("LARWQCB") Plan; and

- ✓ The State Water Resources Control Board ("SWRCB") Anti-Degradation Policy as established by SWRCB Resolution No. 68-16, which requires that any changes to the existing quality of the State's waters: (a) be consistent with maximum benefit to the people of the State; (b) not unreasonably affect present and anticipated beneficial use of such water; and (c) not result in water quality less than that prescribed in the policies. In addition, any discharges to these high quality waters must meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that: (a) a pollution or nuisance will not occur; and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.

**Stormwater Quality Assessment: Standard Stormwater Constituents**

This section provides results of analyses that compare post-treatment stormwater quality with the project's thresholds of significance. Post-BMP stormwater quality calculations are based upon values of anticipated raw stormwater quality and BMP removal efficiencies, both of which have been reported previously in this report. Discussion and analysis of additional constituents, including pesticides, pathogens, chromium-VI, and MTBE is provided in a subsequent section.

**Stormwater Discharges to Santa Clara River:** For both existing and post-development conditions, raw and post-treatment stormwater concentrations are calculated. Table 8 provides the anticipated stormwater constituent concentrations for project stormflows discharged to the Santa Clara River.

Treated project stormwater concentrations that exceed the applicable surface water quality impact thresholds—i.e., Basin Plan objectives and CTR criteria, in addition to ambient river concentrations where applicable—are highlighted in bold in Table 8. One constituent is identified: fecal coliform. This exceedance represents a significant impact to Santa Clara River water quality as a result of stormwater discharges from the project. In Table 8, two threshold values are shown: one presenting the anticipated ambient River concentration range, and the other presenting the Basin Plan objective for REC-1 designated surface water bodies. The more stringent Basin Plan objective serves as the applicable threshold for determining a potentially significant impact.

Treated post-project stormwater quality is substantially improved over existing stormwater quality (which is currently discharged without treatment) for all constituents analyzed, including fecal coliform. Treated post-project stormwater quality is also substantially improved over that of raw post-project stormwater quality as a result of the effective stormwater treatment BMP's incorporated into the proposed design. In addition, treated post-project stormwater—although not discharged to a water body designated as a municipal supply beneficial use—is of better quality than California primary Maximum Contaminant Levels ("MCL's") for drinking water for all constituents, except coliform.

The project stormwater quality impact to the Santa Clara River is relatively minor. Notably, the log-mean 2001 Ventura River fecal coliform concentration (2,100 MPN/100 ml) also exceeds the Basin Plan objective for fecal coliform, and is nearly identical to the concentration anticipated for project stormwater discharges. In addition, the anticipated stormwater discharge fecal coliform concentration represents a significant improvement over that of existing project stormwater discharges.

Finally, groundwater impacts due to riverbed infiltration were considered. Negligible project stormwater constituent quantities are anticipated to infiltrate into the aquifer via the Santa Clara River because the Stroube drain is located at the southwestern-most corner of the Montalvo forebay (which represents the unconfined region of the Oxnard Plain aquifer system). Because of this rapid transition from unconfined to confined groundwater conditions, stormflows discharged to the river at the Stroube drain will very quickly lose hydraulic connection with the underlying aquifer.

**Stormwater Discharges to Groundwater**: Anticipated stormwater constituent concentrations for storms which exceed the capacity of the proposed stormwater treatment system are provided in Tables 9. These flows represent rare, large storm events. As evidence of this, based upon local historical daily precipitation data analyzed by Todd Engineers, following implementation of the proposed treatment facilities no stormwater discharges to the pits would have occurred in the past 20 years. For both existing and post-development conditions, Table 9 provides anticipated raw stormwater concentrations for discharges to the Water Storage/Recharge Basins at both the point of contact (i.e., the stormwater outfall) and the point of compliance (i.e., the pit-groundwater interface). At the point of compliance, anticipated project stormwater concentrations are based on blended stormwater discharge concentrations (i.e., concentrations at the point of

contact) minus the particulate fraction for TSS and metals, thereby reasonably simulating the removal that would naturally occur in the pits.

For pathogenic indicators, however, the point of compliance is established as the downgradient project boundary, and therefore downgradient groundwater quality estimates are based on anticipated raw stormwater quality values (for greater than 10 year storm events) reduced by a 5.6 log removal factor, as predicted by Kennedy/Jenks' Reverse Engineering work (Kennedy/Jenks, 2000b). This value represents the volumetric dilution of stormwater constituents during the saturated zone transport between the pits and the downgradient project boundary. This removal factor also accounts for die-off and filtration/sorption during saturated zone transport.

Similar to the presentation of stormwater discharges to the Santa Clara River, Table 9 indicates in bold the project stormwater concentrations for discharges to the Water Storage/Recharge Basins that exceed the applicable groundwater quality impact thresholds. The only anticipated constituents that exceed the threshold are the metals iron, manganese and nickel.

These anticipated exceedances represent significant impacts to the Montalvo Forebay resulting from stormwater discharges from the project. No exceedances of drinking water standards exist. This is even the case for arsenic, whose primary MCL will likely be made more stringent by the State or federal EPA soon.

The iron impact is primarily a result of high stormwater concentrations observed at the off-site industrial and agricultural drainage areas. The manganese impact is primarily a result of high stormwater concentrations observed at the off-site agricultural drainage areas. The nickel impact is primarily a result of very low ambient groundwater concentrations as the anticipated stormwater concentration is over an order of magnitude less than even the applicable drinking water standard.

The quality of project stormflows discharged to the pits will represent an improvement over existing stormwater discharges. This is primarily due to the fact that, based on the design of the proposed stormwater treatment system, only the more dilute, greater than 10-year event stormflows will be sent to the pits. However, and what is perhaps more significant, constituent *loads* to the groundwater should be substantially reduced as a result of the proposed stormwater treatment system due to the fact that the vast majority of project stormwater will be treated and sent to the Santa Clara River.

**Stormwater Quality Summary:** Based on the results of these water quality analyses, there are relatively few significant impacts to surface and ground water quality anticipated to result from stormwater discharges from the proposed project, given the fairly conservative water quality impact thresholds. However, the project stormwater impact to the water quality of the Santa Clara River—i.e., fecal coliform—results in substantial improvement relative to existing river water quality during storm events considering both the existing ambient water quality of the River and the existing stormwater discharge concentrations. The proposed stormwater treatment system will

provide substantial water quality improvement for project stormwaters discharged to the Santa Clara River.

Project stormwater impacts to the water quality of the Montalvo forebay (via discharges to the exposed groundwater of the existing pits)—i.e., iron, manganese, and nickel—are also minor. No exceedances of drinking water standards are identified. In addition, these groundwater impacts are rare because the proposed RiverPark treatment facilities will treat the vast majority of stormflows and then convey them to the Santa Clara River.

**Stormwater Quality Assessment: Other Constituents of Concern**

This section provides discussion and analysis of the following constituents: pesticides, pathogens, chromium-VI and MTBE. Because these constituents have not traditionally been evaluated as part of stormwater sampling programs, limited regional monitoring data are available to base anticipated stormwater concentrations on. Based upon the few studies available for these constituents, this section provides an analysis of anticipated stormwater concentrations, associated levels of treatment and post-treatment concentrations for these constituents.

***Pesticides***

**Background:** Each RWQCB is responsible for the development of Total Maximum Daily Loads ("TMDL's") for each "impaired" surface water body within the region's boundaries. Clean Water Act ("CWA") section 303(d)(1)(A) requires states to identify impaired surface waters within their boundaries where numeric or narrative water quality objectives are not being maintained and/or beneficial uses are not fully protected after application of technology-based controls. Each state is also required to establish a priority ranking for such waters, considering the severity of the pollution and the beneficial uses of the waters. For those surface water bodies identified and prioritized in the aforementioned list, section 303(d)(1)(C) requires that each state establish TMDL's for those constituents identified under CWA section 304(a)(2) as suitable for TMDL development correlated with the achievement of water quality objectives.

A TMDL is a numeric target which, when achieved, will result in attainment of water quality objectives. The TMDL includes allocations (i.e., allowable constituent loading) for both point and nonpoint sources. The loadings are established with consideration given to seasonal variations of constituent loadings and a margin of safety which considers any lack of knowledge concerning the relationship between effluent limitations and water quality. Each TMDL is first developed by the governing RWQCB, and then implemented through National Pollution Discharge Elimination System (NPDES) permits (for point sources) and/or through a wider range of authorities and programs (for nonpoint sources), including the use of applicable State enforcement authorities. TMDLs are formalized via their adoption as amendments to a RWQCB's Basin Plan.

**Project Conditions:** The Santa Clara River Estuary, located at the Pacific Ocean coastline, downstream from the project, is a 303(d)-listed impaired surface water body located downstream of outlets through which the proposed RiverPark development project will discharge into the Santa Clara River. The Estuary is listed as impaired for

coliform, ChemA (a class of historic, chlorinated pesticides, including aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, HCH, endosulfan and toxaphene) and toxaphene. The RWQCB is in the process of developing TMDLs for the Estuary for each listed impairment. These TMDLs are expected to be completed by 2006/07 (LA RWQCB, 2000). Once finalized, waste load allocations for each targeted constituent will be distributed among point and nonpoint dischargers upstream of the impairment. The allocations will serve as numeric loading standards to which stormwater discharges from the RiverPark project to the Santa Clara River must adhere.

The applicable pesticide standards exceeded within the estuary are the National Academy of Science Guideline (tissue) of 100 ng/g for ChemA and the State Board numeric objective Maximum Tissue Residue Level of 8.8 ng/g for toxaphene (LA RWQCB, 2000). In addition, primary MCL's exist for most of these compounds, and are therefore applicable to stormwater discharges to the pits per UWCD's recent RiverPark stormwater quality resolutions. Based upon review of pesticide use data and communications with staff from the County Agricultural Commissioners office, ChemA pesticides, including toxaphene, are no longer in use in Ventura County. The only potential sources of these compounds are sediment-associated residuals. However, based upon lab analyses of Hanson and UWCD stormwater samples from the off-site drainage areas, none of these compounds were detected above analytical detection limits. ChemA compounds were also not detected in the local groundwater based on lab reports for UWCD's sampling at the El Rio spreading ground wells used to establish ambient groundwater quality based on 2 samples in August 1999. Analytical detection limits for these constituents are, for the most part, less than primary MCL's (the only exceptions are for heptachlor and heptachlor epoxide). Detection limits are also less than CTR aquatic life CMC's for freshwater (except for toxaphene). Therefore, all available evidence suggests that detectable concentrations of ChemA pesticides will not be found in project stormwater runoff. Hence, ChemA pesticides (which include toxaphene) are not expected to cause significant impacts—i.e., threshold exceedances—to the water quality of either the Santa Clara River or the Montalvo forebay.

Lannate, which is the trade name for the EPA registered compound, methomyl, is an insecticide that is used on a wide variety of crops. Lannate was selected as a representative locally-applied pesticide due to its conservative chemical and toxicological attributes—i.e., high mobility, stability and toxicity. Neither Basin Plan Objectives nor MCL's exist for this compound, although a drinking water standard of 0.85 mg/L has been established based upon an EPA health criteria document. Ambient river concentrations are not available for Lannate. Kennedy Jenks (2000a) has calculated anticipated Lannate concentrations in raw stormwater runoff from Drainage Area #4, the El Rio agricultural area. This estimate is reported as 0.5 mg/L; the justification for the assumptions and approach inherent to this calculation are provided in the associated chapter of the Environmental Impact Report. Lannate concentrations are not expected to be detectable in the runoff from Drainage Areas #1 through #3. The proposed stormwater quality treatment system is not anticipated to provide any treatment for Lannate present in the agricultural runoff, given Lannate's minimal affinity for sorption (octanol-water partitioning coefficient, $K_{ow} = 0.57$) and photolytic degradation ($1^{st}$ order decay coefficient, $K_d = 0.14\ d^{-1}$). This stormwater will be diluted during blending with the better quality stormwater from Drainage Areas #1 through #3 before river discharge.

Therefore, anticipated raw stormwater concentrations should be significantly less than the U.S. EPA drinking water standard for Lannate discharges to the river. Even bypassed stormwater discharged to the pits during large storm events should be less than the drinking water standard based upon Kennedy Jenks' washoff estimates. Ambient groundwater concentrations for Lannate, based on UWCD's ambient groundwater quality data at their El Rio wells, are reported as below detection limits (i.e., 0.005 ppm) based on two (2) samples in August 1999.

***Pathogens***

**Background:** Pathogens are microorganisms, including bacteria, viruses and protozoa, which are capable of causing disease. Elevated pathogen levels may be found in drinking and recreational waters due to fecal contamination from either human or nonhuman sources (wildlife, domestic animals, etc.). Total coliform and fecal coliform are classes of bacteria that serve as indicators for enteric pathogen contamination. These indicators have been selected for several reasons, including a) that they have been considered historically to have a reasonably good correlation with fecal contamination; and b) that they are relatively simple and inexpensive to test for. A 1986 U.S. EPA guidance document (U.S. EPA, 1986) specifically recommends the use of *Escherichia coli* (the dominant species in the fecal coliform group) and *Enterococcus faecalis* (a species included in the fecal streptococci group) for fresh and salt waters, respectively, because of their acceptable correlation with outbreaks of certain diseases. Several recent indicator-illness and indicator-pathogen correlation investigations have affirmed the value of conventional bacterial indicator groups (see: Geldreich, 1996; Efstratiou *et. al.*, 1998; Polo *et. al.*, 1998; and Pruss, 1998).

More recently, however, with the evolution of DNA-identification techniques, environmental microbiologists are becoming increasingly skeptical of the value of bacterial indicators for assessing the presence of pathogens. One reason for this is that significant natural sources are known to exist for these bacterial indicators, including the fact that some coliform are indigenous soil fauna (Hazen, 1988; O'Shea and Field, 1991). In a recent South Coast bacterial source identification study (SB County Public Health Department, 2000), bacterial indicators from the lower Rincon Creek watershed were extracted from creek and lagoon samples for subsequent DNA analysis. Results indicate that 20% of the identified sources were of human origin. Overall, contributions from domestic sources (i.e., humans, dogs, cats, cattle, horses and sheep) accounted for just 46% of the identified sources. Another reason that standard bacterial indicators are poorly correlated with fecal pathogens is that survival times are known to differ. Surface water die-off and groundwater removal rates (via subsurface filtration and competition/antagonism/predation) for standard bacterial indicators are known to differ substantially from those of more mobile and persistent enteric pathogens, such as viruses and encysted protozoa. Therefore, unless more representative fecal indicator organisms are found, actual pathogen concentrations may need be enumerated in order to more accurately diagnose the potential of water body contact to cause illness.

Originating in the gastrointestinal tract of an infected individual, the enteric virus group (which includes hepatitis A virus, adenovirus and enterovirus), is the most significant

virus group affecting water quality and human health. Recent research has shown F-specific coliphage, a virus which infects coliform cells, is a much more reliable indicator of enteric viruses than the standard bacterial indicator classes (Jiang, 2000). These investigators have reported concentrations ranging from 2.8 to 3,413 plaque forming units per liter ("PFU/L"), <2 to 300 PFU/L, and 880 to 7,500 genomes/L for coliphage, F-specific coliphage and adenovirus, respectively, in coastal creeks and lagoons in southern California. Similar ranges in coliphage concentration were recently reported by Lipp *et. al.* (2001) for several urban creeks in west Florida, although positive detections for enterovirus and the encysted protozoan pathogens, *Cryptosporidium* and *Giardia*, were relatively infrequent (sample results were 25% positive, on average). Virus enumeration studies have not yet been conducted specifically for stormwater runoff, and therefore virus concentrations in stormwater can only be estimated based on studies such as the aforementioned, which sample and report on coastal urban creeks. The only other option is relying on bacterial indicator estimates to evaluate the quality of project stormwater.

In addition, to these aforementioned microorganisms, standards for *Giardia* and *Cryptosporidium* were also developed. *Giardia* and *Cryptosporidium* are two microbial constituents that have been considered in recent water quality regulations. Both are protozoa that are difficult to enumerate and as such, monitoring for these constituents is difficult and expensive.

**Project Conditions:** Despite intuitively being the most reliable method of assessing illness risk, direct pathogen enumeration is not yet regularly conducted as part of municipal stormwater sampling regimens, and therefore County monitoring reports do not typically report enteric virus and protozoan concentrations. In addition, quantitative pathogen standards have yet to be established by federal, state and regional agencies responsible for surface and ground water quality management. Therefore, an assessment of the impact of virus concentrations in the project's stormwater discharges to either the river or the groundwater can only be qualitative, at best. Considering the elevated concentrations in the river during storm events, as well as the potential stormwater quality improvement provided by the proposed treatment system, virus levels in project stormwater discharges are not anticipated to significantly impact existing river water quality or beneficial uses. And considering the rarity of stormwater discharges to the Water Storage/Recharge Basins, as well as the 5.6 log virus removal (Kennedy Jenks 2000b) expected to occur during aquifer transport between the Water Storage/Recharge Basins and the downgradient project boundary, virus levels in project stormwater discharges are not anticipated to significantly impact existing groundwater quality or beneficial uses.

Although regulatory agencies acknowledge the limited value of bacterial indicators for quantifying levels of enteric pathogen contamination, public health criteria for recreational and drinking waters still rely on them. The Santa Clara River estuary is 303(d)-listed as being impaired for coliform. The LARWQCB has established a water quality objective for the Santa Clara River of 200 MPN/100ml (logmean average of not less than 4 samples in a 30 day period) for fecal coliform in association with the river's beneficial use designation as "REC-1" (water contact recreation). The applicable water quality objective for the Montalvo forebay is 1.1 MPN/100ml for fecal coliform. Federal

primary MCL's are more stringent, requiring municipal drinking water supplies to demonstrate that no more than 5% of samples are total coliform-positive; each positive sample must then be analyzed for fecal coliform, and the result must be negative (i.e., zero concentration). Ambient Santa Clara River total coliform concentrations during storm events are only known to exceed 1,600 MPN/100 ml based on UWCD data for their Freeman diversion sampling station. Ambient Ventura River (the most analogous, local river system) total coliform, fecal coliform and fecal streptococci concentrations range from 13,000 to 160,000 MPN/100ml, 800 to 5,000 MPN/100ml and 3,000 to 17,000 MPN/100ml, respectively, based upon most recent Ventura County Flood Control District monitoring data for their Foster Park sampling station (based on three samples taken during winter/spring 2001).

Ambient local groundwater concentrations indicate total coliform values ranging from less than 1.1 to 9.2, with no detectable fecal coliform levels ever observed. This information is based on UWCD sampling data for their El Rio wells, with one anomalous high result in March 2000 being discarded.

Based on anticipated fecal coliform concentrations for stormwater discharged to the river, as shown Table 8, stormwater discharges to the Santa Clara River will likely exceed Basin Plan Objectives, although post-project stormwater quality will be greatly improved over that of existing conditions. Notably, because Basin Plan objectives are not designed to apply to stormwater *discharges*, this is likely an unreasonable comparison. Basin Plan objectives are exceeded in 58% of Southern California coastal waters sampled subsequent to storm events of 1 inch or more (Noble, 2000). Furthermore, anticipated pathogen indicator concentrations in project stormwater discharges, as shown in Table 8, are well within the aforementioned ranges of Ventura River concentrations for these constituents.

Based on anticipated fecal coliform concentrations for stormwater discharged to the Water Storage/Recharge Basins, as shown in Table 9, and considering that the point of compliance is at the downgradient project boundary (and therefore 5.6 logs of removal, which are expected to occur during aquifer transport, are applicable for the raw stormwater concentrations shown), stormwater discharged to the Water Storage/Recharge Basins will meet State and federal drinking water standards.

Ambient river data for Giardia and Cryptosporidium are based upon a single sample collect 500 feet downstream of the Freeman Diversion Dam on November 18, 1996. Ambient groundwater data for Giardia and Cryptosporidium are based upon single samples collected in wells 22N22W-21H2 AND 2N22W-G1 ON April 9, 1997. Analysis these constituents in stormwater runoff from the areas within and tributary the Specific Plan area have not been conducted. Research data and results from analog studies are not available or have not been conducted, precluding an evaluation of the impacts from these constituents.

***Chromium-VI***

**General:** Chromium is a metal that occurs naturally in groundwater, but may also enter groundwater via industrial discharges and leaching from hazardous waste sites. Chromium may be present in drinking water sources in two forms: trivalent chromium (chromium-III) and hexavalent chromium (chromium-VI). Chromium-VI, often occurring as chromate, is the more toxic form of chromium and is the primary health concern when present in drinking water.

Primary MCL's for total chromium are 50 and 100 ug/L based on state and federal drinking water standards, respectively. The California Department of Health Services ("DHS") has recently requested that the State Office of Environmental Health Hazard Assessment ("OEHHA") establish a specific Public Health Goal ("PHG") for chromium-VI. The PHG would formally identify a level of chromium-VI in drinking water that does not pose a significant human health risk. In developing drinking water standards, state law requires DHS to consider economic and technical feasibility as well as the PHG. A blue-ribbon panel of expert scientists from throughout the United States has been established by the University of California ("UC") to review scientific questions concerning the potential of chromium-VI to cause cancer when ingested. The UC panel's review will provide recommendations to assist OEHHA in the development of a chromium-VI PHG.

**Project Conditions:** For the purposes of RiverPark's stormwater quality analyses, neither river nor groundwater concentration data is available for chromium-VI as a separate component from the total chromium as traditionally reported. Regional stormwater quality monitoring studies have not reported concentrations for chromium-VI because it is not yet included in the Title 22 suite of regulated drinking water constituents. Because numeric thresholds, including Regional Basin Plan Objectives and State/federal drinking water standards, are not yet established for this constituent, quantitative analysis of the water quality impacts cannot be conducted as with the other constituents considered in this report.

The PHG for *total* chromium, which is set at 2.5 ug/L, was calculated based on scientific information on the potential carcinogenicity of ingested chromium-VI, along with an estimate that chromium-VI comprised about 7 percent of the total chromium in water. However, more recent studies of chromium-VI in a limited number of California water supplies indicate this percentage can be much higher, perhaps greater than 50 percent (Ca DHS, 2001). Given the stormwater quality estimates provided in this report, and assuming that chromium-VI comprises 50% of the total chromium in water, anticipated post-treatment chromium-VI stormwater concentrations for discharges to the river (approximately 9 ppb) are not anticipated to exceed the CTR aquatic life CMC for freshwater. This aquatic life criteria is set at 16 ppb for total recoverable chromium-VI.

Regarding discharges to the pits during rare intense storm events, until a federal primary MCL is established for this constituent, its impacts due to anticipated stormwater concentrations could not be evaluated. The current analysis indicates that all anticipated *total* chromium concentrations are well below both State and federal primary MCL's.

***MTBE***

**General:** Methyl tertiary butyl ether (MTBE) has been added in relatively low concentrations to increase octane ratings in premium grade fuels since the late 1970's. Beginning in the early 1990's MTBE has been added in much higher concentrations (up to 15 percent) to enhance gasoline combustion and reduce tailpipe emissions. MTBE is the most common fuel oxygenate, used in more than 80 percent of oxygenated fuels.

Potential and documented contamination of water resources by MTBE has become a cause for major public concern and increasing controversy. MTBE readily dissolves in water, can move rapidly through soils and aquifers, is resistant to microbial decomposition and is difficult to remove via conventional water treatment schemes. The U.S. EPA has classified MTBE as a potential human carcinogen. Finally, MTBE can give water an unpleasant taste and odor. These factors have caused widespread concern that drinking water supplies and human health may be at risk. In early 1999, a UC technical advisory group completed their comprehensive evaluation of the health and environmental effects of MTBE and other oxygenates, which concluded that, "on balance, there is significant risk to the environment from using MTBE in gasoline in California." (Keller *et. al.*, 1998). In response to this scientific evaluation, on March 25, 1999 California Governor Gray Davis issued Executive Order D-5-99, calling for the removal of MTBE from gasoline by January 1, 2003.

In another recent scientific evaluation, an EPA-appointed independent blue-ribbon panel of leading experts from the public health, environmental and scientific communities, fuels industry, water utilities, and local and state governments concluded, among other things, that MTBE has primarily caused odor and taste concerns, and that only in rare instances has it been found in drinking water supplies at levels well above health-based drinking water standards (Blue Ribbon Panel, 1999). Based on the panel's recommendations, recent federal EPA legislation has been enacted to protect surface water and groundwater from MTBE contamination. These actions include:

- regulatory action under the Toxic Substances Control Act ("TSCA") to significantly reduce or eliminate use of MTBE in gasoline;
- the establishment of a federal secondary drinking water standard, based on taste and odor, of 5 ug/L for MTBE;
- a new rule requiring that public water systems monitor for MTBE in ground and surface water sources;
- efforts to work with states to increase the compliance rate with UST regulations (e.g., regarding leak detection and monitoring), enforce remedial actions, and develop UST operation and maintenance manuals; and
- funding demonstration remediation projects to evaluate MTBE remediation technologies.

**Project Conditions:** Ambient Santa Clara River data is not available for MTBE. However, a nationwide survey of MTBE contamination has been initiated by the USGS as part of their National Water Quality Assessment ("NAWQA") program, which began in 1991. This is the most comprehensive study conducted to date in which MTBE concentrations in freshwater stream and aquifers are evaluated. The most analogous study unit of the program is the Santa Ana region of southern California. Based upon limited surface water sampling data from this region, stream concentrations from MTBE

range from not-detected (lower reporting limit = 0.17 ug/L) to 0.49 ug/L, with a mean of 0.33 ug/L (USGS, 1999). Surface water MTBE concentrations in California have been reported up to 12 ug/L in water bodies where motorized recreation activities are allowed, although MTBE in California urban storm runoff samples generally has been less than 2 ug/L (USGS, 2001). In a recent source identification study conducted by the Southern California Coastal Water Research Project (Bay, 2000), non-point sources of MTBE were shown to constitute negligible portions of the cumulative MTBE load to the coastal waters of the Southern California Bight.

Based on several recent samples from UWCD El Rio wells, MTBE has not been detected in local groundwater (analytical detection limit = 3 ug/L). Even at a reporting limit of just 0.2 ug/L, MTBE was detected in 21% of 480 wells located in areas of the nation that use MTBE in gasoline to abate air pollution; in the rest of the nation, MTBE detection frequency in groundwater was just 2% (USGS, 1999a). The State DHS has reported MTBE detection frequencies of 0.65 and 4.5% for ground and surface waters based on a 3 ug/L detection limit, 0.4% and 1.4% exceeding 5 ug/L (State secondary MCL), and 0.2% and 0.3% exceeding 13 ug/L (State primary MCL) (CA DHS, 2001). Basin Plan objectives and CTR criteria have not been established for this constituent.

MTBE concentrations in groundwater greater than 30 ug/L usually can be attributed to a leaking tank or pipeline facility. Low MTBE concentrations, less than 3 ug/L, are more likely to result from atmospheric sources (Squillace *et. al.*, 1998). Groundwater sampling in rural areas has a low frequency of detection, and concentrations of MTBE are generally low when detected. In California and in other States there is a high correlation between urban land use, motor vehicle traffic and population density, and the frequency of detection and water concentrations of MTBE (Squillace, 1995; USGS, 2001). This is as expected given that gasoline is the only source of MTBE.

In a NAWQA investigation of MTBE in stormwater (Delzer, 1996), MTBE was detected in 6.9% of the 592 stormwater samples collected from 16 U.S. cities and metropolitan areas at an analytical detection limit of 0.2 ug/L. When detected, concentrations ranged from 0.2 to 8.7 ug/L, with a median of 1.5 ug/L. Based on the results of this comprehensive nationwide stormwater monitoring study, MTBE concentrations are not anticipated to exceed the California DHS primary MCL of 10 ug/L. Therefore, MTBE is not an impact to local ground or surface waters as a result of stormwater discharges from the RiverPark project.

## Table 8. Discharges to Santa Clara River: Anticipated Post-Treatment Stormwater Quality for Storms Smaller Than 10-Year Event

| Constituent Concentrations (mg/L) | | | | | Thresholds of Significant Impact | |
|---|---|---|---|---|---|---|
| Constituent | Units | Existing Conditions | Post-Project Conditions | | Water Quality Threshold | Water Quality Criteria Applied |
| | | | Raw Stormwater | Post Treatment Stormwater | | |
| **TSS** | mg/l | 885 | 649 | 70 | 48 - 38,800 | Ambient |
| **Minerals** | | | | | | |
| Sulfate | mg/l | 287 | 169 | 137 | 600 | Basin Plan Obj. |
| Chloride | mg/l | 35 | 33 | 33 | 150 | Basin Plan Obj. |
| TDS | mg/l | 681 | 428 | 428 | 1200 | Basin Plan Obj. |
| Boron | mg/l | 0.43 | 0.32 | 0.06 | 1.50 | Basin Plan Obj. |
| **Nutrients** | | | | | | |
| Nitrate | mg/l as NO3 | 43.7 | 26.2 | 6.9 | 45 | Basin Plan Obj. |
| Ammonia | mg/l as NH3 | 2.16 | 1.60 | 1.30 | 1.30 | Basin Plan Obj. |
| **Metals** | | | | | | |
| Arsenic | mg/l | 0.012 | 0.009 | 0.002 | 0.34 | Ca Toxics Rule |
| Beryllium | mg/l | 0.001 | 0.001 | 0.0005 | NA* | Ca Toxics Rule |
| Cadmium | mg/l | 0.004 | 0.004 | 0.001 | 0.022 | Ca Toxics Rule |
| Chromium | mg/l | 0.096 | 0.059 | 0.009 | 5.4 | Ca Toxics Rule |
| Copper | mg/l | 0.078 | 0.062 | 0.016 | 0.052 | Ca Toxics Rule |
| Iron | mg/l | 3.61 | 3.26 | 1.15 | <0.05 - 12.5 | Ambient |
| Lead | mg/l | 0.031 | 0.027 | 0.007 | 0.48 | Ca Toxics Rule |
| Manganese | mg/l | 0.18 | 0.14 | 0.03 | 0.01 - 0.56 | Ambient |
| Mercury | mg/l | 0.000128 | 0.000163 | 0.000048 | 0.000051 | Ca Toxics Rule |
| Nickel | mg/l | 0.073 | 0.053 | 0.01 | 1.5 | Ca Toxics Rule |
| Selenium | mg/l | 0.007 | 0.006 | 0.001 | 0.005 | Ca Toxics Rule |
| Silver | mg/l | 0.007 | 0.007 | 0.001 | 0.044 | Ca Toxics Rule |
| Zinc | mg/l | 0.345 | 0.310 | 0.083 | 0.39 | Ca Toxics Rule |
| **Pesticides** | | | | | | |
| ChemA | mg/l | ND | ND | ND | See Pesticides Text | Ca Toxics Rule |
| Lannate | mg/l | NA | NA | NA | 0.85 | EPA Criteria Estimate |
| **Hydrocarbons** | | | | | | |
| Oil/Grease | mg/l | 3 | 11 | 3 | 10 | Basin Plan Obj. |
| MTBE | mg/l | ND | 0.0003 | 0.0003 | <0.00049 | Ambient |
| **Pathogen Indicators** | | | | | | |
| Total Coliform | MPN/100ml | 209,180 | 143,819 | 25,918 | 13,000 - 160,000 | Ambient |
| Fecal Coliform | MPN/100ml | 26,150 | 19,653 | **2,027** | 800 - 5,000 / 200** | Ambient / BP Obj. |
| Fecal Streptococci | MPN/100ml | 70,085 | 51,992 | 8,653 | 3,000 - 17,000 | Ambient |
| Giardia | Cysts/100L | NA | NA | <1.6 | <1.6 | Ambient |
| Cryptosporidium | Oocysts/100L | NA | NA | <1.6 | <1.6 | Ambient |

**ND**: Not Detectable. Concentrations below analytical detection limits.

* California Toxics Rule criteria for Beryllium not yet established.

** Threshold of Significant Impact shown with both Basin Plan Objective and Ambient values to document existing river water quality exceedences of Basin Plan Objective. Project discharges are compared to the Basin Plan Objective.

**Ambient**: Ambient Santa Clara River concentration. Pathogen indicator data unavailable for the Santa Clara River; ambient values shown based on 2001 VCFCD data for Foster Park sampling station on the Ventura River. The Ventura River is considered to be sufficiently analogous to the Santa Clara River for the purposes of these water quality analyses. Range of iron and manganese concentrations based on UWCD water quality data for the Santa Clara River at their Freeman Diversion sampling station. TSS concentrations based on 1991-1993 USGS water quality data for the Santa Clara River at their Montalvo sampling station.

**Basin Plan Objective**: LARWQCB Basin Plan Objective for Reach 2 of the Santa Clara River. Ammonia objective conservatively assumes T = 15°C and pH = 8.1 (average Santa Clara River conditions), and Water Designation COLD (4-day avg.). The basin plan objectives for ammonia are currently being considered for revision by the LARWQCB. Oil/grease objective is "sheen-causing", which is conservatively approximated as 10 mg/L.

**California Toxics Rule**: Criteria maximum concentration (CMC) for freshwater aquatic life. Chromium CMC is divided into 5,405 and 16 ppb for total Ch-III and total Ch-VI, respectively. Mercury CMC unavailable and so human health criteria (for consumption of organisms only) is used. Selenium CMC unavailable and so criteria continuous concentration (CCC) is used.

## Table 9. Discharges to Water Storage/Recharge Basins: Anticipated Stormwater Quality for Storms Greater Than 10-Year Event

| Constituent Concentrations | | | | Thresholds of Significant Impact | |
|---|---|---|---|---|---|
| **Constituent** | **Units** | **Project Stormwater Discharge** | **At Point of Contact with Groundwater Beneath Pits** | **Ambient Groundwater Range** | **Drinking Water Standard** |
| **TSS** | mg/l | 54 | 0 | NA | --- |
| **Minerals** | | | | | |
| Sulfate | mg/l | 147 | 147 | 255 - 740 | 500 |
| Chloride | mg/l | 13 | 13 | 21 - 102 | 500 |
| TDS | mg/l | 334 | 334 | 572 - 1710 | 1000 |
| Boron | mg/l | 0.23 | 0.16 | 0.4 - 1.0 | 1 |
| **Nutrients** | | | | | |
| Nitrate | mg/l as NO3 | 6.4 | 6.4 | 0.4 - 140 | 45 |
| Ammonia | mg/l as NH3 | 0.53 | 0.53 | NA | --- |
| **Metals** | | | | | |
| Arsenic | mg/l | 0.004 | 0.002 | <0.0005 - <0.05 * | 0.05 |
| Beryllium | mg/l | 0.001 | 0.0004 | <0.0002 - <0.001 * | 0.004 |
| Cadmium | mg/l | 0.001 | 0.0006 | <0.0002 - <0.001 * | 0.005 |
| Chromium (total) | mg/l | 0.006 | 0.001 | <0.001 - <0.01 * | 0.05 |
| Copper | mg/l | 0.034 | 0.013 | <0.01 - <0.05 * | 1.300 |
| Iron | mg/l | 1.34 | **0.21** | <0.05 - 0.13 | 0.3 |
| Lead | mg/l | 0.010 | 0.004 | <0.0002 - <0.005 * | 0.015 |
| Manganese | mg/l | 0.146 | **0.05** | <0.01 - 0.03 | 0.05 |
| Mercury | mg/l | 0.00004 | <0.00001 | <0.00001 - <0.001 * | 0.002 |
| Nickel | mg/l | 0.011 | **0.007** | <0.001 - 0.003 | 0.1 |
| Selenium | mg/l | 0.001 | 0.001 | 0.002 - 0.009 | 0.05 |
| Silver | mg/l | 0.001 | <0.001 | <0.0005 - 0.01 | 0.1 |
| Zinc | mg/l | 0.134 | 0.035 | <0.02 - 0.05 | 5 |
| **Pesticides** | | | | | |
| ChemA | mg/l | ND | ND | NA | --- |
| Lannate | mg/l | NA | NA | <0.005 | --- |
| **Hydrocarbons** | | | | | |
| Oil/Grease | mg/l | 2 | 2 | NA | --- |
| MTBE | mg/l | 0.0003 | 0.0003 | <0.005 | 0.005--- |
| **Pathogen Indicators** | | **Project Stormwater Discharge** | **Within Aquifer At Downgradient Property Line** | | |
| Total Coliform | MPN/100ml | 163,046 | <1.1 | <1.1 - 9.2 ** | 1.1 |
| Fecal Coliform | MPN/100ml | 24,402 | <1.1 | <1.1 - <2 ** | 0 |
| Fecal Streptococci | MPN/100ml | 58,142 | <2 | NA | --- |
| Giardia | Cysts/100L | NA | NA | <1 | --- |
| Cryptosporidium | Oocysts/100L | NA | NA | <1 | --- |

**ND**: Not Detectable. Concentrations below analytical detection limits.

**NA**: Data Not Available. Constituents not sampled or tested for.

* Upper end of range is an older non-detect result. This occurs as a result of historic sampling which utilized analytical procedures and equipment having higher detection limits than are currently achievable.

** Pathogen Indicator Data for Ambient Groundwater: For Total Coliform, 2 samples were determined to have ">23 MPN/100ml" present; as a conservative approach, these are not included in the range because of their rare occurrence. For Fecal Coliform, all data were reported as non-detect with detection limits of 1.1 and 2, except for a single multi-sampling episode on March 23, 2000 which determined a maximum of 9.2 MPN/100 ml; as a conservative approach, these are not included in the range because of their rare occurrence. Also for Fecal Coliform, the upper end of the constituent range is defined as the detection limit. This occurs as a result of historic sampling which utilized analytical procedures and equipment having higher method detection limits than are currently achievable.

Point of Compliance, as per adopted project water quality thresholds, is established as "point of contact with groundwater beneath pits" for all conservative-behaving constituents (i.e., non-bacteria). These concentrations are identical to those entering the pits ("point of contact with exposed groundwater in pits") for most constituents; however, for metals, the particulate fractions are removed in order to account for sedimentation and filtration mechanisms which will occur in and beneath the pits. Point of Compliance for pathogen indicators is established as "within aquifer at downgradient property line". Removal factor of 5.6 applied to pathogen indicator concentrations at "point of contact with exposed groundwater in pits". This factor is taken from Kennedy/Jenks' Reverse Engineering document (KJ, 2000b) and accounts for dilution, die-off and sorption/filtration removal mechanisms.

**Ambient Groundwater Range**: Values shown represent the range of reported values (1991-2000 data, post-Freeman diversion) as determined from the United Water Conservation District El Rio wells #1, 2A, 3, 4, 5, 6, 7, 8 and 11 located adjacent to the El Rio spreading basins. For each constituent analyzed, the upper end of this range is utilized as the threshold of significant impact.

**Regulatory Considerations**

The proposed stormwater quality treatment system fully complies with the Ventura County Municipal Storm Water NPDES permit. The Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan ("SQUIMP"), developed as part of the Ventura County Municipal Stormwater Program, specifically addresses stormwater pollution from new developments and redevelopment by the private sector. Attachment A to the Ventura Countywide SQUIMP includes detention basins and swales in their list of BMP's that are considered effective at minimizing the "pollutants of concern" to urban stormwater.

The detention basins are volume-based treatment control BMP's which are designed to mitigate the 10-year event. As the 10-year (24-hour duration) storm event represents 5.5 inches of rainfall, this design criteria is significantly greater than the Ventura County SQUIMP volume-based design standard of just a 0.75 inch rainfall event. Similarly, the pretreatment dry swales are designed to handle the 10-year storm event peak flows which correspond to a peak rainfall intensity of over 1 inch per hour (1-hour duration), which is again greatly in excess of the Ventura County SQUIMP flow-based design standard of just a 0.2 inch per hour intensity rain event. Therefore, relative to Ventura County stormwater management criteria, the capacities of the BMP's proposed for Riverpark are inherently very conservative in design.

The design of RiverPark's BMP's also strictly conform to the design specifications listed in various "suggested resources" according to the Ventura County SQUIMP, including the *Project Planning and Design Guide* (2000) of the Caltrans Stormwater Quality Handbooks series and the *Design of Stormwater Filtering Systems* (1996) produced by the Center for Watershed Protection ("CWP").

Finally, the proposed stormwater quality treatment system also meets the intent of the criteria set forth by separate resolutions from United Water Conservation District ("UWCD"), Ventura County and Fox Canyon Groundwater Management Agency ("FCGMA") regarding stormwater discharges from the proposed RiverPark project.

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# APPENDIX A: SAT LITERATURE REVIEW

## History of SAT

Soil Aquifer Treatment (SAT) utilizes principles that wastewater treatment engineers have taken advantage of for decades (Bouwer, 1988). SAT is analogous in principle to onsite sewage disposal practices, such as septic systems. In a septic system, subsequent to solids removal within the septic tank itself, soil filtration provides removal of organics, nutrients and pathogens from wastewater prior to its reaching potable groundwater supplies. Because SAT utilizes the same mechanisms of vadose (unsaturated) zone filtration, SAT has been employed by retention/infiltration facilities to provide alternative and supplementary treatment for stormwater and/or treated wastewater prior to aquifer storage for potable end use.

A significant amount of research and testing of the benefits of SAT occurred in Arizona in response to the 1986 Arizona Environmental Quality Act which established laws to protect Arizona's precious groundwater supplies. One impact of this piece of legislation was that all groundwater was designated as drinking water supply, and so all effluent discharges reaching groundwater must meet Federal Primary Drinking Water Standards (MCLs) at this Point of Compliance (that is, immediately precedent to reaching groundwater). Therefore, it was in the best interest of owners and operators of infiltration and recharge facilities to research the treatment capabilities of the unsaturated (vadose) zone to allow optimization of the necessary level of effluent treatment.

This Arizona-based effort has led to numerous research projects which have studied SAT within recharge basins, particularly in the arid southwest where heightened water demands coupled with diminishing groundwater supplies have encouraged the development of wastewater reuse. In one such research project, Lee and Jones-Lee (1995) use the term "aquifer waste treatment zone" to describe this zone of interest. The authors define it as follows:

> "The aquifer waste treatment zone is primarily the pre-operational unsaturated area of the aquifer where abiotic and biotic (biochemically-mediated) transformations of contaminants present in the recharge water occur. Those transformations can result in the removal of contaminants stored in the aquifer waste treatment zone through precipitation and sorption reactions, as well as transformation to other chemicals."

## Summary of SAT Removal Mechanisms

By definition, SAT utilizes three primary zones of treatment: surficial (or "root"), vadose and aquifer zones. However, it has become generally accepted that it is the unsaturated surficial and vadose zones which most significantly contribute to contaminant removal in infiltrated water. According to Stuyfzand (1993), the upper 15 ft are considered to contribute most (>50%) to the reduction in bacteria, ammonium, dissolved organic carbon (DOC), nitrate, iron and lead. The vadose zone is characterized by high biological activity and high filtration efficiency (due to greater fractions of organic matter) despite its shorter detention times. The biological activity is responsible for

biodegradation of organics, denitrification of oxidized nitrate forms, and die-off due to predation/competition stresses on pathogens. Soil filtering mechanisms further contribute to the removal of sediments and associated contaminants (e.g. hydrophobic organics, ammonia, phosphate, metals and pathogens). Although the vadose zones underlying most of the proposed detention basins within RiverPark have been either partially or completely reworked, because of the heterogeneity noted at previous SAT study sites these SAT processes are anticipated to be quite effective at RiverPark.

The most experienced researcher in the field of SAT and aquifer Storage/Recharge is Dr. Herman Bouwer of the U.S. Water Conservation Laboratory in Phoenix, Arizona and member of the National Research Council's Committee on Groundwater Recharge. Bouwer (1988) states, "Recharge systems for SAT of conventionally-treated sewage effluent typically remove essentially all suspended solids, biodegradable material (BOD) and microorganisms from the water. Concentrations of metals and phosphate are significantly reduced. Nitrogen is removed by denitrification, which can be enhanced by proper scheduling of flooding and drying periods of the basins." Expected removal rates are likely to vary somewhat depending on local sediment types, initial concentrations of each constituent, vadose zone thickness, types of organic materials present in the vadose zone and other factors.

Several researchers, including Bouwer, have documented the mechanisms governing contaminant removal in the vadose zone. The dominant treatment mechanisms known to occur in this zone include:

- Chemical or biochemical degradation or mineralization (complete oxidation to carbon dioxide and water) of organic compounds;
- Natural die-off, predation, inactivation (in the case of viruses), and sorption of pathogens and other microorganisms;
- Nitrification (ammonium oxidation), denitrification (nitrate reduction) and anaerobic ammonia oxidation (the so-called "ANAMMOX" process) via the biochemical processes of indigenous microbial fauna;
- Suspended solids removal via surface filtration; and
- Precipitation and sorption of phosphate and metals onto soil or soil organic matter.

The following sections summarize the results of recent SAT research. The research projects addressed are organized by contaminant group. The four classes of contaminants discussed here are sediments and organics, nutrients, pathogens and heavy metals.

## Sediments and Organics

Total suspended sediments (TSS), total organic carbon (TOC), fuel hydrocarbons, chlorinated and organophosphate pesticides and other organic compounds (such as polycyclic aromatic hydrocarbons (PAHs), phthalate esters and phenolic compounds) are pollutants which are known to be often present in urban and agricultural stormwater runoff. SAT's effectiveness in treating each compound is a function of the compound's abundance, mobility, filterability (or fraction particulate) and stability (or

biodegradability). SAT is quite proficient in removing TSS and TOC. However, pesticides and other organic compounds can be both mobile and recalcitrant (non-reactive), and therefore can pose a significant risk to potable groundwaters when in sufficient abundance in infiltrating waters. Only limited information is available in the SAT literature on the removal of hydrocarbons, allowing similarly limited conclusions regarding the fate of this stormwater constituent.

An extensive study of SAT was conducted by Bouwer (1988) at two artificial recharge basins in the Salt River floodplain of western Phoenix, Arizona, each receiving secondary-treated municipal effluent. At the Flushing Meadows ("FM") site, the vadose zone is 10 feet of loamy sand; at the 23rd Ave site, the vadose zone is approximately 50 feet of coarser sands and gravel. Samples were taken from the effluent and groundwater adjacent to the basins (subsequent to 16 to 20 feet of lateral transport) for comparison to determine removal rates for a multitude of constituents. Essentially 100% removal of biological oxygen demand (BOD), a standard indicator used to determine the amount of easily degradable organic matter present in a wastewater, was noted at the FM site. This result is corroborated by a study of tertiary effluent recharge by Ishaq et. al. (1995). They noted that BOD was reduced by as much as 81% in the first 1.5 ft of the soil column. In this same study, chemical oxygen demand (COD) and turbidity were reduced by as much as 93 and 90%, respectively, in this same zone.

In the Phoenix study, Bouwer (1988) noted 91% removal of TSS (at the 23rd Ave recharge site) and 50 to 75% removal of TOC (for the two sites). In a later study of these same recharge basins (Bouwer, 1991), 93 and 85% removal of TSS and TOC, respectively, was attributed to SAT. In a recharge study involving poor quality river water in the Netherlands (Stuyfzand, 1988), only 31% removal was noted for dissolved organic carbon (DOC)—the major component of TOC in surface and groundwaters—subsequent to vadose zone infiltration and subsurface transport over a distance of up to 325 feet. In a review paper by Wilson *et. al.* (1995), the subsurface fate of DOC and total organic halides (TOX)—a proxy for the suite of toxic constituents referred to as "disinfection by-products" (DBPs)—is discussed. Through the 120-foot thick vadose zone, the two constituents were reduced by, on average, 90 and 84%, respectively. Biodegradation was determined to be the dominant process in reducing DOC levels, while sorption was considered to govern TOX reduction. Based upon field observations at wastewater recharge basins in Tucson, Arizona (Tucson, 1995), 50 and 40% removal of DOC and TOX occurred during SAT. Most DOC and TOX removal is said to have occurred within the uppermost few feet where soils with the highest organic carbon content are present. Similarly, in a recent research project on the sustainability and treatment performance of several SAT systems in southern California and Arizona, Fox et. al. (1999) observed that the majority of effluent DOC was removed within the uppermost 10 ft of the vadose zone.

Perhaps the most relevant SAT study was conducted by Nightingale (1995) as part of the National Urban Runoff Program (NURP). Five urban stormwater retention/recharge basins in Fresno, California were studied, with depths to groundwater ranging from 11 to 76 feet over the course of the study. After reviewing samples for numerous pesticides and other toxic organics, it was concluded that there was no apparent adverse impacts to the soil, turf plants, or the multiple use of the basins (for summer recreation and recharge

with imported surface water). Only the organochlorine pesticide chlordane was found to significantly accumulate in the upper two centimeters of the basins' soils (the maximum level found was 2.7 mg/kg soil (ppm)); however, concentrations dropped to below 0.03 mg/kg soil (ppm) beyond 9_ inches depth. In summary, despite the presence of numerous pesticides and other toxic organics in the local runoff, Nightingale noted that very rarely were any of these compounds found in soil water samples at levels above their analytical detection limits.

According to Bouwer (1988), soil percolation removed 50 to 99% of the non-halogenated, but still potentially toxic organic compounds, which included the aliphatic (nonanes, hexanes and octanes) and aromatic (xylenes, $C_3$-benzenes, styrene, phenanthrene and diethylphthalate) organics. This loss was attributed primarily to microbial decomposition. Halogenated organics (including chloroform, carbon tetrachloride and trichloroethylene), due to their greater mobility and stability, decreased to a lesser extent with passage through the soil and aquifer.

Based upon consideration of the studies discussed above, one can state with reasonable assurance that 80, 50 and 80% removal can be expected for TSS, TOC and BOD through the vadose zone beneath the RiverPark detention basins. There are no specific data in the SAT research literature regarding the removal of oils and grease, common constituents of urban stormwater runoff, during vadose zone infiltration. However, due to the known hydrophobicity (and hence, limited mobility) of these constituents, one may reasonably suspect that their concentration are reduced significantly over the course of subsurface infiltration. Also, the potential for pesticides and other organic compounds to accumulate in the basins' sediments will depend strongly in the hydrophobicity (the affinity of a compound for sorption to soil organic matter) of the individual compounds present in the stormwater. For instance, in the case of the pesticide Lannate, which is relatively mobile and soluble, there is limited potential for sorption and accumulation within the detention basin-floor sediments. And, because of its stability, degradation during vadose zone transport will likely be relatively small.

**Nutrients**

Phosphorus, usually in the form of phosphate, and nitrogen, in the forms of ammonia, organic nitrogen, nitrite and nitrate, are often present in residential and agricultural runoff. Nitrate is in fact one of the most problematic groundwater contaminants in the arid southwestern United States, and is certainly a primary concern to the groundwater quality of this project. Fortunately, SAT has been shown to be quite effective at the removal of these constituents, particularly nitrate.

In a study conducted by Hafer et. al. (1999) at the Sweetwater Recharge Facilities in the City of Tucson, Arizona, nitrogen forms and concentrations in the chlorinated secondary effluent were monitored. The authors noted that aqueous phase ammonia concentrations decreased with depth in the soil profile, reaching essentially undetectable levels (<2 mg/L-N) by five feet below the surface. During wetting periods, SAT served to concentrate ammonia nitrogen in surface soils as water passed through the upper zone. Sorbed ammonia was then oxidized to nitrate and nitrite through the process of nitrification as oxygen was reintroduced during the subsequent drying period.

Nitrate/nitrite concentrations in soil pore water increased over the course of this dry period, reflecting the nitrification of the ammonium. This same phenomenon has also been observed by Wilson (1993). Following re-wetting, local nitrate/nitrite concentrations returned to normal levels within hours. This occurrence was attributed to the processes of biological denitrification in anaerobic zones/films, advective/diffusive transport with infiltrating water or a combination of the two. Hafer et. al. (1999) did not observe concentrations of nitrate/nitrite to exceed 5 mg/L-N at depths greater than 10 ft. Nitrate levels in local wells remained appropriately low with the nitrate concentrations in the migrating groundwater adequately attenuated by dilution, denitrification or both. Similarly, in an evaluation of SAT benefits in a Netherlands river water recharge study, Stuyfzand (1988) documented up to 63% nitrate removal.

A fundamental conclusion to the Fox *et. al.* (1999) effluent recharge study was that insufficient organic carbon was present in the applied effluent to support heterotrophic denitrification (where an organic carbon source is utilized). However, evidence for anaerobic ammonia oxidation (the so-called "ANAMMOX" reaction), where ammonia and nitrate combine under reducing conditions to form di-nitrogen gas, was obtained. Therefore, heterotrophic denitrification may not be necessary for the SAT of nitrogen in recharged waters. This is contrary to conventional understanding of nitrogen removal during SAT, but has been theorized and demonstrated by various researchers. The authors of this particular study noted total nitrogen removals of 50% or greater at sites where anoxic or anaerobic conditions developed. However, it should be noted that it is not necessarily required that large scale anaerobic conditions be present for nitrate reduction to occur. In addition to the ANAMMOX processes discussed above, denitrification is known to occur in the anaerobic biological films which surround soil grains and are always present in the vadose zone.

In a more recent study of the Phoenix recharge sites, Bouwer (1995) observed an overall removal of 70% total nitrogen. In the original study of these two sites, Bouwer (1988) noted a range of 30 to 70% nitrogen removal. Most of the nitrogen transformations in this original SAT study were shown to occur in the upper 50 cm of the vadose zone.

The most conclusive research effort regarding phosphorous compounds was also conducted by Bouwer (1988), who documented 30 to 73% phosphate removal at two Phoenix effluent recharge sites over a 10 year period of study.

Based upon review of the preceding results, it is likely that the vadose zone beneath the RiverPark detention basins can likely achieve up to 50% removal of phosphate and nitrate.

**Pathogens**

Pathogens are microorganisms—including viruses, bacteria and protozoa—capable of inflicting damage on an infected host. Due to their potential to cause acute health effects in humans, their concentrations in potable waters are strictly regulated under the EPA's Surface Water Treatment Rule (SWTR). Although they are present in significantly greater quantities in municipal wastewaters, they are also known to be quite problematic to water bodies receiving urban runoff. SAT has been shown to be effective in removing

pathogens and indicators of pathogens from both municipal effluent and urban stormwater.

The conventional method of describing pathogen removal in pathogen survival literature is in terms of "log" removal. For example, if the concentration of organisms subsequent to treatment divided by the concentration prior to treatment is equal to 0.0001, since the negative logarithm of this is 4, this is described as 4 log removal. Therefore, 1 log removal corresponds to 90% removal, 2 log removal to 99%, 3 log to 99.9%, and so on. In addition, classes of indicator organisms—such as fecal streptococci, total coliform and fecal coliform—are often used to determine the presence of bacterial, protozoan, and viral (in this case, enteric) pathogens. These indicators were adopted by regulatory agencies because of certain desirable attributes, including their: strong association with the pathogenic species which they represent, abundance (and therefore are considered a sufficiently conservative proxy), similar survival characteristics, and ease of culturability and quantification. Therefore, these classes of microorganisms may not be pathogenic themselves, but should be considered to approximate certain pathogen groups where applicable.

In a Phoenix effluent recharge study, Bouwer (1988) noted 2.3 to 6.0 log removal of fecal coliform at the Flushing Meadows site. Removal depended strongly on timing within the flood/dry cycle; i.e. coliform removal increased over the course of the flooding period. It was hypothesized that because soil microbial fauna were present at lower concentrations following dry periods, less antagonistic conditions were available to encourage pathogen die-off. Additionally, upon start-up of flood periods, less surficial silts had accumulated to provide additional filtration of pathogens from the wastewater. Bouwer states that it is in the top three feet of the vadose zone in which most bacteria removal occurs. In a later study by Bouwer (1991) of these same recharge basins, 4 log removal of fecal coliform was noted. Ishaq et. al. (1995) noted coliform reductions of 2 log within the first 20 inches of the soil column. From 20 to 40 inches the additional removal appeared to be only slight, while samples taken at 80 and 180-inch depths showed essentially no removal whatsoever. In the Netherlands river water recharge study (Stuyfzand 1988), just 1 log removal of fecal coliform was observed subsequent to vadose zone infiltration and subsurface transport (over a distance of 130 to 330 feet).

Williams et. al. (1995) established correlations between depth and removal for a variety of pathogens. The pilot-scale study was conducted in recharge basins overlying course-grained alluvial deposits in southern California. The depth to groundwater during the course of the project was at least 40 ft. The correlations established in this study account for dilution in subsurface pore and ground waters, the effects of which were quantified via bromide tracer studies. Therefore, "actual removal", for the purposes of this study, includes solely the processes of die-off and sorption. Based on these correlations, actual vadose zone removals of 3, 3.6 and 5.2 log were determined for total coliform, MS-2 Coliphage (a virus) and fecal streptococci (a bacterial indicator of fecal contamination), respectively, subsequent to 5 ft of vertical transport. Correlations for removal of *Giardia* oocysts were not established due to detection limit issues, but the cysts were not detected in groundwater samples (in this case, depth to groundwater is 40 ft) despite being detected at several cysts per 100 liters in the recharge water. The authors estimate *Giardia* removals, over the 40 ft of vertical vadose zone transport, to be in excess of 1

log. The majority of removal was shown to take place across the sediment layers covering the basin floors. During all tracer tests, virus and bacteria indicators measured in surface water were not measured in groundwater.

In the Bouwer (1988) study, no viruses were detected in groundwater samples that were likely representative of migrating recharge water either near the FM site (despite average unchlorinated effluent concentrations of 2118 plaque-forming units (PFU)/100L) or the 23rd Ave site (whose effluent was chlorinated). However, when the 23rd Ave effluent was not chlorinated, virus concentrations in nearby groundwater averaged 1.3 PFU/100L. In a later study by Bouwer (1991), complete virus removal was observed. Fox *et. al.* (1999) have postulated that virus removals greater than just 65% could be expected after 12 ft of vadose zone percolation.

Fox *et. al.* (1999) noted that, based upon extrapolation of tracer study data, a 7-log reduction of bacteriophage (a viral indicator) should occur within 100 ft of subsurface travel. These results are for a site which receives disinfected tertiary effluent, with a vadose zone of 20 to 50 ft. The study also noted that there was no apparent difference between wells influenced by effluent and control wells; indicator (bacterial and bacteriophage) occurrence in potable wells did not reveal any significant microbial impact related to effluent recharge. Similarly, using very sensitive molecular (polymerase chain reaction, or PCR) techniques, enteroviruses have been detected in groundwaters beneath both effluent recharge and control sites (receiving no recharge) also located in southern California and Arizona (Seidel *et. al.* 1999). Therefore, several of these viral evaluators could be naturally present in groundwaters, and not be a result of infiltrating waste- or stormwater.

Based upon an analysis of the aforementioned studies and consideration of the vadose zone thicknesses anticipated beneath the RiverPark detention basins, SAT at RiverPark is anticipated to provide between 2 and 3 log removal of fecal coliform and viruses. Therefore, vadose zone infiltration is expected to be a highly effective means of addressing pathogen concentration concerns in the project's stormwater runoff.

**Metals**

Metals are very common constituents in urban stormwater runoff. Because of their abundance as well as their chronic toxicity, metals concentrations in potable waters are strictly regulated. Fortunately, SAT is effective at removing these constituents from recharge and infiltration waters prior to contact with groundwater. However, because particulate filtration and adsorption are the dominant mechanisms of their removal, there exists a potential for metal accumulation in the surficial sediments of the basins' floors.

Iinformation on removal rates for metals is found in a variety of the SAT research and other technical literature (see Chang and Page, 1985; Ku and Simmons, 1986; Mikkelson et al., 1994; Nema et al., 2001; Nightingale, 1987a; Nightingale, 1987b; Pit et al, 1996; Schiffer 1989, Smith, 2001, VanLoon et al., 2000; Wigington et al., 1986). Based upon data from the Phoenix FM recharge site (which has a 10 ft loamy-sand vadose zone), Bouwer (1988) noted 87, 82, 22 and 6% SAT removals of copper, zinc, lead and cadmium, respectively. In a Netherlands river water recharge study (Stuyfzand, 1988),

analysis of samples for several metal constituents indicated infiltration and subsurface transport (over a distance of 130 to 330 feet) resulted in 25% removal of nickel . Little to no removal was observed for lead, while arsenic and iron levels both increased during aquifer transport. Increases in arsenic levels were attributed to desorption of naturally-present desposits from the soils; increases in iron levels were attributed to the reduction and subsequent dissolution of oxidized forms which coated local sand grains. Silt bound constituents—including the copper, zinc, lead, cadmium, chromium, mercury, and nickel—were all found to accumulate and largely be retained in the sediment collected on the basins' surfaces. In the Fresno stormwater recharge study by Nightingale (1995), similar results were found. Arsenic, nickel, copper and (especially) lead were found to have accumulated in the first few centimeters of the basins' soils. However, their concentrations in the recharge-mound water were similar to those found in the groundwater, and therefore there was no evidence for degradation of the water quality of the recharge mound.

Metals that are less mobile and found in greater particulate (as opposed to dissolved) fractions are more likely to be removed in the layer of accumulated silts on a basin's floor. Based upon analysis of the limited studies available on metal removal by SAT, it is likely that copper and zinc will be removed significantly from infiltrating waters. A conservative estimate for their treatment in the vadose zone beneath the RiverPark detention basins is 70% removal for each of these constituents. However, more mobile metals such as lead, nickel and cadmium may become problematic if present in relatively high concentrations in the stormwater runoff. It is for this reason that pretreatment dry swales are proposed to supplement the removal capabilities of RiverPark's detention basins. In addition, accumulation of metals (particularly copper, zinc and lead) in the surficial sediments of the basins' floors may require occasional removal during maintenance operations.

**Summary of Vadose Zone Treatment**

As discussed, infiltration facilities have been demonstrated to successfully remove the majority of suspended solids and microorganisms from percolating water. Stormwater organic carbon, metal and nutrient loads are significantly attenuated as well. Metals commonly found in urban runoff are typically found in high fraction particulate form, and are therefore easily removed through the basin's bottom sediments. Because this filtration may lead to excessive metals concentration in surficial sediment layers following a series of storm seasons, these sediment layers may require shaving or scraping and subsequent disposal in order to prevent downward migration of metals. The frequency of this type of maintenance will be determined by the metals concentrations present in the stormflows.

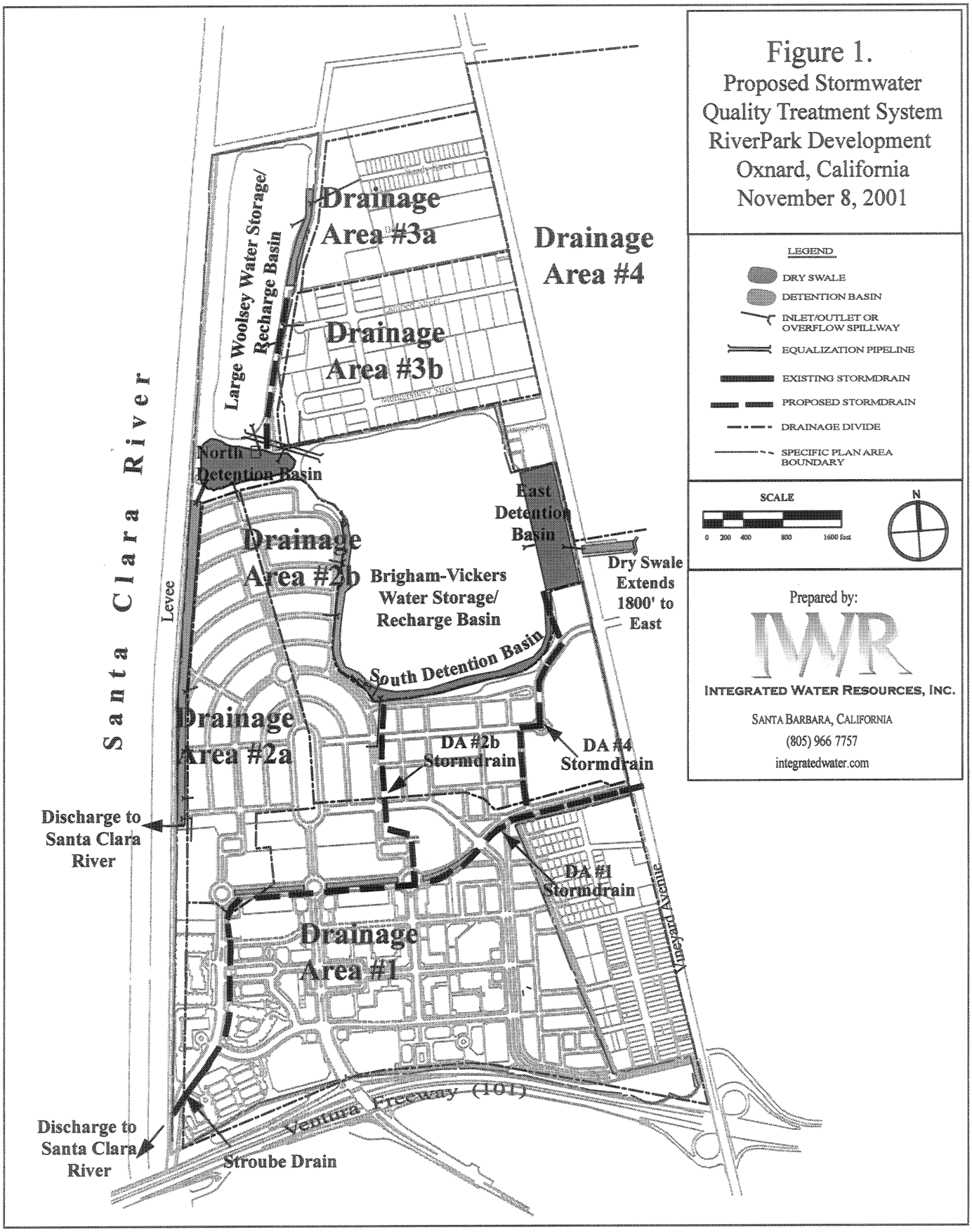
Table 12 summarizes the removal capabilities of SAT based upon the analyses found in the above appendix discussion. The infiltration facilities will treat most nutrients, pathogens and metals in urban stormwater to within MCL's, particularly during periods when the stormwater concentrations of these constituents are relatively low, based upon the standard range of anticipated concentrations for each of the constituents analyzed. Higher concentrations of any of these constituents may not be removed to within MCL's.

The frequency at which these higher concentration inflows occur is not well documented, but likely represents only a very limited proportion of the total number of runoff events.

Based upon expected infiltration at nearby recharge facilities, infiltration rates on the order of 1 to 2 feet per day can likely be maintained in RiverPark infiltration basins during periods of inundation. Therefore, during periods when a given basin is full to its design depth of 4 ft, it may take from 2 to 4 days for the stored water to fully infiltrate. This is a reasonable drawdown time, given that the average time between storms during the wet season in southern California is on the order of 200 hours (Camp Dresser & McKee, 1993).

Table 12. Anticipated Constituent Removal Capabilities for Vadose Zone Treatment in Detention basins

| **Constituent** | **Estimated % Removal** |
|---|---|
| Total Suspended Solids | 80 |
| Total Organic Carbon | 50 |
| BOD | 80 |
| Phosphate | 30 |
| Nitrate | 50 |
| Cadmium | Negligible |
| Copper | 70 |
| Lead | Negligible |
| Zinc | 70 |
| Fecal Coliform | 2 log |
| Viruses | 3 log |


Drainage Area #3a
Drainage Area #4
Drainage Area #3b
Large Woolsey Water Storage/ Recharge Basin
North Detention Basin
East Detention Basin
Dry Swale Extends 1800' to East
Drainage Area #2b
Brigham-Vickers Water Storage/ Recharge Basin
South Detention Basin
Santa Clara River
Levee
Drainage Area #2a
DA #2b Stormdrain
DA #4 Stormdrain
Discharge to Santa Clara River
DA #1 Stormdrain
Drainage Area #1
Ventura Freeway (101)
Discharge to Santa Clara River
Stroube Drain
Figure 1.
Proposed Stormwater Quality Treatment System
RiverPark Development
Oxnard, California
November 8, 2001
LEGEND
DRY SWALE
DETENTION BASIN
INLET/OUTLET OR OVERFLOW SPILLWAY
EQUALIZATION PIPELINE
EXISTING STORMDRAIN
PROPOSED STORMDRAIN
DRAINAGE DIVIDE
SPECIFIC PLAN AREA BOUNDARY
SCALE
0 200 400 800 1600 feet
N
Prepared by:
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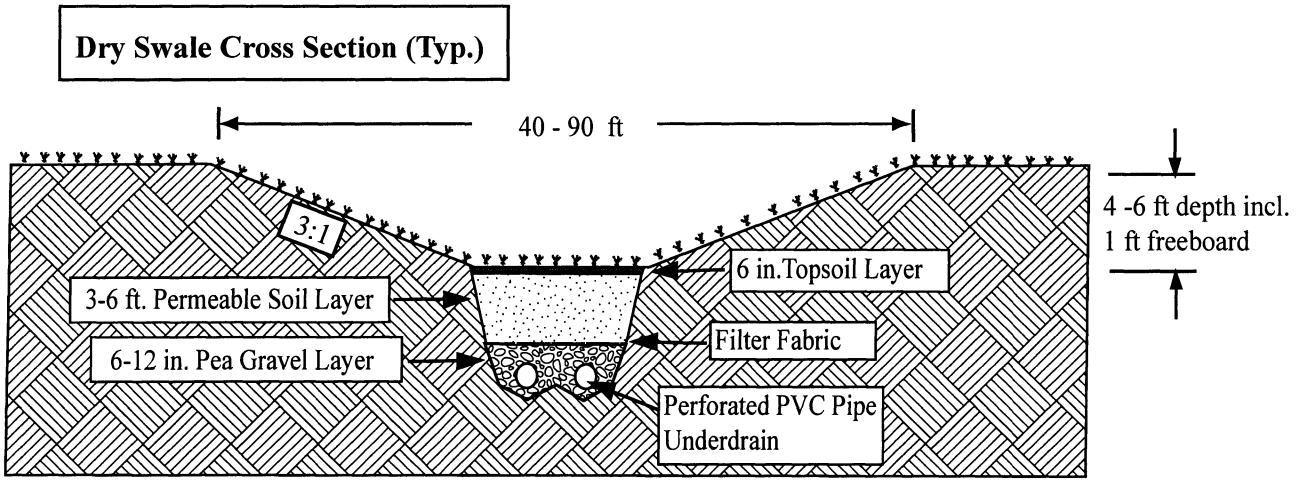


Note: Perimeter buffer zones vegetated per landscape architects' and biologists' designs and recommendations.

**Figure 2.**
**Dry Swale Cross Section**
RiverPark Development
Oxnard, California
November 8, 2001
Not to scale.

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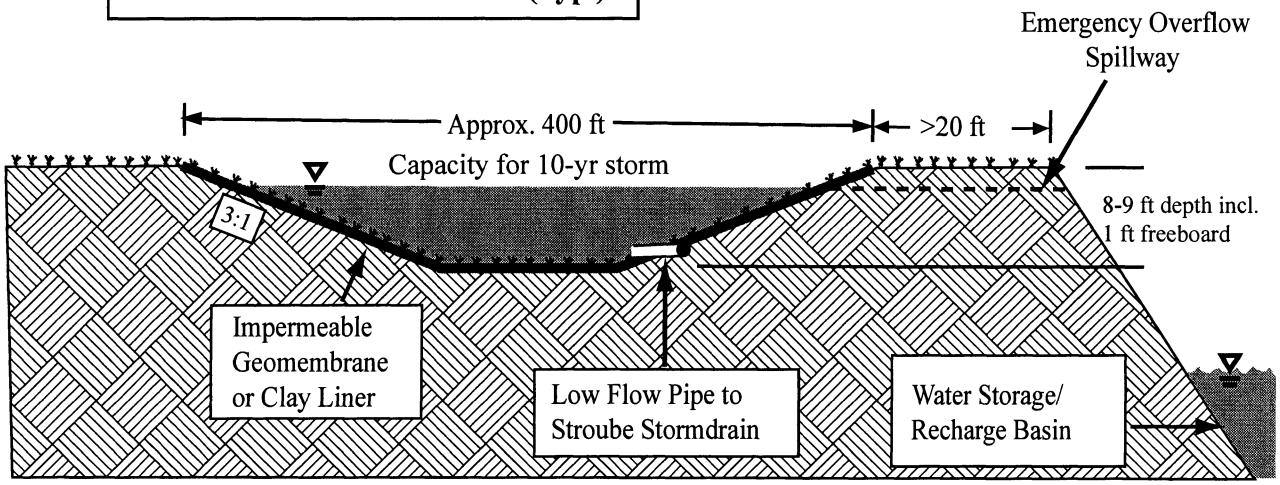
**Detention Basin Cross Section (Typ.)**




Note: Perimeter buffer zones vegetated per landscape architects' and biologists' designs and recommendations.

# Figure 3.

**Detention Basin Cross Section**

RiverPark Development

Oxnard, California

November 8, 2001

Not to scale.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# APPENDIX 4.5-6

## Conceptual Level Stormwater Treatment Plant Designs and Costs for RiverPark

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*ENVIRONMENT AND WATER RESOURCES*

September 28, 2001
Project: 175-001

**Integrated Water Resources, Inc.**
P.O. Box 2610
Santa Barbara, California
93120-2610

*Attn: Mr. Tim Thompson, R.G.*

**Re: Conceptual Level Stormwater Treatment Plant Designs And Costs For RiverPark**

Dear Mr. Thompson:

Thank you for providing us with the necessary technical information to complete the designs and costs noted above. As you will see in the following sections, treating the stormwater to the required discharge limits for the various contaminants is not an issue. However, the huge volume of stormwater that is expected to be generated during the noted storm events presents some difficulties with regards to flow equalization. We have based our design concepts upon a modular treatment plant approach with a minimum capacity of 1,000 gpm. Additional treatment modules can be added to double or triple the capacity of the system (or any number of modules for that matter). As you will see, it is not the cost of the treatment facilities that is alarming, but the cost of flow equalization tankage (as well as the land area required for that tankage). We would like to stress that these are conceptual level designs only and would urge the involved parties to consider other upstream forms of flow equalization in order to minimize the volume of tankage required downstream near the treatment works.

## 1.1 SCOPE OF WORK

As noted in your "Attachment B" provided to us on August 31, 2001, we have briefly summarized our Scope of Work as follows:

- Conceptual level design of treatment facilities for discharges to the Santa Clara River for flows up to the 10-year event;
- Conceptual level design of treatment facilities for discharges to exposed groundwater in the existing gravel pits for flows greater than the 10-year event and up to the 25-year event;

- Anticipated capital costs for the facilities;
- Anticipated operations and maintenance costs for the facilities; and
- A written description of the facilities for incorporation into the Draft EIR.

## 1.2 TREATMENT VOLUMES AND FLOW RATES

### 1.2.1 10-YEAR STORM DISCHARGE TO STROUBE DRAIN

Background hydrological data and other information was provided by Integrated Water Resources (IWR), Inc. **Table 1**, shown below, summarizes the relevant information for this particular discharge case including drainage area identification, hydrograph volume by drainage area, peak flow rate with additional notes and corrections as per instructions from IWR.

**Table 1 – Data For 10-Year Storm Discharge To Stroube Drain**

| Drainage Area | Hydrograph Volume | | Peak Flow Rate | |
|---|---|---|---|---|
| | (acre-feet) | (gallons) | (cfs)[1] | (gpm)[2] |
| DA-1 | 55 | 17,922,000 | 241 | 108,170 |
| DA-2a | 20 | 6,517,000 | 126 | 56,550 |
| DA-2b | 28 | 9,124,000 | - | - |
| DA-3a | 21 | 6,843,000 | - | - |
| DA-3b | 37 | 12,057,000 | - | - |
| DA-4 | 100 | 32,585,000 | - | - |
| Sub-Total | 261 | 85,048,000 | 367 | 164,720 |
| Correction[3] | - | - | 73 | 32,760 |
| **Total** | **261** | **85,048,000** | **440** | **197,480** |

1. cfs = cubic feet per second.
2. gpm = gallons per minute.
3. A 20% correction factor was applied to account for smaller effluent flows draining from the detention basins serving the other drainage areas as per instruction from IWR personnel on Tuesday, September 11, 2001.

Ultimately, all the stormwater generated during events up to the 10-year return period will be treated prior to discharge to the Santa Clara River. It has been assumed that flow equalization will be required for the stormwater flows from DA-1 and DA-2a only, and that all other stormwater flows from the remaining drainage areas are equalized upstream. It is further assumed that the equalization provided by the three (3) detention basins will be sufficient to limit the combined discharge rate from these basins to 1,000 gallons per minute. Additional details on flow equalization are discussed in the sections that follow.

### 1.2.2 10-YEAR+ TO 25-YEAR STORM DISCHARGE TO INFILTRATION BASINS

**Table 2**, shown below, summarizes the relevant information for these particular discharge cases including drainage area identification, hydrograph volumes by drainage areas and peak flow rates. This data is based upon the differences between the hydrograph volumes and peak flow rates for the 25-year storm and the 10-year storm for the areas noted below (ie. the 10-year storm was subtracted from the 25-year storm to yield the data in **Table 2**).

| Table 2 - Data For 10-Year+ To 25-Year Storm Discharge To Infiltration Basins | | | | |
|---|---|---|---|---|
| **Drainage Area** | **Hydrograph Volume** | | **Peak Flow Rate** | |
| | **(acre-feet)** | **(gallons)** | **(cfs)** | **(gpm)** |
| DA-2b | 6 | 1,955,000 | 35 | 15,710 |
| DA-3a | 4 | 1,303,000 | 21 | 9,430 |
| DA-3b | 7 | 2,281,000 | 36 | 16,160 |
| DA-4 | 21 | 6,843,000 | 53 | 23,790 |
| **Total** | **38** | **12,382,000** | **145** | **65,090** |

As the flows from these storm events exceed the equalization capacity of the three (3) detention basins and the dry swales, additional flow equalization will be required to limit the incoming flow rate at the treatment plant site. Additional details on flow equalization are discussed in the sections that follow.

## 1.3 TREATMENT OPTIONS

### 1.3.1 PARAMETERS OF CONCERN FOR 10-YEAR STORM DISCHARGE

As identified in information provided by IWR, the parameter of concern for the 10-year storm discharge through the Stroube Drain into the adjacent Santa Clara River is fecal coliform. IWR has identified a post-project, post-treatment condition for fecal coliform of 2,027 MPN/100 mL whereas the Basin Plan Objective (BPO) for fecal coliform is 200 MPN/100 mL. As such, disinfection of the entire 10-year storm volume will be required prior to discharge to the Santa Clara River in order to meet the BPO.

### 1.3.2 PARAMETERS OF CONCERN FOR 10-YEAR+ TO 25-YEAR STORM DISCHARGE

As identified in information provided by IWR, the parameters of concern for the 10-year+ to 25-year storm discharge into the water storage / infiltration basins (WS/IBs) are iron, manganese and nickel.

**Table 3**, shown below, summarizes stormwater quality data for the blended stormwater discharge at the point of contact with the WS/IBs and the treatment objectives for the discharge.

| Table 3 – Water Quality Data For Discharge To The WS/IBs | | |
|---|---|---|
| **Parameter** | **Point Of Contact (mg/L)** | **Treatment Goal (mg/L)** |
| Iron | 1.341 | 0.833 |
| Manganese | 0.146 | 0.083 |
| Nickel | 0.011 | 0.005 |

### 1.3.3 DISINFECTION OPTIONS

Several disinfection options were initially examined, including the following:

- Chlorination. This option was ruled out because of concerns regarding the production of trihalomethanes (THMs) and the associated water quality (and environmental impact) issues that would result from this process. This concern also applies to other potential disinfectants including bromine and ozone.
- Hydrogen Peroxide. Initially considered as feasible, this option was later ruled out. Hydrogen peroxide is a poor microbiocide compared to chlorine, bromine, ozone and other commonly used disinfectants. In principle, hydrogen peroxide can be used to disinfect stormwater, however, specific applications where that has actually been done are unknown. CT tables for determining contact times and dose concentrations for the inactivation of bacteria are unknown and as such, the appropriate hydrogen peroxide dose for adequate disinfection is also unknown. As such, insufficient information is available at this time to allow for estimation of construction and operation costs.
- Ultra-Violet (UV) Light. This option was initially dismissed as total suspended solids (TSS) concentrations in the influent were predicted by IWR to be approximately 70 mg/L. The UV disinfection system would not be effective with that concentration of TSS. TSS concentrations must be in the order of 5 to 10 mg/L before UV is effective and efficient at destroying fecal coliform bacteria. However, because of the constraints involved in using other forms of disinfection, it was found that the use of UV with a pre-treatment filtration step was a feasible and cost-effective option for this task. As such, the treatment plant option for treating the 10-year storm flows is based upon pre-filtration followed by UV disinfection prior to discharge to the Santa Clara River.

For the purposes of this conceptual level planning document, it is proposed to locate one (1) central treatment facility to treat stormwater flows up to the 10-year event near the vicinity of the Stroube Drain. Details on this location and the treatment plant are provided in the sections that follow.

### 1.3.4 METAL REMOVAL OPTIONS

Two metal removal options were initially examined, including the following:

- Chlorine Oxidation with Filtration to Remove Metal Hydroxide Precipitates. This option was ruled out because of concerns regarding the production of THMs and the associated water quality (and environmental impact) issues that would result from this process.
- Manganese Green Sand Filtration with Continuous Regeneration by Potassium Permanganate. This option was examined and found to be technically and economically feasible. As it avoids the complications associated with chlorine oxidation, manganese green sand filtration has been selected as the treatment plant option for treating the 10-year+ to 25-year storm flows that will be discharged to the WS/IBs.

For the purposes of this conceptual level planning document, it is proposed to locate one (1) central treatment facility to treat stormwater flows greater than the 10-year event and up to the 25-year event in the area between the South Detention Basin and the East Detention Basin. Details on this location, the treatment plant and the associated drainage area interconnections are provided in the sections that follow.

## 1.4 EQUALIZATION OPTIONS

As noted in Section 1.2, the stormwater volumes expected to be generated, and requiring treatment, are extremely large. Three philosophies of treatment include the following:

- Design a treatment plant large enough to treat the flows as they arrive at the treatment plant with no additional requirements for flow equalization;
- Design a small, modular treatment plant based upon a realistic, economically-feasible size and temporarily store the excess untreated flows in a large volume flow equalization system (or several smaller systems built into the stormwater infrastructure throughout the site); and
- Based upon an expansion of the second item, construct multiple modular treatment systems in parallel and temporarily store the excess untreated flows in a large volume flow equalization system (or several smaller systems built into the stormwater infrastructure throughout the site), with a volume reduction from that shown in the second item to account for the increased treatment capacity.

On the basis of having to treat 261 acre-feet (85,048,000 gallons) with a peak flow rate of 440 cfs (197,480 gpm) for the 10-year storm event, the first option is not feasible. This also applies for the flows greater than the 10-year event and up to the 25-year event which are in the order of 38 acre-feet (12,382,000 gallons) at a peak flow rate of 145 cfs (65,090 gpm).

As such, options two and three can be examined to see which is the most feasible. On the basis of a single, modular treatment plant having a capacity of 1,000 gpm (2.23 cfs) and the design storms having

a duration of 1,500 minutes as noted on the IWR-provided hydrographs, a single treatment plant will be capable of treating 1,500,000 gallons during the storm event. Obviously, this treatment volume can be subtracted from the total equalization volume required and several different treatment / equalization options can then be examined. **Table 4** summarizes treatment capacity versus required equalization volume for a range of modular treatment plant configurations for both the 10-year storm event and the 10-year+ to 25-year storm event.

**Table 4 - Treatment Plant Options Versus Required Equalization**

**10-Year Storm Event**

| Treatment Plants (#) | Plant Capacity (gpm) | Volume Treated During Storm (gallons) | DA-1 & DA-2a Total Volume (gallons) | Required Equalization (gallons) | DA-1 & DA-2a Treatment Time (days) | Other DAs Total Volume (gallons) | Other DAs Treatment Time (days) | Total Treatment Time (days) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1,000 | 1,500,000 | 24,439,000 | 22,939,000 | 17.0 | 60,609,000 | 42.1 | 59.1 |
| 2 | 2,000 | 3,000,000 | 24,439,000 | 21,439,000 | 8.5 | 60,609,000 | 21.0 | 29.5 |
| 3 | 3,000 | 4,500,000 | 24,439,000 | 19,939,000 | 5.7 | 60,609,000 | 14.0 | 19.7 |
| 4 | 4,000 | 6,000,000 | 24,439,000 | 18,439,000 | 4.2 | 60,609,000 | 10.5 | 14.8 |

**Table 4 - Treatment Plant Options Versus Required Equalization (continued)**

**10-Year + To 25-Year Storm Event**

| Treatment Plants (#) | Plant Capacity (gpm) | Volume Treated During Storm (gallons) | Total Volume (gallons) | Required Equalization (gallons) | Treatment Time (days) |
|---|---|---|---|---|---|
| 1 | 1,000 | 1,500,000 | 12,383,000 | 10,883,000 | 8.6 |
| 2 | 2,000 | 3,000,000 | 12,383,000 | 9,383,000 | 4.3 |
| 3 | 3,000 | 4,500,000 | 12,383,000 | 7,883,000 | 2.9 |
| 4 | 4,000 | 6,000,000 | 12,383,000 | 6,383,000 | 2.1 |

As noted in **Table 4**, for the 10-year storm event, there is no real advantage to having additional modular treatment units other than for reducing the time required to treat the volume of water generated by the storm. The required equalization volume does not decrease significantly when more modular treatment units are considered. On this basis, we developed our conceptual cost estimates based upon utilizing a single modular treatment system for the 10-year storm event. For the 10-year +

storm event up to the 25-year storm event, quadrupling the treatment plant capacity will reduce the equalization volume by approximately 40%. Again, on this basis, we developed our conceptual cost estimates based upon utilizing a single modular treatment system for the 10-year + storm event up to the 25-year storm event.

## 1.5 CAPITAL COSTS

### 1.5.1 10-YEAR STORM EVENT TREATMENT SYSTEM

Prior to disinfecting stormwater from the 10-year storm event with UV-light, the TSS concentration in the influent must be reduced from approximately 70 mg/L to a range of 5 to 10 mg/L. A pre-filtration step will be necessary to achieve this TSS reduction. Conceptually, flows from the Stroube Drain system will be routed into an equalization tank with flows then being pumped at a rate of 1,000 gpm to a tube settler module sized for a flow of 1,000 gpm. From the tube settler, stormwater is then pumped through a sand filter module also sized for a flow of 1,000 gpm. Effluent from the sand filter is now suitable for disinfection with UV-light. This will be accomplished by means of submersible UV packs placed online in a contact tank. This UV disinfection module is also sized for a flow of 1,000 gpm. The disinfected effluent flows from the disinfection module to a downstream connection on the Stroube Drain and then into the Santa Clara River.

As noted in **Table 4**, the volume required for flow equalization is approximately 23 million gallons. Also noted above is that the capacity of the treatment plant has little influence on the flow equalization volume as the stormwater volume expected from the 10-year storm is significantly greater than what can be treated at an economical rate. For the purposes of this conceptual plan, we have based our estimate on providing underground concrete tankage to store and equalize this flow volume. We would urge the parties involved to consider other forms of flow equalization upstream within the development that could include:

- Flat roofs with curbs and slow release piping connections;
- Temporary storage in parking lots;
- Oversized collection piping throughout the site;
- Temporary storage in parks and on golf courses; and
- Additional water features such as "duck ponds", etc.

Other preliminary ideas for flow equalization that were examined, but not proven feasible, included lining the Large Woolsey Water Storage / Infiltration Basin and using that gravel pit for flow equalization. Obviously, given the urban, built-out nature of the proposed development, and the stormwater volumes involved, flow equalization prior to treatment is a significant concern. It should be stressed that the other forms of equalization noted above should be investigated by the project team, however, for the purposes of this concept, we have developed our estimates based upon a single

equalization tank (to demonstrate not only the size and volume required, but the cost associated with that option).

The flow equalization tank will consist of a single, large, underground concrete tank with the approximate dimensions of 132 m wide (433 feet) by 132 m long (433 feet) by 5 m deep (16.4 feet). Some settling of suspended solids (and fecal coliform bacteria associated with those particles) will occur in the equalization tank. This reduction may amount to approximately 20% of the influent concentration. Additional pre-treatment steps prior to UV disinfection are still required.

The tube settler module is provided for suspended solids reduction and will be built in the ground in a concrete tank. This module will occupy a land area of approximately 105 square meters ($m^2$) [1,130 square feet {$ft^2$}]. Tube settlers are gravity settling clarifiers with the settling process being enhanced using inclined tube packs placed to reduce the velocity of the incoming stormwater and provide additional surface area to settle out suspended solids. The tube settler media is u-PVC and can be assembled on site. The dimensions of the 1,000 gpm tube settler module are 15 meters (m) long (49.2 feet) by 7 m wide (23.0 feet) with a sidewall depth of 4.5 m (14.8 feet).

The sand filtration module is provided for additional suspended solids removal (with bacterial removal also occurring in this module). This module will be built in the ground in a concrete tank and will occupy a land area of approximately 50 $m^2$ (538 $ft^2$). The sand filtration unit will be composed of four (4) individual cells, each with an area of approximately 12.5 $m^2$ (135 $ft^2$). This will permit continuous operation while individual filter cells are being backwashed. The dimensions of the 1,000 gpm sand filtration module are 7.1 m long (23.3 feet) by 7.1 m (23.3 feet) wide by 5 m deep (16.4 feet).

The UV disinfection system will provide destruction of fecal coliform bacteria to concentrations below the BPO. The system will consist of a sub-surface, flow-through concrete channel with 32, 200 watt UV lamps in two banks of 16 lamps each. The UV disinfection system includes automatic, in-place cleaning and submersible ballasts. This module will be built in the ground and will occupy a land area of approximately 6 $m^2$ (65 $ft^2$). The dimensions of the 1,000 gpm UV disinfection system are approximately 9 m long (29.5 feet) by 0.66 m wide (2.2 feet) by 0.8 m deep (2.6 feet).

The footprint of the 10-year storm event treatment system has been superimposed upon the figure provided by IWR and is included with this letter as **Figure 1**. The total footprint for the 10-year storm event treatment system (including the flow equalization tank) is summarized by component in **Table 5** as shown below.

**Table 5 – Summary Of Area Requirements For 10-Year Storm Treatment System**

| Component | Dimensions | Area Required |
|---|---|---|
| Flow Equalization Tank | 132 m x 132 m x 5 m<br>433 feet x 433 feet x 16.4 feet | 17,424 $m^2$<br>187,489 $ft^2$ |

| | | |
|---|---|---|
| Tube Settler Module | 15 m x 7 m x 4.5 m<br>49.2 feet x 23 feet x 14.8 feet | 105 $m^2$<br>1,132 $ft^2$ |
| Sand Filtration Module | 7.1 m x 7.1 m x 5 m<br>23.3 feet x 23.3 feet x 16.4 feet | 50 $m^2$<br>543 $ft^2$ |
| UV Disinfection Module | 9 m x 0.66 m x 0.8 m<br>29.5 feet x 2.2 feet x 2.6 feet | 6 $m^2$<br>65 $ft^2$ |
| **Total** | - | **17,585 $m^2$**<br>**189,229 $ft^2$** |

Capital costs for the 10-year storm event treatment system are summarized by component in **Table 6** as shown below. These capital costs include all aspects related to the design, permitting, supply, construction and installation, and commissioning of the noted treatment system.

**Table 6 – Summary Of Capital Costs For 10-Year Storm Treatment System**

| Component | Cost |
|---|---|
| Flow Equalization Tank | $23,000,000 |
| Tube Settler Module | $520,000 |
| Sand Filtration Module | $455,000 |
| UV Disinfection Module | $180,000 |
| **Total** | **$24,155,000** |

**Assumptions:**

1. The conceptual cost for the flow equalization tank is based upon suggestions from ASL/Tetratech personnel of $1 per gallon of storage. However, based upon the following subsequent assumptions, the actual construction cost for that large flow equalization tank may be in the order of $10,000,000.
2. Excavation, soil disposal and concrete tank construction costs are based upon R.S. Means data for 1998.
3. Soil disposal costs have been assumed at $10- per cubic yard.
4. Data for 1998 have been adjusted upwards by 10% to allow for inflation.
5. Expected tank dimensions have been adjusted upwards by 20% to allow for the inclusion of pump pad costs and equipment shelter costs.
6. An overall contingency of 20% has been added to all costs for unknowns at this early conceptual stage.

### 1.5.2 10-YEAR+ TO 25-YEAR STORM EVENT TREATMENT SYSTEM

Conceptually, flows from Drainage Areas 3a, 3b, 2b and 4 will be routed via additional stormwater piping from the drainage areas into an equalization tank located between the South Detention Basin and the East Detention Basin near the Brigham-Vickers Water Storage / Infiltration Basin. Stormwater will then be pumped through a manganese green sand filter module at a rate of 1,000 gpm

to remove the metals of concern which include iron, manganese and nickel. This treated stormwater will then be directly discharged to the Brigham-Vickers Water Storage / Infiltration Basin.

As noted in **Table 4**, the volume required for flow equalization is approximately 11 million gallons. Also noted above was that quadrupling the treatment plant capacity will reduce the equalization volume by approximately 40%. However, for the purposes of this conceptual plan, we have based our estimate on providing underground concrete tankage to store and equalize 10.9 million gallons of stormwater with the treatment plant consisting of a single, 1,000 gpm treatment module. Again, flow equalization prior to treatment is a significant concern.

The flow equalization tank will consist of a single, large, underground concrete tank with the approximate dimensions of 91 m wide (300 feet) by 91 m long (300 feet) by 5 m deep (16.4 feet).

The manganese green sand filter module is provided for metals removal. Manganese green sand is an engineered media which relies on regeneration by potassium permanganate. Potassium permanganate is a strong oxidant which oxidizes the metals of concern (iron, manganese and nickel) to their insoluble forms. Once in this form, these metals are adsorbed, chemisorbed and filtered by the manganese green sand filter. Continuous regeneration of the potassium permanganate has been adopted for this particular treatment application. The metals of concern in the effluent (which will be present at low concentrations) from this treatment system are all in their insoluble form. The effluent will not contain any metals of concern in their dissolved form. The insoluble metals in the effluent will remain in that insoluble form in the receiving environment and will not revert back to their dissolved form unless they encounter severe environmental conditions (such as a pH of less than 2 or combined in a process that would allow catalysis to occur). This module will be built in the ground in a concrete tank and will occupy a land area of approximately 50 $m^2$ (538 $ft^2$) [the same as the sand filtration unit noted for the 10-year storm event]. The manganese green sand filtration unit will be composed of four (4) individual cells, each with an area of approximately 12.5 $m^2$ (135 $ft^2$). This will permit continuous operation while individual filter cells are being backwashed. The dimensions of the 1,000 gpm manganese green sand filtration module are 7.1 m long (23.3 feet) by 7.1 m (23.3 feet) wide by 5 m deep (16.4 feet).

The footprint of the 10-year+ to 25-year storm event treatment system has been superimposed upon the figure provided by IWR and is included with this letter as **Figure 1**. The total footprint for the 10-year+ to 25-year storm event treatment system (including the flow equalization tank) is summarized by component in **Table 7** as shown below.

| Table 7–Summary Of Area Requirements For 10-Year+ To 25-Year Treatment System | | |
|---|---|---|
| **Component** | **Dimensions** | **Area Required** |
| Flow Equalization Tank | 91 m x 91 m x 5 m<br>300 feet x 300 feet x 16.4 feet | 8,281 $m^2$<br>90,000 $ft^2$ |
| Manganese Green Sand Filtration Module | 7.1 m x 7.1 m x 5 m<br>23.3 feet x 23.3 feet x 16.4 feet | 50 $m^2$<br>543 $ft^2$ |
| **Total** | - | **8,331 $m^2$**<br>**90,543 $ft^2$** |

Capital costs for the 10-year+ to 25-year storm event treatment system are summarized by component in **Table 8** as shown below. These capital costs include all aspects related to the design, permitting, supply, construction and installation, and commissioning of the noted treatment system.

| Table 8 – Summary Of Capital Costs For 10-Year+ To 25-Year Storm Treatment System | |
|---|---|
| **Component** | **Cost** |
| Stormwater Piping From Areas To EQ Tank | $350,000 |
| Flow Equalization Tank | $10,900,000 |
| Manganese Green Sand Filtration Module | $505,000 |
| **Total** | **$11,755,000** |

**Assumptions:**

1. The conceptual cost for the flow equalization tank is based upon suggestions from ASL/Tetratech personnel of $1 per gallon of storage. However, based upon the following subsequent assumptions, the actual construction cost for that large flow equalization tank may be in the order of $5,000,000.
2. Excavation, soil disposal and concrete tank construction costs are based upon R.S. Means data for 1998.
3. Soil disposal costs have been assumed at $10- per cubic yard.
4. Data for 1998 have been adjusted upwards by 10% to allow for inflation.
5. Expected tank dimensions have been adjusted upwards by 20% to allow for the inclusion of pump pad costs and equipment shelter costs.
6. Stormwater piping costs have been based upon a combination of 18" diameter pipe (at an installed cost of $50 per foot) and 24" diameter pipe (at an installed cost of $75 per foot).
7. An overall contingency of 20% has been added to all costs for unknowns at this early conceptual stage.

## 1.6 OPERATIONS AND MAINTENANCE COSTS

### 1.6.1 POWER REQUIREMENTS

Power requirements for the treatment systems are related to the pumps used in the various components as well as the electrical requirements for the UV system.

### 1.6.1.1 10-Year Storm Treatment System

**Table 9** summarizes the electrical requirements for each of the components in the treatment system for the 10-year storm flow.

**Table 9 – Summary Of Electrical Requirements For 10-Year Storm Treatment System**

| Treatment Component | Electrical Component | Power (hp) | Power (kW) | Operation (hours / event) |
|---|---|---|---|---|
| Equalization Tank | Feed Pump | 30 | 22.4 | 1,718 |
| Tube Settler | Feed Pump<br>Sludge Pump | 30<br>5 | 22.4<br>3.7 | 1,718<br>236 |
| Sand Filter | Feed Pump<br>Backwash Pump | 30<br>30 | 22.4<br>22.4 | 1,718<br>236 |
| UV Disinfection System | UV Lamps | - | 7.5 | 1,718 |

Operation is based upon the time it will take the treatment system to treat the entire 10-year storm event. Sludge pump operation is based upon 4 hours per day for the duration of the treatment time. Backwash pump operation is based upon 4 hours per day for the duration of the treatment time. All pumps will be installed in duplex configuration for redundancy, however, only one of the two pumps in the duplex configuration will be operating at any one time.

### 1.6.1.2 10-Year+ To 25-Year Storm Treatment System

**Table 10** summarizes the electrical requirements for each of the components in the treatment system for the 10-year+ to 25-year storm flow.

**Table 10 – Summary Of Electrical Requirements For 10-Year+ To 25-Year Storm Treatment System**

| Treatment Component | Electrical Component | Power (hp) | Power (kW) | Operation (hours / event) |
|---|---|---|---|---|
| Equalization Tank | Feed Pump | 30 | 22.4 | 206 |
| Manganese Green Sand Filter | Feed Pump<br>Backwash Pump | 30<br>30 | 22.4<br>22.4 | 206<br>34 |

Operation is based upon the time it will take the treatment system to treat the entire 10-year+ to 25-year storm event. Backwash pump operation is based upon 4 hours per day for the duration of the treatment time. All pumps will be installed in duplex configuration for redundancy, however, only one of the two pumps in the duplex configuration will be operating at any one time.

### 1.6.2 ROUTINE MAINTENACE COSTS

The 10-year event stormwater treatment system will treat all flows up to that event, and as such, it will be utilized significantly more than the 10-year+ to 25-year event stormwater treatment system which will sit idle until needed. On that basis, we have developed a conceptual annual maintenance program to be performed twice during any given year. It will be the responsibility of the maintenance technician to "exercise" the systems and ensure proper functioning. His duties may include:

- Checking the electrical connections for all components;
- Performing "test runs" of the system to ensure that each component is functioning;
- Service and repair equipment and treatment components as necessary; and
- Collect effluent water samples to verify system performance.

On that basis, we have conceptually allocated four days per treatment system per 6-month period (a total of 8 days per year) for the maintenance technician to perform his scheduled duties. Based upon an hourly rate of $60 per hour over the course of eight, 10-hour days, annual labor costs for operator maintenance of the treatment systems is estimated at approximately $4,800.

The annual cost for replacement parts and components for the treatment system is difficult to estimate at this stage based upon expected usage. It is expected that approximately 150 gallons per day of potassium permanganate will be used during storm events. We estimate that approximately $20,000 per year should be allocated for chemical supplies, routine part replacement or component repair.

## 1.7 REMOVAL EFFICIENCIES

### 1.7.1 10-YEAR STORM EVENT TREATMENT SYSTEM

This treatment system is designed to disinfect the stormwater prior to discharge to the Santa Clara River. Data provided by IWR showed that typical fecal coliform concentrations in the stormwater exiting the Stroube Drain are expected to be 2,027 MPN/100 mL. On the basis of the treatment system proposed, removal of fecal coliform will occur through the equalization tank and the sand filter with the UV disinfection system reducing the fecal coliform concentration to non-detectable levels of <10 MPN/100 mL. The BPO for this discharge is 200 MPN/100 mL. Should fecal coliform concentrations increase in the untreated wastewater to levels greater than 2,027 MPN/100 mL, the treatment system will still be capable of reducing the concentrations to non-detectable levels. In all

cases, based upon the proper functioning of the treatment system, fecal coliform concentrations in the treated stormwater will remain lower that the BPO.

### 1.7.2 10-YEAR+ TO 25-YEAR STORM EVENT TREATMENT SYSTEM

This treatment system is designed to remove metals (particularly iron, manganese and nickel) from the stormwater prior to discharge to the WS/IBs. **Table 11**, shown below, summarizes data provided by IWR for the concentrations of these metals in the untreated stormwater, the treatment goals and the expected concentrations in the effluent, based upon expected removal efficiencies for the manganese green sand filtration system. Removal efficiencies for this system are expected to be in the order of 70 to 95%.

**Table 11 – Metal Removal Efficiencies For The Manganese Green Sand Filtration System**

| Parameter | Point Of Contact (mg/L) | Treatment Goal (mg/L) | Effluent Concentration Range (mg/L) |
|---|---|---|---|
| Iron | 1.341 | 0.833 | 0.067 to 0.402 |
| Manganese | 0.146 | 0.083 | 0.007 to 0.044 |
| Nickel | 0.011 | 0.005 | 0.001 to 0.003 |

As noted previously, the metals of concern (iron, manganese and nickel) will be oxidized to their insoluble forms. Once in this form, these metals are adsorbed, chemisorbed and filtered by the manganese green sand filter. The metals of concern in the effluent (which will be present at low concentrations) from this treatment system are all in their insoluble form. The effluent will not contain any metals of concern in their dissolved form. The insoluble metals in the effluent will remain in that insoluble form in the receiving environment and will not revert back to their dissolved form unless they encounter severe environmental conditions (such as a pH of less than 2 or combined in a process that would allow catalysis to occur).

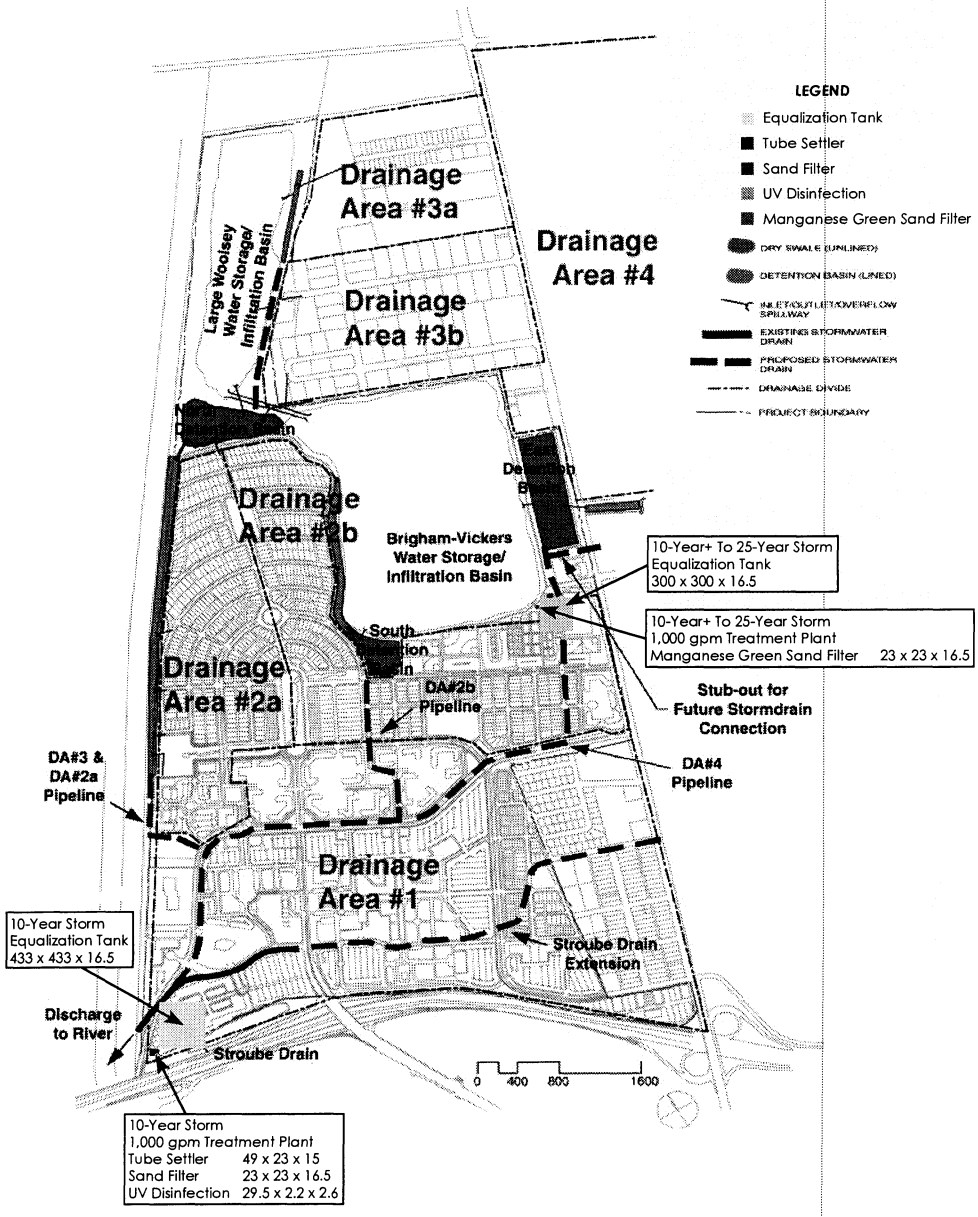
## 1.8 CLOSURE

We have enjoyed this interesting and challenging conceptual stormwater treatment design project. Treating the stormwater for the parameters of concern to the desired levels can be accomplished fairly easily, however, flow equalization prior to treatment is a significant concern because of the extremely large volumes of water that must be treated. As noted previously, we would urge the parties involved to consider other forms of flow equalization upstream within the development.

If you have any questions or comments, please contact the undersigned at (714) 379-1157 Extension 141 or by e-mail at wmajor@losangeles.komex.com.

Sincerely,

Wade Major
*Environmental Engineer*




**Note: Treatment components are drawn to scale and color-coded for ease of reference.**

**Based map adapted from IWR Figure 1**

KOMEX

*PREPARED FOR THE USE OF OUR CLIENT AND NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH KOMEX HAS NOT ENTERED INTO CONTRACT*

| | |
|---|---|
| CLIENT | INTEGRATED WATER RESOURCES, INC. |
| PROJECT/SITE | OXNARD, CALIFORNIA |
| Date | 09-28-01 |
| Project No | 175-001 |
| TITLE | RIVERPARK DEVELOPMENT TREATMENT PLANT FOOTPRINTS |
| Figure No | 1 |

# APPENDIX 4.5-7

## Particulate Fraction Settling Articles

(2)

# CHAPTER 21

# Soil Deposition of Trace Metals during Groundwater Recharge Using Surface Spreading

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Treated wastewater effluents are frequently the source of water for artificial groundwater recharge. Under extremely high hydraulic loading rates, it is quite conceivable that large amounts of undesirable constituents of wastewater may be introduced into the aquifer. Even if the contaminants are prevented from entering the underground reservoir, they may be deposited in the soil profile where the recharge process has taken place. Thus, water quality aspects of the groundwater recharge are equally important as hydraulic and geologic considerations. To anticipate the impact of an artificial groundwater recharge operation on the quality of finished water, it is essential to fully understand the fate of potential contaminants in the soil. In the following sections, the occurrence of trace metals in treated wastewater effluents is reviewed, their potential impacts on the beneficial use of the water are evaluated, and the capability of soils in attenuating contaminants of the recharging water is demonstrated.

## INORGANIC CONTAMINANTS IN TREATED WASTEWATER

Conventional wastewater treatment systems are designed to remove suspended solids, colloidal solids, and biochemical oxygen-demanding substances from the incoming wastewater. Before final discharge, the effluent

may be subject to disinfection to reduce microorganisms of sanitary significance. With the removal of these constituents, the wastewater also becomes generally free of turbidity, color, and odor. Any reduction of other categories of contaminants during the water purification process would be, however, considered incidental. Under these conditions, treated wastewater effluents are not likely to be rendered entirely free of undesirable substances for subsequent beneficial use.

Unlike the organic constituents of wastewater, which are added into the water through its uses, the inorganic constituents reflect, to a large extent, the chemical composition of the source water. The mineral contents of wastewater, therefore, may vary over a wide range of concentrations (Table 21.1). Since they are not affected by the wastewater treatment, additional amounts of minerals are picked up with each cycle of water use (Table 21.2). The incremental increase in the mineral concentration due to beneficial uses directly contributes to an increase in water salinity. Almost

**Table 21.1** Mineral Compositions of Treated Wastewater Effluents and the Mineral Requirements in *Water Quality Criteria*

| | *Wastewater Effluent*[a] | | | *Water Quality Criteria*[b] | |
|---|---|---|---|---|---|
| *Constituents* | *Range* | *Mean* | *Median* | *Public Water Supply* | *Irrigation* |
| EC (μmho/cm) | 423–6,570 | 2,099 | 1,735 | — | 750[b] |
| pH | 6.3–8.4 | 7.3 | 7.3 | 5.0–9.0 | 4.5–9.0 |
| TDS (mg/L) | 210–4,580 | 1,201 | 930 | — | 500 |
| Total hardness (mg/L as $CaCO_3$) | 62–915 | 291 | 232 | — | — |
| $Ca^{++}$ (mg/L) | 9–84 | 40 | 39 | — | — |
| $Mg^{++}$ (mg/L) | 12–176 | 47 | 34 | — | — |
| $Na^{+}$ (mg/L) | 44–1,320 | 289 | 224 | — | — |
| $K^{+}$ (mg/L) | 9–108 | 23 | 19 | — | — |
| $NH_4^{+}$ (mg/L) | 0–501 | 43 | 36 | 0.5 | — |
| $HCO_3^{-}$ (mg/L) | 76–563 | 331 | 338 | — | — |
| $SO_4^{=}$ (mg/L) | 14–490 | 109 | 85 | 250 | — |
| $Cl^{-}$ (mg/L) | 43–2,450 | 440 | 311 | 250 | — |
| $NO_3^{-}$ (mg/L) | 0.4–30 | 7.8 | 1.3 | 45 | — |
| $PO_4^{=}$ (mg/L) | 1.2–46 | 29 | 31 | — | — |
| $F^{-}$ (mg/L) | 0.2–3.8 | 1.5 | 1.2 | 1.4–2.4[c] | — |
| $SiO_2$ (mg/L) | 10–76 | 26 | 22 | — | — |

[a]Derived from data in reference [1].

[b]For unrestricted use in irrigation. Under proper conditions, water with EC as high as 7,500 μmho/cm or tds 4,000 mg/liter may be used to irrigate salt-tolerant crops. See EPA Water Quality Criteria for details.

[c]Actual recommendation is based on annual average of maximum daily temperature.



**Table 21.2** Incremental Increase of Mineral Constituents Due to Domestic Water Use

| *Constituent* | *Range of Incremental Increase (mg/L)* |
|---|---|
| Boron | 0.1–0.4 |
| Sodium | 40–70 |
| Potassium | 7–15 |
| Magnesium | 4–10 |
| Calcium | 6–16 |
| Phosphate ($PO_4^{=}$) | 20–40 |
| Sulfate ($SO_4^{=}$) | 15–30 |
| Chloride ($Cl^{-}$) | 20–50 |
| Total dissolved solids | 100–300 |
| Alkalinity (as $CaCO_3$) | 100–150 |
| Total nitrogen | 20–40 |

SOURCE: California Wastewater Study [2].

all of the mineral constituents in treated wastewater effluents are present in dissolved form [2].

Besides the common dissolved mineral constituents, treated wastewater effluents also contain trace elements. In the wastewater, concentrations of trace elements are expected to be low and hardly contribute to any significant increase of the dissolved minerals in wastewater. Because of their unique biological importance, however, their presence in the treated wastewater presents a different type of water quality problem. Although the term *trace elements* is not clearly defined, it refers generally to a group of otherwise unrelated chemical elements present in the natural environment in minute quantities. In small amounts, many of these elements are essential to biologic growth. At slightly higher concentrations, though, they could be harmful to both animals and plants. There are also several trace metals that have no known beneficial physiologic function (e.g., Cd, Hg, and Pb among others).

Natural water is not free of trace elements and significant quantities may be added through domestic use of the water [3]. However, consistently high concentrations of trace elements in the wastewater usually indicate some contribution from industrial waste discharges [3, 4, 5]. Except for boron, trace elements in the wastewater appear to be adsorbed strongly by organic solids or to form inorganic precipitates and, thus, are concentrated into the sludge fraction. Since the wastewater treatment system is not designed to remove trace elements, it is not certain that their consistent removal can always be accomplished. Even with the treatment, significant amounts of trace elements (especially metallic elements) in treated waste-

water effluents are in finely divided suspended solid forms [6]. The trace metals constitute almost the entire inorganic microcontaminants of wastewater used for artificial groundwater recharge.

## WATER QUALITY CONSIDERATIONS

If the treated wastewater effluents are destined for beneficial uses, their chemical characteristics should be carefully examined in terms of their suitability for the particular use intended. Tables 21.1 and 21.3 summarize the chemical composition of selected wastewater effluents in California and compare them with the water quality requirements for both drinking water (public water supply) and crop irrigation [7]. The data show that mineral contents of many wastewater effluents exceed the recommended upper limits [Table 21.1]. For the public water supply, the presence of common mineral constituents (Na, Ca, Mg, K, $SO_4$, Cl, $HCO_3$) at concentrations exceeding the limits does not represent any overt health hazard to consumers. However, such water may become aesthetically objectionable.

In crop irrigation, the water quality considerations are more complicated. Irrigating with water high in dissolved minerals would cause the soil salinity to rise. The impact of such increased salinity on growing plants depends largely on the salinity tolerance of the crop species grown. Salt-tolerant crops such as sugar beets, barley, and date palm may be irrigated

**Table 21.3** Concentrations of Trace Elements of Selected Secondary Effluents in California and the Trace Elements Requirements in *Water Quality Criteria* (mg/L)

| | *Wastewater Effluent* | | *Water Quality Criteria*[a] | | |
|---|---|---|---|---|---|
| | | | | *Irrigation Water* | |
| *Element* | *Range* | *Median* | *Public Water Supply* | *Continuous Use*[b] | *Short-term Use*[c] |
| As | <0.005–0.023 | <0.005 | 0.1 | 0.1 | 2.0 |
| B | 0.3–2.5 | 0.7 | — | 0.75 | 2.0 |
| Cd | <0.005–0.22 | <0.005 | 0.01 | 0.01 | 0.05 |
| Cr | <0.001–0.1 | 0.001 | 0.05 | 0.1 | 1.0 |
| Cu | 0.006–0.053 | 0.018 | 1.0 | 0.2 | 5.0 |
| Pb | 0.003–0.35 | 0.008 | 0.05 | 5.0 | 10.0 |
| Mo | 0.001–0.018 | 0.007 | — | 0.01 | 0.05 |
| Hg | <0.0002–0.001 | 0.0002 | 0.002 | — | — |
| Ni | 0.003–0.60 | 0.004 | — | 0.20 | 2.0 |
| Se | — | — | — | 0.02 | 0.02 |
| Zn | 0.004–0.35 | 0.04 | 0.05 | 2.0 | 10.0 |

[a]From reference [7].
[b]For waters used continuously on all soils.
[c]For use up to 20 years on fine-textured soils of pH 6.0 to 8.5.



by water with total dissolved solids as high as 4000 mg per liter. The disproportionately higher concentrations of $Na^+$ relative to $Ca^{++}$ and $Mg^{++}$ in many wastewaters may cause the exchangeable sodium percentage of the receiving soil to increase. The sodic effects of the irrigation water are characterized by the dispersion of soil colloids resulting in loss of water permeability, formation of soil clods, and difficulty in tillage. Under certain circumstances, plant nutrients (i.e., nitrogen), bicarbonate, and chloride may also be detrimental to the irrigation water [8]. Because the outcome may be influenced by many factors not directly related to water quality, the impact of water quality in a crop irrigation practice may be minimized by proper water management and crop selection.

The concentrations of most trace metals in drinking water (i.e., As, Ba, Ag, Cd, Cr, F, Hg, and Se) are regulated because of their potential health effects on water users. There are also constituents whose presence in public water supply is primarily of an aesthetic concern. For example, small amounts of Cu, Fe, Mn, and Zn in the water could result in objectionable color and/or taste. The recommended maximum concentrations of trace metals in irrigation water were intended to protect even the most sensitive plant species from trace metal–induced injuries. Based on the data in Table 21.3, it appears that B, Cd, Cr, Mo, and Pb contents of wastewater effluents frequently exceed the maximum levels defined by the water quality criteria for public water supply and irrigation. Concentrations of As, Cu, Hg, Ni, and Zn of the treated effluents rarely exceed the recommended limits. Since the occurrence of trace metal elements and their concentrations vary from one wastewater to another, the suitability of wastewater for groundwater recharge should be evaluated on a case by case basis. If the trace metal contents of the wastewater exceed the upper limits, it is essential that they be attenuated by the soil during the recharging process.

## ATTENUATION OF TRACE METALS IN SOILS

Soils are a porously structured medium consisting of weathered mineral fragments, organic matter, microorganisms, water, and air. They are chemically and microbiologically active. Passage of treated wastewater effluents through the complicated and heterogeneous soil matrix would induce a variety of physical and chemical reactions that are the basis for any soil in renovating wastewaters.

Depending on the physical characteristics of impurities present in the water, the mechanisms for removing undesirable constituents from the rapidly moving water could be quite different. For constituents that are present in the recharge water in suspended form, the primary mechanism of removal would be filtration. Particles larger than the soil pores will be strained off at the soil-water interphase. The accumulated particles gradually form a layer restricting the infiltration of water. Even for those suspended solids

that are not retained at the water-soil interphase, removal by trapping and adsorption in the soil profile can be effected. As water flows through passages formed by the soil particles, suspended and colloidal solids far too small to be retained by straining would be thrown off the streamline through hydrodynamic actions, diffusion, impingement, and sedimentation. The suspended particles will then gradually be intercepted by and adsorbed onto the surface of the stationary soil matrix. The degree of trapping and adsorption of suspended particles by soils is a function of the suspended solids concentration, a soil's mechanical characteristics, and hydraulic loading [9]. Generally, longer water traveling distances enhance suspended solid removal. Since significant amounts of trace metals are present in wastewater effluents as finely divided suspended solids [6], there is reason to believe that filtration is probably the most effective mechanism for removing trace elements from the recharging water.

Studies indicated that the restriction of water movement caused by suspended solids in the applied water is usually confined to the surface few centimeters of the soil [10, 11]. In coarse-textured soils, however, the depth of the clogged soil layer may be extended deeper. Since suspended solids of treated effluents are primarily organic in nature, the decomposition of organic matter during the resting period would destroy the barrier to water movement and restore the infiltration rate and percolation in the recharge zone.

Many trace metals are also present in the recharged water in a dissolved state. The physical action of filtering would have no effect on the removal of dissolved constituents. In order for trace metals to be effectively retained in the soil, chemical and microbiologic reactions are required to immobilize the dissolved constituents. In a groundwater recharge system, the impact of microbial activities on the attenuation of inorganic constituents is conceivably small. The following chemical reactions are important to a soil's capability to react with trace metal elements in soluble forms:

Ion exchange reactions
Precipitation
Surface adsorption
Chelation and complexation

Over a long period of time, trace metals may also be occluded into clay minerals. Because the rate is relatively slow, it is not expected to alter the outcome in a groundwater recharge system.

### Ion Exchange

When an electrolyte solution is brought into contact with the soil, it exhibits properties that allow the exchange of cations and anions between the solid phase (the soil) and the liquid phase (the electrolyte solution). In normal soils, the exchange of cations is by far the predominant chemical reaction. The reversible electrostatic reaction of exchanging cations in the soil is due to its net negative charge resulting from three different phenomena: (1) isomorphous substitution in the layered silicate minerals; (2) proton dissociation or hydroxide association from amorphous hydroxides and oxides of Fe, Al, Mn, and silica; and (3) dissociation of protons from various function groups in organic matter. When substitution of an ion of lesser valence occurs in layer silicates present in soils (e.g., $Al^{+3}$ for $Si^{+4}$ in the tetrahedral layers and $Mg^{+2}$ or $Fe^{+2}$ for $Al^{+3}$ in the octahedral layers), a charge imbalance occurs in these minerals, giving rise to their ability to adsorb and exchange cations.



Because of differences in mineral contents and organic matter, soils exhibit distinctively differential cation exchange capacities. At least a portion of the soil's cation exchange sites are known to be pH dependent. Regardless of the capacity of soils to exchange cations, the chemical equilibrium established through such exchange reaction may be expressed reasonably well by a number of equations.

Two of the more common expressions used are those developed by Vanselow [12] and Gapon [13]. For the equilibrium between mono- and divalent cations, the Vanselow equation takes the following form:

$$\frac{(M^{+})^2 \times [D^{++}\text{–Soil}] \times [\{D^{++}\text{–Soil}\} + \{M^{+}\text{–Soil}\}]}{(D^{++}) \times [M^{+}\text{–Soil}]^2} = K_v \qquad (1)$$

where $M^{+}$ and $D^{++}$ represent monovalent and divalent cations in solution, respectively, and $M^{+}$–Soil and $D^{++}$–Soil represent monovalent and divalent cations adsorbed on soil surfaces, respectively. Brackets in the equation represent concentrations on the soil (mmol/unit weight) and parentheses represent activities in solution (mmol/L). The selectivity coefficient $K_v$ can be determined under specified soil conditions and, once determined, can be used to predict exchanger composition at specified equilibrium activities of dissolved mono- and divalent cations. The Gapon equation takes the form

$$\frac{(M^{+})}{(D^{++})^{1/2}} = \frac{[M^{+}\text{–Soil}]}{[D^{++}\text{–Soil}]} K_G \qquad (2)$$

where $K_G$ designates the selectivity coefficient, and the other symbols have the same meanings as those discussed for the Vanselow equation. However, $M^{+}$–Soil and $D^{++}$–Soil are expressed in meq per unit weight of soil.

It is apparent that, at low monovalent saturation of the soils, the Gapon coefficient, $K_G$, is approximately equal to the square of the Vanselow coefficient (if consistent units are used). Therefore, it is not surprising that the two equations frequently describe the exchange reaction equally well. Both equations have been used extensively to describe the equilibria between the alkali (Na, K) and the alkaline earth (Ca, Mg) metals. Because

the trace metals (Cu, Ni, Zn, etc.) occur in wastewaters and in soil solutions at concentrations several orders of magnitude less than those of the alkali and alkaline earth metals (compare Tables 21.1 and 21.3); it is doubtful that ion exchange plays a major role in immobilizing trace metals in soils. However, research has demonstrated that even though trace metals occur at very low concentrations in wastewater, soils exhibit a very high capacity to immobilize them. This suggests that soils possess exchange sites highly selective for the trace metals, or that the trace metals themselves form highly insoluble compounds in soils. The exact mechanism by which the trace metals are attenuated in soils has yet to be elucidated.

### Adsorption

Adsorption denotes chemical and physical adhesion of dissolved substances onto the surface of a solid medium in a thin layer. Quantitatively, the adsorption reaction may be described by adsorption isotherms that establish the relationship of the amount adsorbed from a solution and the residual concentration of dissolved adsorbate at equilibrium. Once the adsorption isotherm is established, the maximum extent of and selectivity of adsorption may be determined.

Recent studies have indicated the strongly selective affinity of trace metal ions at certain adsorption sites in soils [14, 15, 16]. It was suggested that the strong adsorption of trace metals occurred at the surface of amorphous and crystalline forms of iron, manganese, and aluminum oxides [16, 17]. Other soil properties, such as texture and cation exchange capacity, did not appear to influence significantly the soil's trace metal adsorption characteristics. Unlike the exchange reactions for the alkali and alkaline earth metals, the adsorption of trace metal ions, apparently induced by covalent bonding, generally was more specific and the adsorption reaction was not easily reversible by other cations. There were also indications that metal ions in exchangeable form might be converted gradually into nonexchangeable forms in the soil [18].

Those trace elements that normally occur in solution as anions (As, Cr(VI), F, Mo, Se) are also retained by soils with high affinity. In soils, the chemistry of Cr(VI) is unique. It is usually rapidly reduced to a cationic form Cr(III), which forms highly insoluble compounds in soils. The mechanism by which trace metal anions ($AsO_3^{=}$, $AsO_4^{=}$, $F^-$, $MoO_4^{=}$, $SeO_3^{=}$, $SeO_4^{=}$) are retained by soil is thought to involve an interaction with amorphous or crystalline forms of iron and aluminum oxides. It has been proposed that positive exchange sites capable of adsorbing the anions are created either by the association of a proton or dissociation of a hydroxide ion by iron, aluminum, and manganese oxides. Thus, adsorption of anions by soils is pH-dependent and increases as the pH of the system decreases.

Compared to other trace metals, B is rather weakly adsorbed by soils.



It occurs in soil solutions in the pH range up to 8.5, mainly in the form of undissociated boric acid. It is adsorbed weakly by clay minerals and iron and aluminum oxides [19, 20, 21]. Given sufficient amounts of leaching water (approximately three pore volumes), most of the adsorbed B is desorbed [22].

### Precipitation

Since both adsorption and precipitation reactions in soil serve to reduce the concentration of trace metals in applied wastewater, it is difficult to distinguish between the two mechanisms. Researchers have attempted to relate concentrations of trace metals in soil solutions to the solubility products of a variety of compounds [23, 24]. Under conditions in which the concentration of a trace metal ion in the soil solution is equal to that predicted from the solubility product of a particular compound, it is presumed that this compound forms and its solubility product controls the equilibrium concentration of the ion in the soil solution. A number of studies have shown that concentrations of most trace metals in watewaters and soil solutions are much lower than those predicted from solubility product constants of metal hydroxides and carbonates [23, 24, 25, 26]. Lower-than-predicted metal concentrations indicate either that fewer soluble metal compounds are forming with other constituents, or that adsorption reactions control the equilibrium concentration of trace metal elements in the soil solution.

### Chelation and Complexation

In aqueous solutions, metallic ions are capable of combining with organic or inorganic ligands to form complex or chelate ions. The equilibrium constant of a complex reaction would determine the stability of complexes formed. The undissociated but soluble chemical species usually are more stable than the uncombined ions in the solution. The occurrence of chelating and complexing reactions as the water moves through the soil profile would affect the chemical kinetics and equilibrium of other trace metal–associated reactions.

Besides the described chemical pathways, the pH, the concentration of electrolyte solution, and the redox potential in soils may also have significant influence on shifting the chemical equilibrium of trace metal elements. In view of the interacting nature of the various processes occurring and constituents reacting in both the soil and water, it is difficult to segregate experimentally the distinct contribution from each chemical pathway when a wastewater effluent is brought into contact with the soil. Attempts have been made to model the trace metal equilibria in soil solutions based on solubility product constants of various chemical reactions in soils [27]. The

application of this approach could help to assess the water quality impact of trace metals in groundwater recharge using wastewater effluents.

In a groundwater recharge site that is hydraulically very active, chemical kinetics also may control the extent of the chemical reaction. The short hydraulic retention time in soils may not always allow some of the slowly reacting components to reach equilibrium. Although most soils (except acid soils) exhibited high efffectiveness in immobilizing trace metal elements, complete removal of trace metals from percolating waters was not experienced [28, 29, 30]. Undoubtedly, even with their high trace metal adsorption, soils do not possess an unlimited capacity to retain trace metals. However, the retention in the soil may function for a long period of time before any significant breakthrough takes place [29, 30].

## TRACE METAL ACCUMULATION AT WASTEWATER EFFLUENTS RECHARGE SITES

Unlike the trapped organic contaminants that may gradually decompose in the soil, the relatively immobile trace metals are expected to be deposited in the soil almost permanently. The retention of trace elements in soils, therefore, may have long-term impacts on land use even after the recharge operation is terminated. This section discusses the possible extent of trace element accumulation in soils based on estimations derived from using water that meets established water quality criteria. Data obtained at an artificial groundwater recharge site are also used to demonstrate deposition of trace elements in the soil profile.

If any water with trace metal concentrations not exceeding the recommended limits for either public water supply or crop irrigation is considered suitable for groundwater recharge, the trace element input to the soil may be estimated by the amounts of water applied. In normal land application of wastewater, the water application rate varies from 0.6 to 6.0 m per year at the slow rate applications, to 6 to 170 m per year at rapid-infiltration sites [31]. The selection of a suitable water application rate depends on both the soil's and the aquifer's ability to receive water and the purpose of the water appliction. The range of trace element inputs at recharge sites may be estimated (Tables 21.4 and 21.5) by using the average water applications for slow rate (1.5 m/year) and rapid infiltration (80 m/year). The results are compared with those substituted by treated wastewater effluents.

At slow rate applications, with water meeting the quality criteria for public water supply or long-term crop irrigation, the amounts of trace metals (except for B and Cd) added into the soil through 20 years of artificial groundwater recharge are well within the concentration ranges for ordinary soils (Table 21.4). Applying a water meeting the trace element requirements



**Table 21.4** Calculated 20-year Trace Metal Inputs (Concentration × Volume of Water Applied) to Soils for Slow Rate (1.5 m/year) Application with a Water That Meets the *Water Quality Criteria* and with Wastewaters (Kg/ha)

| | *Input According to Water Quality Criteria*[a] | | | | |
|---|---|---|---|---|---|
| | | *Irrigation Water* | | *Input According to Concentration in Wastewater*[b] | *Typical Concentration Range in Soils*[c] |
| *Element* | *Public Water* | *Continuous* | *Short-Term* | | |
| As | 30 | 30 | 600 | 1.5–6.9 | 0.2–80 |
| B | — | 225 | 600 | 90–750 | 4–200 |
| Cd | 3 | 3 | 15 | 1.5–66 | 0.05–1.4 |
| Cr | 15 | 30 | 300 | 0.3–30 | 10–6,000 |
| Cu | 300 | 60 | 1,500 | 1.8–15.9 | 4–200 |
| Pb | 15 | 1,500 | 3,000 | 1–105 | 4–400 |
| Mo | — | 3 | 15 | 0.3–5.4 | 0.4–10 |
| Hg | 0.6 | — | — | 0.06–0.30 | 0.02–0.6 |
| Ni | — | 60 | 600 | 0.9–180 | 20–2,000 |
| Se | — | 6 | 6 | — | 0.02–4 |
| Zn | 15 | 600 | 3,000 | 1.2–105 | 20–600 |

[a]Based on the concentration requirements in *Water Quality Criteria* [7].
[b]Based on the wastewater concentration range in Table 21.3.
[c]Typical concentration range for uncontaminated soils. Derived from data in Page, A.L. "Fate and Effect of Trace Elements in Sewage Sludges When Applied to Agricultural Land." U.S. Environmental Protection Agency EPA-670/2-74-005 (1974).

for short-term crop irrigation at 1.5 m per year for 20 years, however, would result in trace metal depositions (except for Cr and Ni) exceeding levels typically observed in soil. Because of the high hydraulic loading at rapid-infiltration sites, large amounts of trace elements are being added into the soil through the recharge operation (Table 21.5). Except for B, they are expected to deposit in the soil profile. Long-term, continuous high-rate application of wastewater, therefore, could cause substantial trace metal enrichment of the surface soil and, in turn, may render the land in question unsuitable for subsequent uses. However, using wastewater effluents for groundwater recharge actually might contribute far less trace metals to the soil than using a water that meets the *Water Quality Criteria* (Tables 21.4 and 21.5).

How high a level of trace elements may the soil receive before a groundwater recharge operation is terminated? Since a set of trace metal input criteria specifically for this purpose have not been developed, guidelines proposed by the U.S. Environmental Protection Agency in limiting heavy metal inputs to cropland receiving sludge are used as the reference [32, 33]. Assuming that the 20-year trace metal load at a groundwater recharge site should not exceed the upper limits of the proposed sludge disposal guideline, the maximum permissible trace element concentrations in

Table 21.5 Calculated 20-Year Trace Metal Inputs (Concentration × Volume of Water Applied) to Soils for Rapid-Infiltration Systems (80 m/year) Applications Based on *Water Quality Criteria* and Wastewater Composition (Kg/ha)

| | *Input According to Water Quality Criteria*[a] | | | | |
|---|---|---|---|---|---|
| | | *Irrigation Water* | | *Input According to Concentration in Wastewater*[b] | *Typical Concentration Range in Soils*[c] |
| *Element* | *Public Water* | *Continuous* | *Short-Term* | | |
| As | 1,600 | 1,600 | 32,000 | 80–368 | 0.2–80 |
| B | — | 12,000 | 32,000 | 4,800–40,000 | 4–200 |
| Cd | 160 | 160 | 800 | 80–3,520 | 0.05–1.4 |
| Cr | 800 | 1,600 | 16,000 | 16–1,600 | 10–6,000 |
| Cu | 16,000 | 3,200 | 80,000 | 96–848 | 5–200 |
| Pb | 800 | 80,000 | 160,000 | 48–5,600 | 5–400 |
| Mo | — | 160 | 800 | 16–288 | 0.5–10 |
| Hg | 32 | — | — | 3.2–16 | 0.02–0.6 |
| Ni | — | 3,200 | 32,000 | 48–9,600 | 20–2,000 |
| Se | — | 320 | 320 | — | 0.02–4 |
| Zn | 800 | 32,000 | 160,000 | 64–5,600 | 20–600 |

[a]Based on the concentration requirements in *Water Quality Criteria* [7].
[b]Based on the wastewater concentration range in Table 21.3.
[c]Typical concentration range for uncontaminated soils. Derived from data in Page, A.L. "Fate and Effect of Trace Elements in Sewage Sludges When Applied to Agricultural Land," U.S. Environmental Protection Agency EPA-670/2-74-005 (1974).

the recharging water may be determined (Table 21.6). In this table, the calculated maximum permissible trace metal concentration in the water used for recharging is compared with the trace metal contents typical of a wastewater and with the upper limits listed in irrigation water quality criteria. It is apparent that all wastewater effluents could meet the concentration requirements specified for the slow rate applications. However, many wastewater effluents would not be considered suitable for rapid-infiltration operations. Even for a water that meets the quality requirement for public water supply or crop irrigation, trace element concentrations (especially for Cd) may exceed the calculated upper limits in Table 21.6.

At Whittier Narrows (Los Angeles County, California), secondary wastewater effluents have been used for groundwater recharge since 1963 [28; see also Chapter 11]. The annual water application rate averaged 83 m. In 1980, the soils in the spreading basins were sampled. The trace element deposition of the contaminated soil profile is summarized in Table 21.7. Significant amounts of Cd, Cr, Cu, Ni, Pb, and Zn have accumulated in the surface 60 cm of the soil profile. The average concentrations of Cd, Cr, Cu, Ni, Pb, and Zn in the soil (0–60 cm) have risen from 0.3, 35, 46, 29, 3 and 78 to 3.1, 119, 99, 104, 37 and 189 μg per gram, respectively, over approximately 20 years. At this rate of accumulating trace metals, the artificial



Table 21.6 Calculated Maximum Wastewater Concentration (Cumulative Metal Input Divided by Volume of Water Applied) for 20 Years of Groundwater Recharge with Trace Metal Input not to Exceed the Upper Limits of U.S. EPA Proposed Cropland Sludge Disposal Guideline.

| | | *Calculated Maximum Permissible Wastewater Concentration (mg/L)* | | | |
|---|---|---|---|---|---|
| *Element* | *Cumulative Metal Input*[a] *(Kg/ha)* | *Slow Rate* | *Rapid Infiltration* | *Irrigation Water Quality Criteria*[b] *(mg/L)* | *Median Conc. of Wastewaters*[c] *(mg/L)* |
| Cd | 5 | 0.017 | 0.0003 | 0.01 | 0.005 |
| | 10 | 0.033 | 0.0006 | | |
| | 20 | 0.067 | 0.0013 | | |
| Cu | 125 | 0.417 | 0.008 | 0.2 | 0.018 |
| | 250 | 0.833 | 0.016 | | |
| | 500 | 1.667 | 0.031 | | |
| Ni | 125 | 0.417 | 0.008 | 0.2 | 0.004 |
| | 250 | 0.833 | 0.216 | | |
| | 500 | 1.667 | 0.031 | | |
| Pb | 500 | 1.667 | 0.031 | 5.0 | 0.008 |
| | 1,000 | 3.333 | 0.062 | | |
| | 2,000 | 6.667 | 0.125 | | |
| Zn | 250 | 0.833 | 0.016 | 2.0 | 0.04 |
| | 500 | 1.667 | 0.031 | | |
| | 1,000 | 3.333 | 0.062 | | |

[a]Permissible metal inputs in the proposed guideline are based on the cation exchange capacity (CEC) of the soils. Low value applies to soils with CEC < 5 meq/100 g; intermediate value applies to soils with CEC from 5–15 meq/100 g; and maximum value applies to soils with CEC > 10 meq/100 g.
[b]For continuous use.
[c]From Table 21.5.

groundwater recharge site at Whittier Narrows, with a soil profile 2.0 to 2.7 m in depth, should be able to receive water for a long period of time before the soil's capacity of attenuating trace metals is exhausted. Although the trace metal deposition in the soil has not yet influenced the quality of the groundwater, it has elevated the concentrations of water-extractable trace metal elements in the affected soil (Table 21.8).

## CONCLUSIONS

The trace metals constitute almost the entire inorganic microcontaminants of the treated wastewater effluents that are used for artificial groundwater recharge. For trace metals present in the water in suspended forms, the

**Table 21.7** Accumulation of Heavy Metals in Soils (4 *M* $HNO_3$ extractable in μg/gm) Used for Groundwater Recharge (Whittier Narrows, Los Angeles County, California)

| Depth (cm) | Artificial Recharge Area[a] | | | | | | Control Area[b] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Cd* | *Cr* | *Cu* | *Ni* | *Pb* | *Zn* | *Cd* | *Cr* | *Cu* | *Ni* | *Pb* | *Zn* |
| 0–5 | 2.3 | 88 | 69 | 71 | 61 | 176 | 0.2 | 32 | 41 | 26 | 9 | 83 |
| 5–10 | 4.3 | 156 | 101 | 132 | 65 | 253 | 0.1 | 33 | 46 | 27 | 8 | 83 |
| 10–15 | 7.0 | 275 | 154 | 159 | 93 | 390 | 0.1 | 32 | 44 | 27 | 2 | 82 |
| 15–30 | 3.4 | 111 | 117 | 128 | 34 | 209 | 0.1 | 27 | 41 | 24 | 5 | 65 |
| 30–60 | 2.2 | 95 | 86 | 84 | 21 | 136 | 0.1 | 40 | 51 | 33 | 3 | 83 |
| 60–90 | 0.9 | 46 | 42 | 44 | 6 | 73 | <0.1 | 14 | 19 | 13 | 1 | 40 |
| 90–120 | 0.3 | 27 | 31 | 37 | 5 | 62 | <0.1 | 20 | 27 | 60 | 1 | 60 |
| 120–150 | 0.2 | 32 | 37 | 47 | 6 | 76 | 0.1 | 28 | 51 | 33 | 2 | 95 |
| 150–180 | 0.2 | 31 | 37 | 44 | 6 | 74 | 0.2 | 23 | 38 | 29 | — | 78 |

[a]Represents the arithmetic mean of four sampling locations in artificial recharge basins receiving secondary wastewater effluents since 1963.

[b]Represents the result from one sampling location adjacent to the recharge basins.

**Table 21.8** Concentrations (mg/L) of Heavy Metals in Soil Saturation Extracts of Soils Used for Artificial Groundwater Recharge (Whittier Narrows, Los Angeles County, California)

| Depth (cm) | Artificial Recharge Area[a] | | | | | Control Area[b] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cd* | *Cr* | *Cu* | *Ni* | *Zn* | *Cd* | *Cr* | *Cu* | *Ni* | *Zn* |
| 0–5 | 0.0014 | 0.011 | 0.222 | 0.115 | 0.034 | 0.0014 | 0.002 | <0.02 | 0.194 | 0.079 |
| 5–10 | 0.0011 | 0.018 | 0.180 | 0.075 | 0.025 | 0.0001 | 0.002 | <0.02 | 0.181 | 0.073 |
| 10–15 | 0.0013 | 0.025 | 0.239 | 0.101 | 0.028 | 0.0003 | 0.002 | <0.02 | 0.181 | 0.07 |
| 15–30 | 0.0002 | 0.024 | 0.119 | 0.056 | 0.020 | 0.0002 | <0.002 | <0.02 | <0.025 | 0.07 |
| 30–60 | <0.0001 | 0.033 | 0.121 | 0.065 | 0.016 | 0.0002 | <0.002 | <0.02 | <0.025 | 0.07 |
| 60–90 | <0.0001 | 0.018 | 0.093 | 0.056 | 0.017 | 0.0002 | <0.002 | <0.02 | <0.025 | 0.07 |
| 90–120 | <0.0001 | 0.005 | 0.080 | 0.053 | 0.016 | 0.0004 | <0.002 | <0.02 | <0.025 | 0.068 |
| 120–150 | <0.0001 | 0.005 | 0.062 | 0.040 | 0.021 | 0.0001 | <0.002 | <0.02 | <0.025 | 0.071 |
| 150–180 | 0.0001 | 0.004 | 0.076 | 0.041 | 0.020 | — | <0.002 | <0.02 | <0.025 | 0.081 |

[a]Represents the arithmetic mean of four sampling locations in artificial recharge basins receiving secondary wastewater effluents since 1963.

[b]Represents the result from one sampling location adjacent to the recharge basins.

primary mechanism for their removal is filtration. Trace metals dissolved in the water may be reduced by adsorption at the soil surface or by chemical precipitation. Soils appear to possess a strong ability to attenuate trace metals. After almost 20 years of artificial groundwater recharge at an average annual input of 83 m in Whittier Narrows, California, trace metals of the applied water were found only in the surface 60 cm of the soil profile. At present, it is not certain how much trace metals should be permitted to deposit in the soil profile used for groundwater recharge. If any water with trace metal concentrations not exceeding the recommended upper limit for public water supply or crop irrigation is considered suitable for artificial groundwater recharge, then most treated wastewater effluents will meet the criteria. If the U.S. Environmental Protection Agency proposed cumulative metal input limits for sludge-receiving cropland soils are used as a guide, a water with Cd contents not exceeding the maximum contamination level for public water supply (0.01 mg/L) applying at 80 m per year will reach the Cd loading limit in less than 3 years. Long-term, continuous high-rate artificial groundwater recharge, therefore, could result in substantial trace metal enrichment of the affected soil and, in turn, may render the land in question unsuitable for subsequent uses.

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# Ground Water Recharge Using Waters of Impaired Quality

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and pathogen movement because it is desirable to keep these compounds from migrating below the surface zone. Based on the information from studies conducted under controlled conditions in the field, preferential flow is widespread and often significant and also has been observed to occur in the structureless fine sandy soils that are favored in SAT systems (Jury and Fluhler, 1992). However, the presence of clogging material in SAT systems may act to prevent funnel flow from occurring to any great extent in SAT because this mechanism depends on very high permeability in the portion of the matrix that is active in flow (Kung, 1990). A more likely circumstance that could cause preferential flow in an SAT system is the presence of a more permeable zone located beneath a less conducting one, which can create fingering of fluid through narrow channels within a small part of the pore space of the more coarse-textured soil (Hillel, 1987).

Reviews of the prevalence of preferential flow and its importance in soil are given elsewhere (Beven and Germann, 1982; Jury and Roth, 1990; Jury and Fluhler, 1992).

## TRANSPORT AND FATE OF SPECIFIC CONSTITUENTS OF RECHARGE WATER

The principles discussed in the previous sections are useful to understanding the chemical and pathogen removal processes that occur during transport through soil and aquifer material. This section looks at categories of solution constituents that correspond to groupings used elsewhere in this report.

### Nitrogen

Nitrogen is a common constituent of wastewater and agricultural return flow. In the former, it is mostly present in the form of $NH_4^+$ after conventional primary and secondary treatment, as it first makes contact with the soil surface. Because $NH_4^+$ partitions to gaseous ammonia at the air-water interface, some volatilization occurs during the detention time and later during drainage cycles that expose soil $NH_4^+$ remaining near the surface.

After $NH_4^+$ enters the soil, it is biologically transformed to $NO_3^-$ by a two-stage process called nitrification. In contrast to $NH_4^+$ which is positively charged, $NO_3^-$ is an anion and is quite mobile in soil. However, $NO_3^-$ can be biologically transformed under conditions of high water content and sufficient organic carbon availability into nitrogen and nitrous gases, which escape into the atmosphere. This reaction occurs when nitrogen substitutes for oxygen as a terminal electron acceptor under conditions of limiting aeration, moderated by the availability of a carbon source. Since organic carbon is normally low in aquifers, denitrification is generally confined to the near-surface regime. Crites (1985)

TABLE 3.4 Nitrogen Removal Rates at SAT Sites

| | Loading Rate (feet/year) | Flooding: Drying Time | BOD:N[a] | Percentage Nitrogen Removal |
|---|---|---|---|---|
| Hollister, California | 50 | 1:14 | 5.5:1 | 93 |
| Brookings, South Dakota | 40 | 1:2 | 2:1 | 80 |
| Calumet, Michigan | 56 | 1:2 | 3.6:1 | 75 |
| Phoenix, Arizona | 200 | 9:12 | 1:1 | 65 |
| Ft. Devons, Massachusetts | 100 | 2:12 | 2.4:1 | 60 |
| Lake George, New York | 190 | 1:4 | 2:1 | 50 |
| Disney World, Florida | 180 | 150:14 | 0.3:1 | 12 |

[a]BOD:N = ratio of biochemical oxygen demand to nitrogen.

Source: Crites, 1985.

states that carbon is required at a BOD (biochemical oxygen demand) to nitrogen ratio of about 3:1 for maximum denitrification.

Under SAT conditions the removal rates of nitrogen can be quite high if denitrification is optimized. Bouwer (1985) found that flooding and drying cycles allowed $NH_4^+$ to adsorb to soil mineral surfaces by cation exchange, while the drying cycle permitted oxygen diffusion that promoted nitrification to the $NO_3^-$ form, which subsequently denitrified after diffusion into anaerobic microsites. Table 3.4 shows nitrogen removal efficiencies measured at a number of SAT sites throughout the United States. The primary removal mechanism in these operations is denitrification, with perhaps some ammonia volatilization losses during drying cycles.

## Phosphorus

Phosphates in recharge water are removed by precipitation to amorphous or crystalline forms with iron, aluminum, or calcium. At low pH, precipitation with iron and aluminum is favored, whereas under alkaline conditions, calcium phosphate is controlling. Phosphate mobility is greatest under neutral conditions (Bouwer, 1985).

Phosphorus removal is achieved through a fast sorption reaction and slow precipitation reactions. The final phosphorus concentration in the effluent water after passage through the SAT system is controlled by the solubility products of



the solution constituents; for that reason, removal is not complete and depends on soil properties and loading rates. The duration of the flooding cycle can be varied to promote optimal levels of denitrification for nitrogen-rich recharge waters.

## Inorganics and Trace Metals

The organic constituents found in municipal wastewater tend to have been added during water use, while inorganic chemical concentrations tend to be characteristic of the source water. Moreover, they are not removed to any extent during use, but rather tend to accumulate as water is extracted from the source stream (Chang and Page, 1985). For that reason, mineral concentrations in municipal wastewater vary widely depending on the genesis of the water and its use prior to arrival at the SAT system. In contrast, inorganic chemical increases, especially in heavy metals, are more typical of stormwater runoff.

Trace elements present in suspended matter generally are removed during SAT by filtration and do not migrate. However, they do accumulate in colloidal material trapped in the clogging layer, which eventually must be removed from soil to restore its infiltration rate. Smaller suspended particulates that can move through soil pores without becoming trapped are also attenuated by sorption to mineral surfaces in the soil matrix. Chang and Page (1985) state that filtration and associated colloidal sorption are the primary means of removal of trace elements in soil.

Not all of the trace element mass is associated with suspended material in wastewater; it is also present in a dissolved form that is not affected by filtration. The dissolved constituents are affected by various chemical reactions in soil, some of which act to attenuate their movement through soil. Aerobic conditions and a high pH also decrease trace metal mobility.

Positively charged trace metal ions can be attenuated by ion exchange with negatively charged clay mineral surfaces. This process is a partition reaction affecting all cations in soil and therefore is not a significant removal mechanism for trace elements at low values. Moreover, soil cation exchange capacity is finite and therefore can be exhausted after many pore volumes of material have passed through the profile.

A more specific sorption reaction appears to occur with trace elements, which are strongly attracted to amorphous and crystalline oxides of iron, aluminum, and magnesium. This reaction is not easily reversed by other ions in solution and may become nonexchangeable over time (Jenne, 1968; Sharpless et al., 1969).

Precipitation reactions of trace metals also occur with other constituents of wastewater, which causes the concentrations in solution to be regulated by the solubility products of the species present. This reaction is difficult to separate from specific sorption.

Metals can also form complexes with dissolved organic matter (chelation), increasing their mobility in the process. Because of the complexity of solution chemistry when organic ligands are present, little is known about the behavior of specific complexes.

Because trace metal removal is incomplete and the soil sorption capacity is finite, SAT is not completely effective in preventing migration of all constituents within this group. There are also significant variations in trace element mobility, ranging from strongly attenuated (zinc and copper), to more mobile (cadmium and lead), to extremely mobile (boron). Ground water concentrations of silver, barium, cadmium, cobalt, and chromium below the treatment site at Hollister, California, have been unaffected by the additions of wastewater to the overlying soil. However, manganese, nickel, iron, zinc, lead, and copper were above background levels (Crites, 1985). Soil samples taken in the Whittier Narrows recharge plant after over 20 years of operation showed elevated levels of cadmium, chromium, copper, nickel, lead, and zinc in the top 60 cm (2 ft), but not below that depth, suggesting that the soil had the capacity to remove metals for many more years of operation before ground water would be affected (Chang and Page, 1985).

## Organic Chemicals

Organic chemicals vary enormously in their mobility, volatility, and persistence in soil. In an SAT system, volatile compounds volatilize prior to application, and only the soluble organic constituents enter the soil. The organic removal efficiency of an SAT system depends on the degree to which a given compound can be chemically or biologically transformed to an innocuous state during its time of passage through the system. Organic compounds degrade chemically by hydrolysis, photodecomposition, or redox reactions to varying degrees depending on their structure (Armstrong and Konrad, 1974). Microbial conversion occurs chiefly in the surface zone of soil, where bacterial populations and organic carbon levels are high. Low organic carbon levels generally limit microbial action in deeper regions of the vadose zone and in aquifers.

As discussed in a previous section, the travel time of an organic chemical may be roughly designated by its retardation factor in a given soil, or more intrinsically by its organic carbon partition coefficient $K_{oc}$. In a similar manner, the overall action of the chemical and microbiological processes transforming an organic chemical moving in soil may be crudely expressed as a half-life or degradation rate constant. Then, the length of the half life compared to the travel time can be used as an index of the potential for the compound to survive its passage through the soil. This approach has been used to develop pesticide screening models to determine (in a relative sense) the potential of a compound to reach ground water (Rao et al., 1985; Jury et al., 1987).



## Pathogens

The extent to which soil can remove pathogens depends on a variety of factors, including the physical, chemical, and biological characteristics of the soil, the size and nature of the organism, and the environmental conditions. The largest organisms, such as protozoa and helminths, are removed effectively by filtration unless the soil contains large pores or continuous voids. Bacteria are also filtered, but in addition may adsorb to soil solid material. Viruses are too small to be filtered by most soil pores and are attenuated only by sorption. The latter mechanism is much more pronounced in unsaturated soil than under saturated conditions, for reasons that are not clear at the present time. Speculation about explanations for the increase in sorption under unsaturated conditions have centered on the role of the air-water interface, either because it forces viral particles nearer to the solid surfaces (Lance and Gerba, 1984) or because the interface itself can trap the particle and perhaps deform it enough to cause inactivation (Powelson et al., 1990).

The most important factor in microorganism survival in soil and ground water is temperature. Below 4°C, microorganisms can survive for long periods of time, but they die off rapidly with increasing temperature. The bacterial die-off rate approximately doubles with each 10°C increase in temperature, but viruses have been observed to follow a more linear relation between inactivation rate and temperature (Yates and Yates, 1987). The soil pH affects survival, which shortens under acidic conditions. There is evidence that viral sorption increases at low pH, because the isoelectric points of soil minerals generally are lower than those of viruses, so that the viral particles become more electropositive than the soil at low pH. Soil moisture affects survival of all microorganisms, with inactivation decreasing significantly as water content is increased above air dry levels. Viral movement is not sufficiently well understood to model at the present time, in part because independent measurements of sorption in the laboratory seriously underestimate the extent of attenuation during transport through unsaturated soil. Gerba and Goyal (1985) discuss the major factors affecting viral movement in soil.

Evidence from monitoring at SAT sites suggests that the larger pathogens are mostly removed by filtration and do not reach ground water during their lifetime in soil, unless a continuous coarse-textured or void pathway is present through the surface soil zone. The greatest removal occurs in the surface mat of suspended particles that forms on the top few millimeters of soil and strains the entering solution.

Field measurements of viral movement at ground water recharge sites are limited. At the Flushing Meadows surface spreading site in Phoenix, Arizona, viruses were not detected after 10 to 30 m (33 to 98 ft) of travel through the fine sandy soil of the system, while more sensitive measurements at the Sweetwater surface spreading site in Tucson, Arizona, detected migration of viruses through

the soil system (Powelson and Gerba, 1993). A review of 6 land application (irrigation) sites and 11 rapid infiltration sites by Gerba and Goyal (1985) indicated that viruses have been isolated underground after various migration distances. Vertical migration ranged from 1.4 to 30.5 m (4.6 to 100 ft) at spray irrigation sites and from 2.4 to 67 m (8 to 220 ft) at rapid infiltration sites. At the rapid infiltration sites reviewed by Gerba and Goyal (1985), horizontal migration of viruses in the underground ranged from 3 to over 400 m (10 to over 1,300 ft). Disinfection of the water prior to recharge by surface spreading or injection can minimize or eliminate microorganisms underground, as can proper site selection and management of surface spreading systems.

## Disinfection By-products

In most cases, source water intended for recharge will be disinfected with chlorine, chloramine, ozone, or a combination of these disinfectants. Table 3.5 lists the major potentially problematic by-product compounds that would be most likely to be produced from these disinfectants (Bull and Kopfler, 1991). Because bromide is present in many ground water systems, many brominated derivatives are included although data on occurrence frequency and concentrations for these compounds is limited. In addition, Table 3.5 presents only examples of DBP categories by structural class; many others could be listed in most cases.

### *Nature of Reduced Carbon Species*

A major uncertainty arises from the fact that most of the product identification work has been done on standardized humic or fulvic acid fractions isolated from surface water sources of sufficient quality (low organic carbon levels) to be considered as a traditional water supply source. The chemical composition of alternative water sources, however, may be drastically different from that of traditional water sources. In the case of drainage from low-lying peat areas, it might be reasonable to assume that this water source differs only in the higher level of humic carbon present. However, Amy et al., (1984) found that higher levels of trihalomethanes (THMs) are characteristic of more than 200 agricultural drains in the Sacramento River delta and that the larger amount of dissolved organic carbon (DOC) in these water sources is characterized by a higher molecular weight and greater THM reactivity than that found in delta tributaries. Some research showed THM formation potential values as high as 3,580 micrograms per liter (µg/l) and di- and trichloracetic acid values of 1,650 and 1,990 µg/l, respectively (Amy et al., 1984). Clearly, carbon level is the largest single parameter controlling DBP levels, although chlorine to carbon dose ratio, pH, temperature, and contact time are also important. However, it remains uncertain whether the carbon levels from non-traditional sources are more or less sensitive

# EFFECT OF URBAN STORMWATER RUNOFF ON GROUND WATER BENEATH RECHARGE BASINS ON LONG ISLAND, NEW YORK

by Henry F. H. Ku and Dale L. Simmons

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U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 85-4088

↳ no impact to gw
for sw recharge
(metals, bacteria, org's)

Prepared in cooperation with

LONG ISLAND REGIONAL PLANNING BOARD

Syosset, New York

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## CONTENTS


| | Page |
|---|---|
| Abstract | 1 |
| Introduction | 2 |
| Purpose and scope | 3 |
| Location and extent of study area | 3 |
| Previous studies | 4 |
| Acknowledgments | 5 |
| Hydrogeologic setting | 5 |
| Hydrogeologic units | 5 |
| Precipitation | 6 |
| Streamflow | 7 |
| Ground water | 7 |
| Movement | 7 |
| Recharge | 7 |
| Urban hydrology of Long Island | 8 |
| Population | 8 |
| Sewerage history and plans | 9 |
| Sanitary sewers | 9 |
| Storm sewers and recharge basins | 9 |
| Description of monitoring sites | 10 |
| Centereach (commercial) | 10 |
| Huntington (shopping center and parking lot) | 11 |
| Laurel Hollow (low-density residential) | 11 |
| Plainview (highway) | 11 |
| Syosset (medium-density residential) | 11 |
| Sample collection and data management | 22 |
| Sampling equipment | 22 |
| Precipitation measurement | 22 |
| Stormwater and ground-water measurement | 23 |
| Flow-meter calibration | 23 |
| Comparison of discharge-measurement results | 24 |
| Sample collection | 26 |
| Standard chemicals | 26 |
| Priority pollutants | 26 |
| Bacteria | 27 |
| Sample handling | 27 |
| Standard chemicals | 27 |
| Priority pollutants | 27 |
| Bacteria | 27 |
| Data reduction | 27 |
| Data storage | 28 |
| Characteristics of sampled storms | 28 |
| Modified runoff/precipitation relationship | 32 |
| Relationship of stormwater quality to ground-water quality | 37 |
| Concentration of selected constituents | 37 |
| Standard chemicals | 37 |
| Priority pollutants | 46 |
| Bacteria | 47 |
| Loads of selected constituents | 51 |
| Standard chemicals | 52 |
| Priority pollutants | 53 |
| Bacteria | 53 |

## CONTENTS (Continued)


Page

Removal of chemical constituents of runoff by soils . . . . . 57
Metals . . . . . 57
Pesticides . . . . . 57
Summary and conclusions . . . . . 59
References cited. . . . . 61
Appendix A--Standard chemical analysis. . . . . 64
Appendix B--U.S. Environmental Protection Agency priority pollutants. . 64
Appendix C--Data-retrieval information. . . . . 66
Appendix D--Drinking-water standards of New York State, U.S. Public Health Service, and U.S. Environmental Protection Agency. . 67


## ILLUSTRATIONS


Figure 1. Map showing location of major geographic features of Long Island, N.Y. . . . . 3

2. Map showing location of recharge basins used for storm runoff on Long Island in 1969 and of the five basins used in this study . . . . . 4

3. Generalized hydrogeologic section of Long Island showing major hydrogeologic units . . . . . 5

4. Graph showing population of Nassau and Suffolk Counties, Long Island, N.Y., 1920-80. . . . . 8

5. Maps and aerial photographs of drainage areas at:

A. Centereach. . . . . 12
B. Huntington. . . . . 14
C. Laurel Hollow . . . . . 16
D. Plainview . . . . . 18
E. Syosset . . . . . 20

6. Schematic diagram of instrumentation at each recharge basin . . . . . 23

7. Graphs showing relationship between discharge measured simultaneously by flow meter and by dye-dilution method at Centereach, Plainview, Laurel Hollow, and Syosset . . . . . 24

8. Graphs showing modified runoff/precipitation relationship at Centereach, Huntington, Laurel Hollow, Plainview, and Syosset . . . . . 36

## ILLUSTRATIONS (Continued)


Page

Figure 9. Hydrographs, hyetographs, and plots showing constituent concentrations through time during storm at:

A. Centereach, June 5, 1982. . . . . 41
B. Huntington, February 20, 1981 . . . . . 42
C. Laurel Hollow, February 1, 1981 . . . . . 43
D. Plainview, February 1, 1981 . . . . . 44
E. Syosset, April 23, 1981 . . . . . 45

10. Plot showing flow-weighted average concentrations of nitrogen in stormwater and observed concentrations in ground water at Plainview, 1980-82. . . . . 52


## TABLES


Table 1. Physical characteristics of major hydrogeologic units on Long Island. . . . . 6

2. Physical characteristics of recharge basins studied. . . . . 22

3. Comparison of flow measurements recorded by flow meter with measurements obtained by dye-dilution methods . . . . . 25

4. Number of storms sampled per site, by season, 1980-82. . . . 28

5. Characteristics of sampled storms, 1980-82 . . . . . 29

6. Source and type of sample, and number of each type of analysis performed . . . . . 31

7. Source of samples collected for priority-pollutant analysis . . . . . 32

8. Median and range of modified runoff/precipitation ratio, in percent . . . . . 33

9. Precipitation, runoff, and modified runoff/precipitation ratio for sampled storms, 1980-82. . . . . 34

10. Median values of physical and chemical characteristics of stormwater, ground water, and precipitation. . . . . 38

11. Total daily snowfall, eastern Long Island, January 2-10, 1981 . . . . . 46

12. Comparison of median lead and chromium concentrations in rainfall (1980-82) and accumulated snow, January 10, 1981. . 46

## TABLES (Continued)


Page

Table 13. Concentration of selected compounds at recharge basins, 1981-82:

A. Acid- and base/neutral-extractable priority pollutants . 48
B. Volatile priority pollutants, pesticides, phenols, and cyanide. . . . . 49

14. Priority pollutants exceeding New York State drinking-water standards at study sites . . . . . 50

15. Minimum, maximum, and median number of bacteria in stormwater for all samples . . . . . 50

16. Ratio of fecal coliform to fecal streptococci in stormwater . . . . . 51

17. Flow-weighted concentrations and loads of selected constituents in stormwater and observed concentrations in water reaching the water table at recharge basins. . . . . 54

18. Minimum, maximum, and median number of bacteria per storm for all sampled storms, per acre per inch of precipitation. . . . . 56

19. Seasonal comparison of minimum, maximum, and median number of bacteria per storm for all sampled storms, per acre per inch of precipitation. . . . . 56

20. Concentrations of metals, pesticides, and polychlorinated aromatic hydrocarbons in basin soil samples, June 1981 . . . 58

## CONVERSION FACTORS AND ABBREVIATIONS

| Multiply inch-pound units | By | To obtain metric unit |
|---|---|---|
| | **Length** | |
| inch (in) | 25.40 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| | **Area** | |
| acre | 4,047 | square meter ($m^2$) |
| acre | 0.4047 | hectare |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| | **Volume** | |
| gallon (gal) | 3.785 | liter (L) |
| gallon (gal) | 0.003785 | cubic meter ($m^3$) |
| | **Flow** | |
| cubic foot per second (ft3/s) | 0.02832 | cubic meter per second ($m^3/s$) |
| million gallons per day (Mgal/d) | 0.04381 | cubic meter per second ($m^3/s$) |
| | **Mass** | |
| pound (lb) | 453.6 | gram (g) |
| | **Temperature** | |
| degree Fahrenheit (°F) | °C = 5/9 (°F -32) | degree Celsius |

**Abbreviations**

foot per mile (ft/mi)
milligrams per liter (mg/L)
micrograms per liter (µg/L)
milliliter (mL)
picocurie per liter (PCi/L)
microgram per gram (µg/g)
microgram per kilogram (µg/kg)
most probable number (MPN)

# Effect of Urban Stormwater Runoff on Ground Water beneath Recharge Basins on Long Island, New York

by Henry F. H. Ku and Dale L. Simmons


## Abstract

Urban stormwater runoff was monitored during 1980-82 to investigate the source, type, quantity, and fate of contaminants routed to the more than 3,000 recharge basins on Long Island and to determine whether this runoff might be a significant source of contamination to the ground-water reservoir. Forty-six storms were monitored at five recharge basins in representative land-use areas (strip commercial, shopping-mall parking lot, major highway, low-density residential, and medium-density residential).

Runoff/precipitation ratios indicate that all storm runoff is derived from precipitation on impervious surfaces in the drainage area except during storms of high intensity or long duration, when additional runoff can be derived from precipitation on permeable surfaces.

Concentrations of most measured constituents in individual stormwater samples were within Federal and State drinking-water standards. The few exceptions are related to specific land uses and seasonal effects. Lead was present in highway runoff in concentrations up to 3,300 micrograms per liter (µg/L), and chloride was found in parking-lot runoff in concentrations up to 1,100 milligrams per liter (mg/L) during winter, when salt is used for deicing.

The load of heavy metals was largely removed during movement through the unsaturated zone, but chloride was not removed. Total nitrogen was commonly found in greater concentrations in ground water than in stormwater; this is attributed to seepage from cesspools and septic tanks and to the use of lawn fertilizers.

In the five composite stormwater samples and nine ground-water grab samples that were analyzed for 113 U.S. Environmental Protection Agency-designated "priority pollutants," four constituents were detected in concentrations exceeding New York State guidelines of 50 µg/L for an individual organic compound in drinking water: p-chloro-m-cresol (79 µg/L in ground water at the highway basin); 2,4-dimethylphenol (96 µg/L in ground water at the highway basin); 4-nitrophenol (58 µg/L in ground water at the parking-lot basin); and methylene chloride (230 µg/L in stormwater at the highway basin). One stormwater sample and two ground-water samples exceeded New York State guidelines for total organic compounds in drinking water (100 µg/L). The presence of these constituents is attributed to contamination from point sources rather than to the quality of runoff from urban areas.

The median number of indicator bacteria in stormwater ranged from $10^8$ to $10^{10}$ MPN/100 mL (most probable number per 100 milliliters). Fecal coliforms and fecal streptococci increased by 1 to 2 orders of magnitude during the warm season. Total coliform concentrations showed no significant seasonal differences.

Low-density residential and nonresidential (highway and parking lot) areas contributed the fewest bacteria to stormwater; medium-density residential and strip commercial areas contributed the most. No bacteria were detected in the ground water beneath any of the recharge basins.

The use of recharge basins to dispose of storm runoff does not appear to have significant adverse effects on ground-water quality in terms of the chemical and microbiological stormwater constituents studied.

## INTRODUCTION

The aquifer system of Long Island, N.Y. (fig. 1) has been designated by the U.S. Environmental Protection Agency (USEPA) as the "sole-source aquifer" for water supply in Nassau and Suffolk Counties. (Kings and Queens Counties, in western Long Island, obtain water from upstate reservoirs.) The aquifer system receives natural recharge only from precipitation that infiltrates from the land surface to the water table.

Eastward urbanization on Long Island since the beginning of the 20th century, with the attendant construction of highways, houses, shopping centers, industrial parks, and streets and sidewalks in previously undeveloped or agricultural areas, has caused a decrease in the amount of land surface through which precipitation can infiltrate. The increased amount of impervious surface has, in turn, caused a twofold water-management problem--an increased volume of urban storm runoff from paved areas, and a loss of ground-water recharge. To eliminate the need for costly trunk storm sewers to carry runoff to coastal waters, and to minimize the loss of recharge, excavation of shallow stormwater-collection basins, known as recharge basins, was begun as early as 1935 to contain the storm runoff and allow it to infiltrate to the underlying aquifers.

Recent investigations of the chemical quality of urban runoff (Koppelman, 1978) have given rise to questions as to whether urban stormwater may contain substances that could alter the quality of ground water beneath the recharge basins. Substances that may be found in urban runoff include organic compounds, heavy metals, chloride from road salt, and bacteria; however, the extent to which they are transmitted through the unsaturated zone beneath the recharge basins to the underlying aquifers is unknown.

A 5-year study by the Nassau-Suffolk Regional Planning Board (Koppelman, 1978) indicated that routing stormwater runoff to tidewater through streams and storm sewers is the major source of bacterial loading to the saltwater bays surrounding the island and often contributes more than 95 percent of the annual load. Excessive levels of total coliforms in the south-shore bays have caused large areas to be closed to shellfishing, which results in a significant annual economic loss to the island. The Koppelman (1978) study also indicated urban runoff to be an important source of inorganic compounds, organic matter, and sediment, as well as organic compounds, including pesticides, and suggested that urban stormwater may also contribute significant quantities of these constituents to the ground water through stormwater recharge basins.

During 1979-83, the U.S. Geological Survey, in cooperation with the Long Island Regional Planning Board, studied the characteristics of stormwater on Long Island as part of the "Nationwide Urban Runoff Program" funded by the U.S. Environmental Protection Agency. The objectives of this study were to (1) determine the source, type, quantity, and fate of selected constituents of urban stormwater runoff in Nassau and Suffolk Counties; and (2) assess the effects of runoff diverted to selected recharge basins on the chemical and microbiological quality of ground water beneath the basins.

## Purpose and Scope

This report summarizes the results of the study and presents data on runoff quantity, runoff quality, and ground-water quality beneath recharge basins after storms. A list of constituents included in standard chemical and priority-pollutant analyses is given in appendixes A and B, respectively. A guide to computerized water-quality data and a summary of Federal and State drinking-water standards are given in appendixes C and D, respectively. The data presented herein will help to identify sources of current or potential ground-water contamination that may result from the use of recharge basins for stormwater retention and recharge on Long Island.

## Location and Extent of Study Area

Long Island, the southeasternmost part of New York State, extends east-north-eastward roughly parallel to the New England coast (fig. 1). The Island is 120 miles long and has a maximum width of 23 miles. It is bounded on the north by Long Island Sound, on the east and south by the Atlantic Ocean, and on the west by New York Bay and the East River.

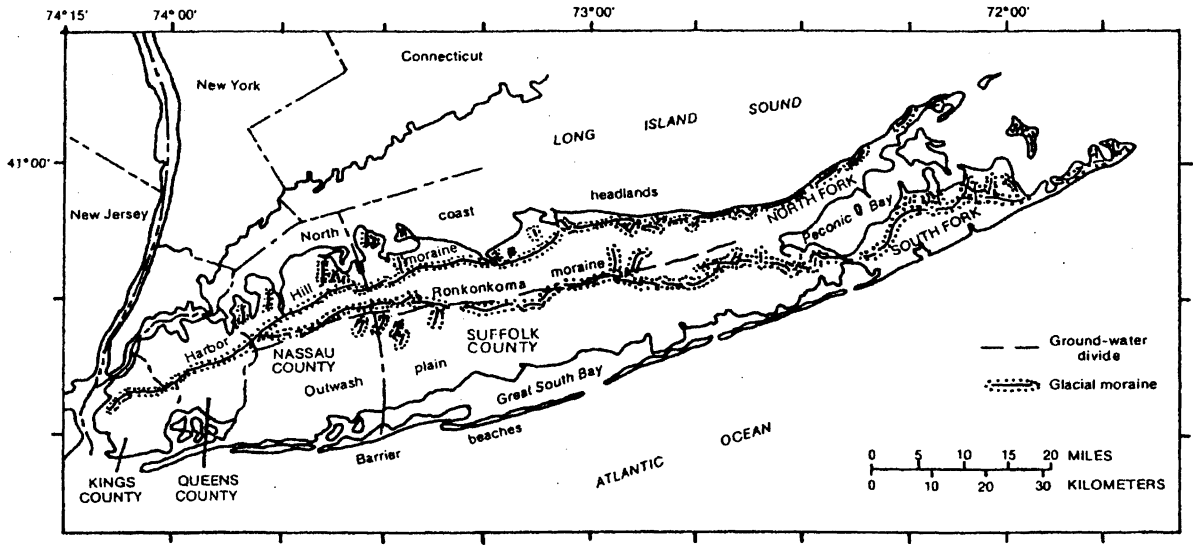



*Figure 1.--Major geographic features of Long Island, N.Y. (Modified from McClymonds and Franke, 1972.)*

Long Island consists of four counties--Kings, Queens, Nassau, and Suffolk. Kings and Queens, the two westernmost counties, are boroughs of New York City. The study area, Nassau and Suffolk Counties, has a combined area of more than 1,200 $mi^2$ and contains more than 3,000 recharge basins, most of which are in eastern Nassau and western Suffolk Counties (fig. 2).

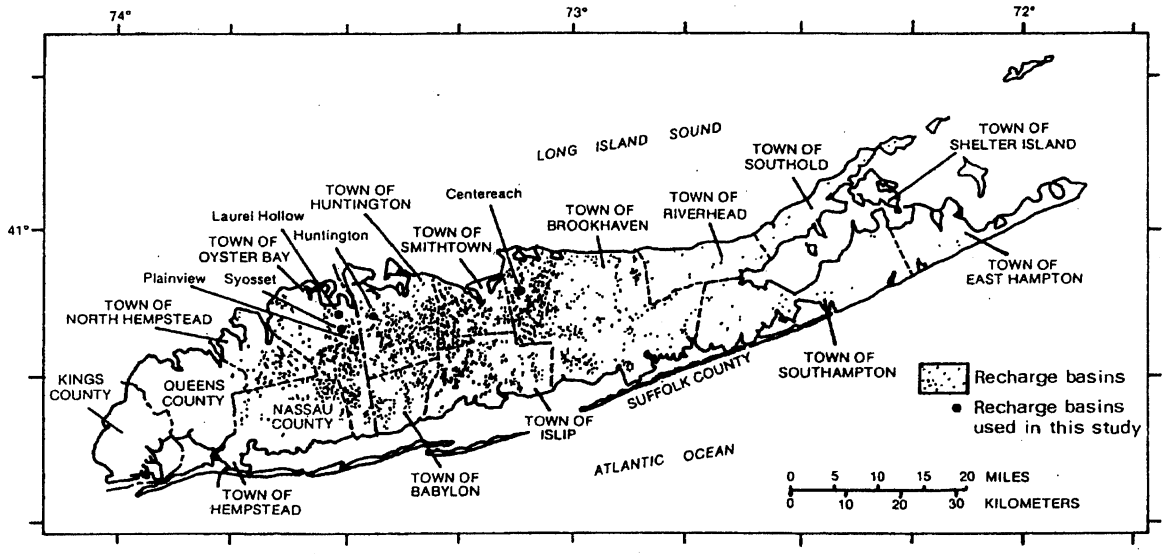



*Figure 2.--Location of recharge basins used for storm runoff on Long Island in 1969 and of the five basins used in this study. (Modified from Seaburn and Aronson, 1973.)*

## Previous Studies

The hydrology of recharge basins has been described by Brashears (1946), Brice and others (1959), Parker and others (1967), Holzmacher and others (1970), and Seaburn (1970a, 1970b). Seaburn and Aronson (1973) compiled a catalog describing the physical characteristics of more than 2,000 recharge basins in operation on Long Island in 1969. They also evaluated the operating efficiency of the recharge basins (Aronson and Seaburn, 1974) and discussed the influence of the basins on Long Island hydrology (Seaburn and Aronson, 1974). Koppelman (1978) discussed the quality of urban runoff on Long Island in detail and estimated annual constituent loading to recharge basins.

Miller and McKenzie (1978) analyzed stormwater quality near Portland, Ore. Ellis and Alley (1979) examined the quantity and quality of urban runoff in the Denver, Colo., area. Mallard (1980) compiled a review of current literature on the microbiological constituents of stormwater.

### Acknowledgments

The authors thank the Long Island Regional Planning Board, particularly Executive Director Lee E. Koppelman and Edith Tanenbaum, for assistance and guidance and also thank the Suffolk County Department of Health Services for field assistance. James Adamsky of the Nassau County Department of Health, Division of Laboratories, provided services for the microbiological analyses included in this report. The Nassau County Department of Public Works and the New York State Department of Transportation provided access to their recharge basins. Special thanks are due to Ronald Shields, Operations Manager of Pembrook Management, Inc., for permission to place instruments on property managed by that firm.

## HYDROGEOLOGIC SETTING

### Hydrogeologic Units

Long Island is underlain by a thick sequence of unconsolidated sediments including gravel, sand, silt, and clay, which are in turn underlain by southward-dipping crystalline bedrock (fig. 3). The units that make up the aquifer system range in thickness from zero in northern Queens County, where bedrock is exposed, to more than 2,000 ft in south-central Suffolk County. The characteristics of the individual aquifers and intervening confining units are summarized in table 1.

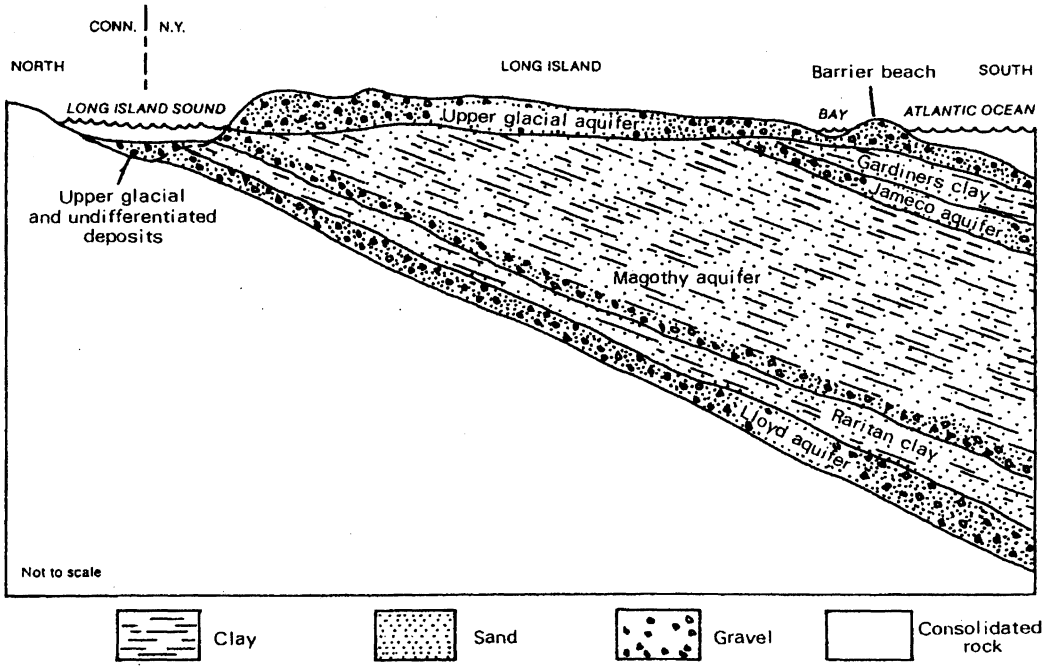



*Figure 3.--Major hydrogeologic units of Long Island. (Modified from Cohen and others, 1968.)*

*Table 1.--Physical characteristics of major hydrogeologic units on Long Island.*

[From Cohen and others, 1968]

| Hydro-geologic unit | Geologic name | Approximate maximum thickness (ft) | Water-bearing character |
|---|---|---|---|
| Upper glacial aquifer | Upper Pleistocene deposits | 400 | Mainly sand and gravel of moderate to high permeability; also includes clayey deposits of glacial till of low permeability. |
| Gardiners Clay | Gardiners Clay | 150 | Clay, silty clay, and a little fine sand of low to very low permeability. |
| Jameco aquifer | Jameco Gravel | 200 | Mainly medium to coarse sand of moderate to high permeability. |
| Magothy aquifer | Matawan Group and Magothy(?) Formation undifferentiated | 1,000 | Coarse to fine sand of moderate permability; locally contains gravel of high permeability, and abundant silt and clay of low to very low permeability. |
| Raritan clay | Clay member of the Raritan Formation | 300 | Clay of very low permeability; some silt and fine sand of low permeability. |
| Lloyd aquifer | Lloyd Sand Member of the Raritan Formation | 300 | Sand and gravel of moderate permeability; some clayey material of low permeability. |

Surficial deposits on Long Island are the result of the Wisconsin glaciation. Two terminal moraines form east-west-trending lines of hills of poorly sorted glacial debris that reach a maximum altitude of 400 ft. These moraines merge in the western part of the island (fig. 1). A gently sloping outwash plain composed of well-sorted glaciofluvial sand and gravel extends southward from the line of moraines to the south shore with a slope of about 20 ft/mi (Cohen and others, 1968). Small patches of poorly sorted till occur sporadically and form localized spots of relative impermeability (Seaburn and Aronson, 1974). The headlands along the north shore consist mainly of glacial deposits eroded by streams and waves to produce several embayments. The south shore is lined with swamp and marsh deposits. Barrier islands, composed mainly of sand transported and deposited by littoral currents, enclose the shallow saltwater bays.

## Precipitation

Mean annual precipitation on Long Island ranges from slightly less than 41 inches on the south shore of Nassau County to slightly more than 50 inches in the island's central region (Miller and Frederick, 1969), with a long-term

mean of 44 inches islandwide (Cohen and others, 1968). Annual precipitation during 1980, 1981, and 1982 was below average, at 40.4, 38.5, and 40.5 inches, respectively. Average warm-season and cool-season precipitation rates are almost equal.

## Streamflow

The stream valleys on Long Island are broad, straight, and shallow and follow the courses established by meltwater channels during glacial retreat. The south-flowing streams are widely spaced with few or no tributaries and have gentle gradients that average 10 ft/mi. The north-flowing streams generally have steeper gradients that average 20 to 40 ft/mi.

The high permeability of the outwash sand and gravel, as well as the flat terrain, enable precipitation to infiltrate almost immediately. Before urbanization, about 95 percent of total streamflow consisted of water from the upper glacial aquifer (Franke and McClymonds, 1972); the remaining 5 percent consisted of direct runoff. Thus, the streams function as ground-water drains, and streamflow during dry weather is controlled directly by ground-water levels adjacent to the stream channel (Pluhowski and Kantrowitz, 1964). The reduction in recharge due to increased impermeable area and the use of sewers has lowered ground-water levels, which has in turn significantly reduced the ground-water contribution to streamflow in Nassau County (Simmons and Reynolds, 1982).

## Ground Water

### *Movement*

The ground-water system of Long Island consists of four major aquifers (table 1). The lower three are confined (artesian); the water-table (upper glacial) aquifer is hydraulically connected to the streams and lakes of the island. The water-table aquifer is no longer extensively used for public-water supply in Nassau County because it has become contaminated from surface sources such as fertilizers and from septic-tank and cesspool discharges.

Some of the precipitation that reaches the water table moves horizontally within the upper glacial aquifer; the rest moves downward toward the underlying aquifers. Ground water north of the ground-water divide (fig. 1) flows north toward Long Island Sound; south of the divide, the general path of ground-water movement is southward. Contaminants that enter the ground water also follow these flow paths.

Where stream channels intersect the water table, they receive ground-water seepage that sustains base flow during dry weather. The remainder of the ground water discharges offshore as subsea outflow into the Sound, the bays bordering the island, or the ocean.

### *Recharge*

Under natural (predevelopment) conditions, about 50 percent of the average annual precipitation on Long Island infiltrated the soil and recharged the ground-water reservoir (Aronson and Seaburn, 1974); the rest was lost

through evapotranspiration or became runoff. Now, however, much of the precipitation falls on impervious surfaces and becomes runoff, decreasing the amount of natural recharge. Today most recharge results from infiltration of precipitation through remaining pervious areas, such as lawns and other open spaces, and by infiltration of storm runoff through recharge basins. Additional recharge results from the recycling of water used for domestic and industrial purposes through cesspools, septic tanks, leaching basins, and recharge wells, and by the infiltration of some of the water used to irrigate lawns.

More than 10 percent of the area in Nassau and Suffolk Counties drains to recharge basins. In these areas, ground-water recharge from precipitation equals or slightly exceeds recharge under predevelopment conditions because evapotranspiration is reduced (Aronson and Seaburn, 1974).

## URBAN HYDROLOGY OF LONG ISLAND

### Population

From the end of World War II to the late 1950's, the population of Nassau County increased rapidly (fig. 4). This wave of urbanization, characterized mainly by the construction of large developments of single-family houses, expanded eastward and, by the late 1950's, had reached Suffolk County. The population of western Suffolk County then began to increase markedly and has continued to increase more rapidly than that of any other area on Long Island.

Since the 1970's, the rate of population increase on Long Island has slowed considerably, and the combined population of Nassau and Suffolk Counties now approaches a stable 2.7 million (U.S. Bureau of the Census, 1982).

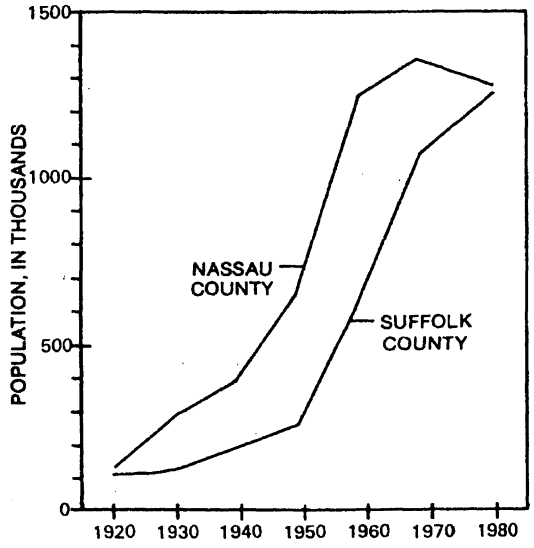



*Figure 4.*

*Population of Nassau and Suffolk Counties, Long Island, N.Y., 1920-80. (Data from U.S. Bureau of the Census, 1982.)*

## Sewerage History and Plans

Sewers in Nassau and Suffolk Counties consist of two distinct systems--sanitary sewers and storm sewers. Storm sewers consist of short sewerlines that direct stormwater runoff to the nearest stream, bay, or recharge basin. Sanitary sewers convey wastewater from residences and commercial and industrial facilities to sewage-treatment plants and carry treated effluent to the ocean. In Nassau County, the sanitary-sewer system is divided into two major sewer districts, each with its own treatment plant. Suffolk County has one sewer district, which is in the southwestern corner of the county.

### *Sanitary Sewers*

Before Long Island's first large-scale sewage-treatment plant (in southwestern Nassau County) began operation in 1953, domestic and industrial waste was discharged into the ground from individual systems, except in the villages of Hempstead, Garden City, Rockville Centre, and Mineola, which had their own sewage systems. Yet, even these plants discharged effluent into the ground. The village of Freeport had the only sewage system that discharged its effluent to tidewater.

As of 1977, the sewage-treatment plant in southwestern Nassau County served an area of 70 $mi^2$ and a population of 580,000 (Ku and Sulam, 1979). Hookups to this system were completed in 1964; about 60 Mgal/d of sewage are now treated here and discharged to tidewater.

Initial planning for sewers in southeastern Nassau County began in 1964 in response to (1) increasing commercial and industrial development, (2) the need to protect the ground-water reservoir from further contamination, and (3) the failure of aging private sewage-disposal units. The treatment plant in southeastern Nassau County is an activated-sludge type with an average design flow of 45 Mgal/d; it will serve a population of approximately 500,000. Effluent from this plant is discharged to the ocean.

The percentage of Nassau County's population served by sanitary sewers increased from 8 percent in 1940 to 54 percent in 1970; after completion of sanitary-sewer installation in southeastern Nassau County, approximately 98 percent of the county's population will be served by sanitary sewers.

The sewage-treatment plant in southwestern Suffolk County began operation in 1981. It has a capacity of 30 Mgal/d and serves a population of approximately 280,000.

### *Storm Sewers and Recharge Basins*

Shallow stormwater-collection basins, known as recharge basins, were constructed in Nassau County beginning in 1935 (Pluhowski and Spinello, 1978). The conveyance of storm runoff to these basins through storm sewers enabled efficient disposal of storm runoff and replenishment of the ground water.

Most of the recharge basins on Long Island are unlined open pits ranging in size from 0.1 to 30 acres, with an average of 1.5 acres. Most are about 10 ft deep, but some are as deep as 40 ft (Seaburn and Aronson, 1973). Long Island today has more than 3,000 such basins, mainly in eastern Nassau County and western Suffolk County, near the ground-water divide (fig. 1). According to Aronson and Seaburn (1974), 91 percent of these basins are dry within 5 days after a 1-inch rainfall. Those that hold water for longer periods do so either because they intersect the regional or a perched water table, are excavated in till or moraine of low hydraulic conductivity rather than in outwash deposits, or are clogged by sediment and debris.

Since the early 1960's, many storm sewers have been constructed in southern Nassau County and southwestern Suffolk County, where the population increase has been rapid (Pluhowski and Spinello, 1978). Here, however, the water table is less than 20 ft below land surface (Koszalka, 1975), which makes the excavation of recharge basins impractical. Therefore, most of the storm runoff in this area is conveyed directly to streams, which in turn discharge to the south-shore bays.

## DESCRIPTION OF MONITORING SITES

Five recharge basins--three in Nassau County and two in Suffolk County (fig. 2)--were chosen for study by the U.S. Geological Survey on the basis of the type of land use in the area from which they receive stormwater runoff. The five basins together represent a wide variety of land uses. The physical characteristics of these recharge basins and their drainage areas are described below and are summarized in table 2 (p. 22); a map and aerial photograph of each area are shown in figures 5A-5E.

### Centereach (Commercial)

The recharge basin at Centereach (fig. 5A) receives storm runoff from a four-lane asphalt State highway that is bordered on both sides by small commercial establishments. Although the topographic drainage area includes 553 acres, the area served by storm sewers that lead to the basin, as determined by the New York State Department of Transportation (DOT), which owns and maintains the basin, is only 69 acres. Of this effective drainage area, 5.8 acres are impervious and consist of the State highway, driveways, and side-road intersections. Topographic relief in the drainage area is about 10 feet.

The basin floor occupies about 0.5 acres and is underlain by sand and gravel. This basin was constructed in 1977 and was designated Ecological Recharge Basin #2 by the New York State DOT. The basin bottom was lined with 30-mil polyvinylchloride sheets so that it retains water and has formed an artificial pond. The pond is stocked by DOT with fish and aquatic vegetation. Beneath the impermeable liner is an exfiltration system consisting of perforated pipes. When the pond level rises, the excess water flows through a filter box into the exfiltration system and ultimately recharges the ground water.

### Huntington (Shopping Center and Parking Lot)

The recharge basin at Huntington (privately owned, fig. 5B) receives runoff from 35 acres of a large shopping center and the adjacent parking lot. The parking lot is paved with asphalt and is curbed. The basin floor occupies about 0.5 acres and is underlain by sand and gravel. Vegetation in this basin is sparser than in the others, and consists mainly of grass and weeds. Topographic relief in the drainage area is near zero.

Most recharge basins on Long Island do not hold water longer than 5 days after a storm. However, those that drain parking areas tend to become clogged with oil and rubber and asphalt particles and therefore contain water most, if not all, the time. Although the basin at Huntington is clogged, ponded stormwater infiltrates through the basin walls above the impermeable part and allows as much runoff to infiltrate as in a basin that is not clogged, although more slowly, owing to the reduced infiltration area.

### Laurel Hollow (Low-Density Residential)

The recharge basin at Laurel Hollow (fig. 5C) drains approximately 100 acres of low-density residential area. Within this area, newly constructed one-family houses occupy lots of one or more acres. This basin was constructed in 1979. It contains little vegetation and is underlain by sand and gravel. The basin floor occupies 0.6 acres.

Roads in the drainage area are two lanes wide, paved with asphalt, and curbed in most places. Topographic relief is 160 feet, which is the greatest relief of the five drainage basins studied.

### Plainview (Highway)

The recharge basin at Plainview (fig. 5D), constructed in 1956, receives runoff from the Long Island Expressway and its service road. Of the 190 acres of topographic drainage area, 12 acres form the contributing area, which consists of a six-lane concrete highway, two-lane asphalt service roads, and a few driveways. The highway is curbed on both sides; the service road is not. Topographic relief in the drainage area is 60 feet.

The basin floor occupies approximately 1 acre. It is underlain by sand and gravel and is covered by thick vegetation including grass, weeds, bushes, and trees.

### Syosset (Medium-Density Residential)

The recharge basin at Syosset (fig. 5E) drains approximately 28 acres of medium-density residential area containing single-family houses on quarter-acre lots. The basin was constructed in 1957. Its floor occupies 0.3 acres and is underlain by sand and gravel. The basin contains thick vegetation, including grass, weeds, bushes, and some trees.

Roads in the drainage area are two lanes wide, paved with asphalt, and curbed. Topographic relief within the drainage area is less than 20 feet.

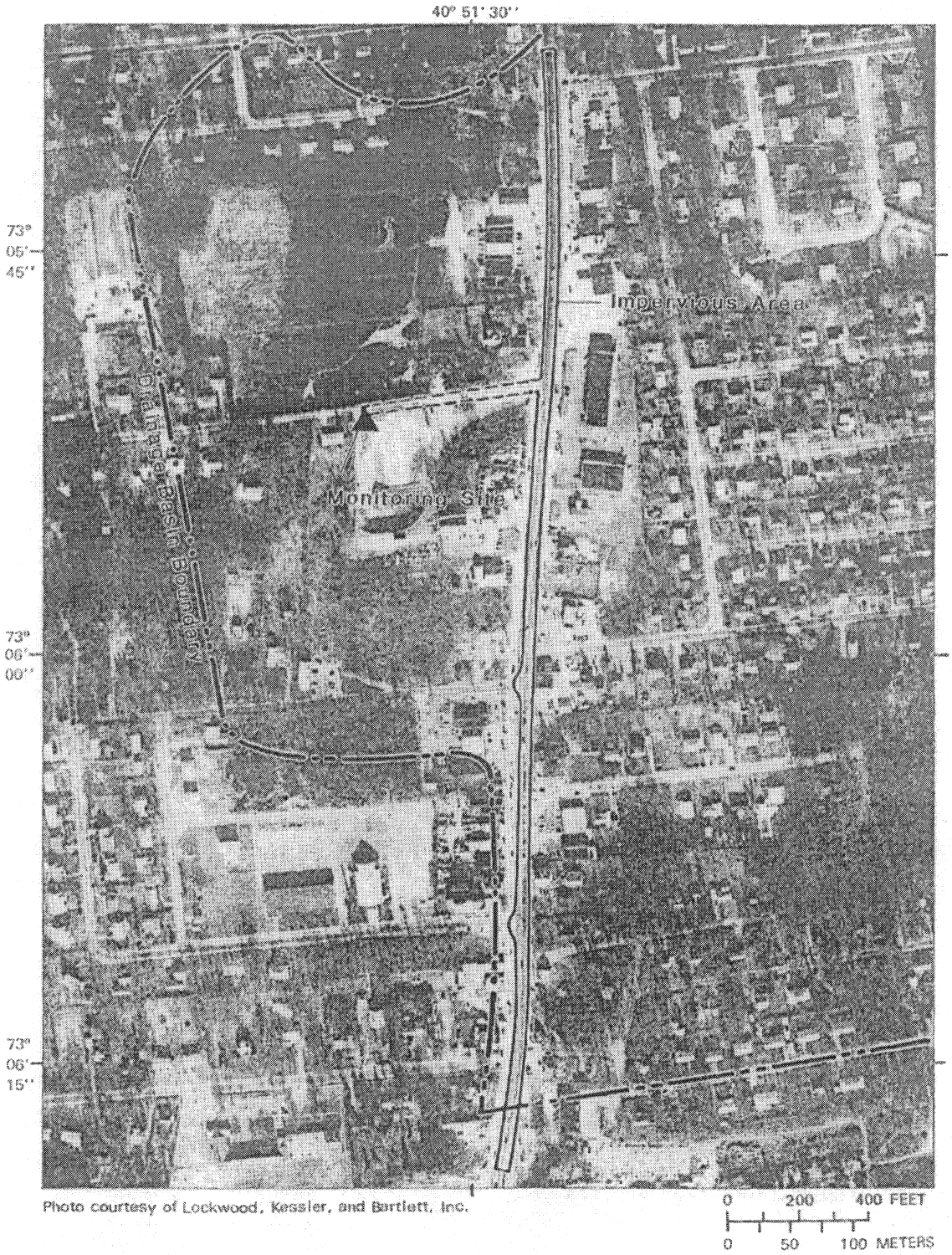
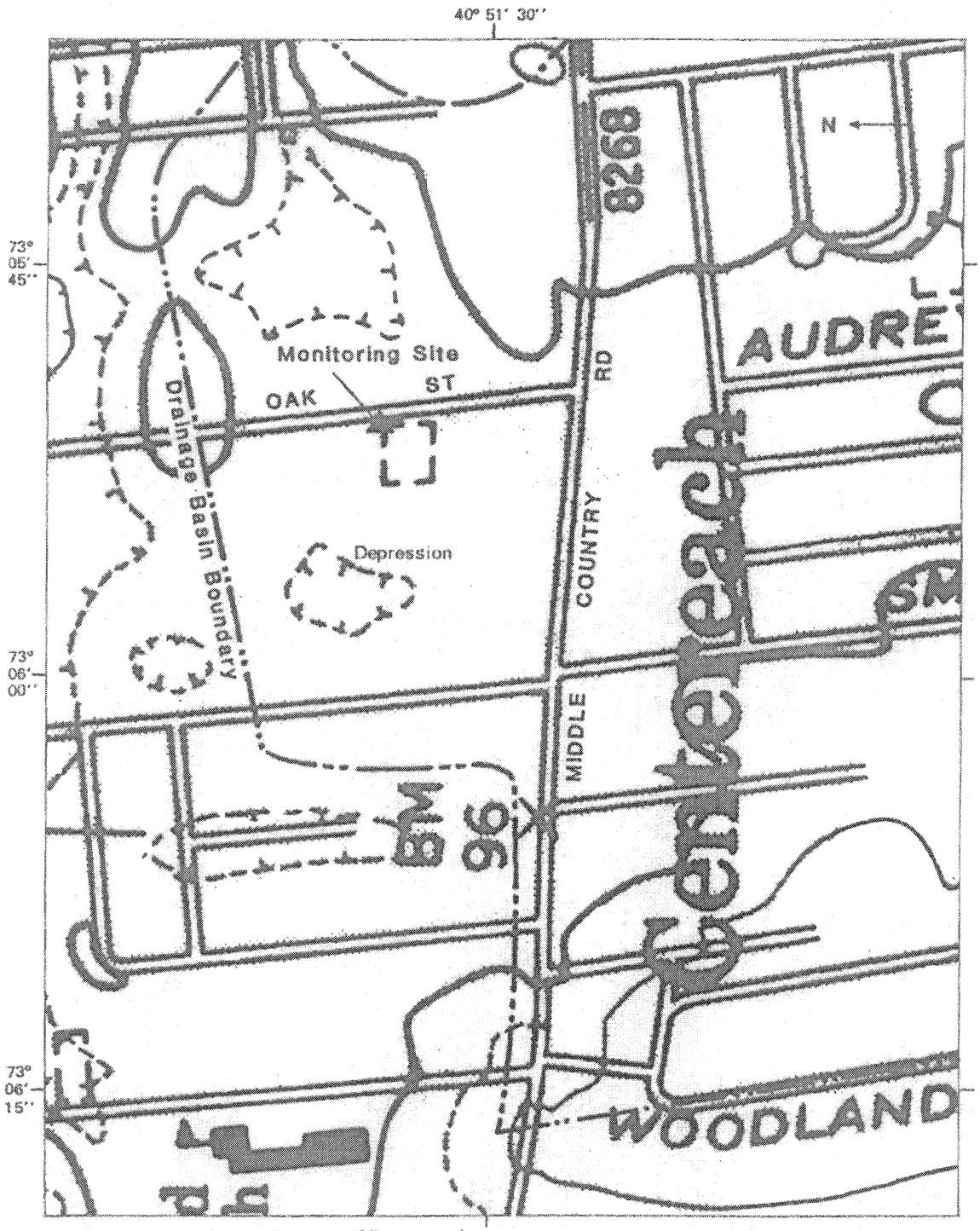



*Figure 5A.--Aerial photograph and map of drainage area*




Base from New York State Department of Transportation, Centereach, N.Y., 1:24,000, 1981

*at Centereach. (Location is shown in fig. 2.)*

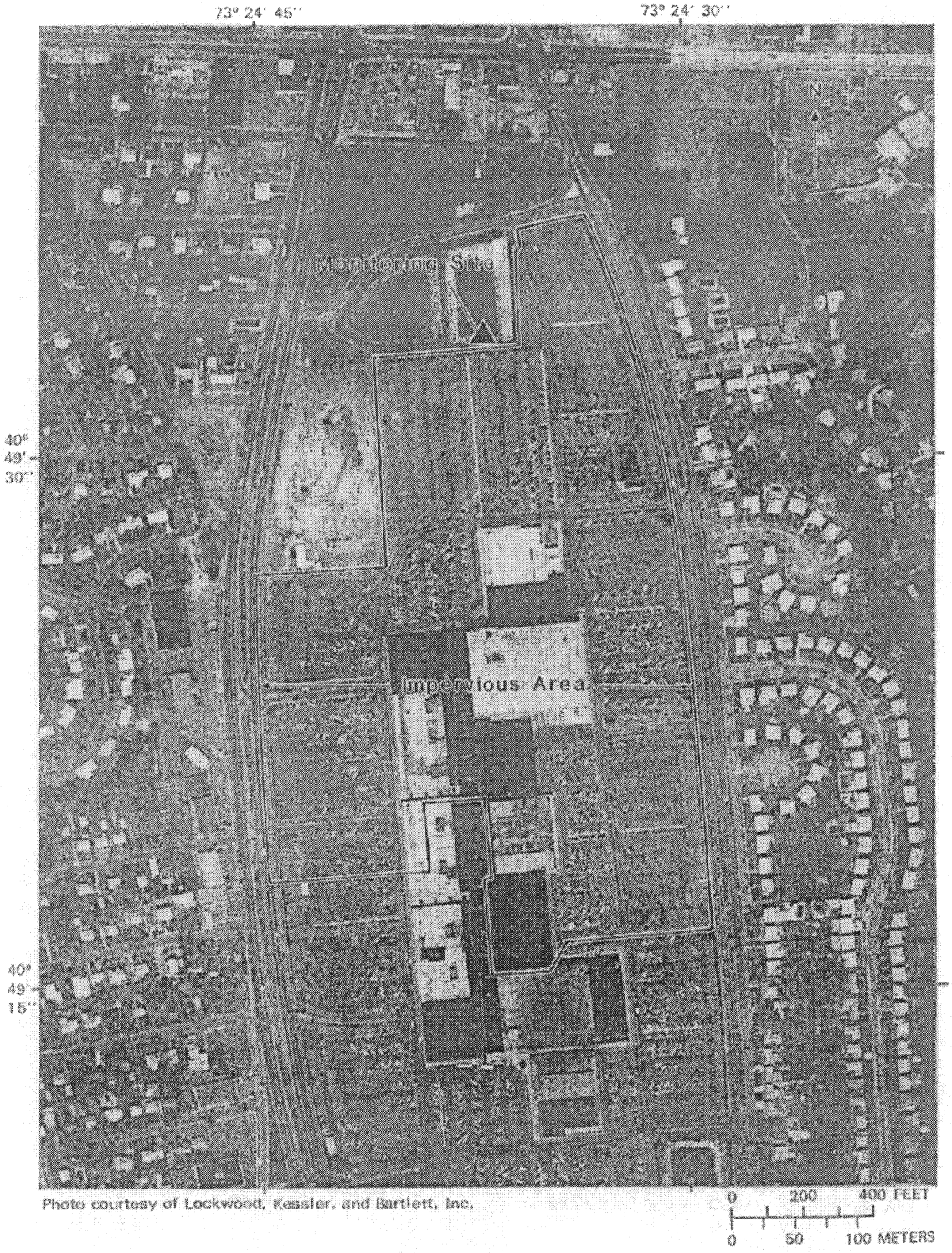
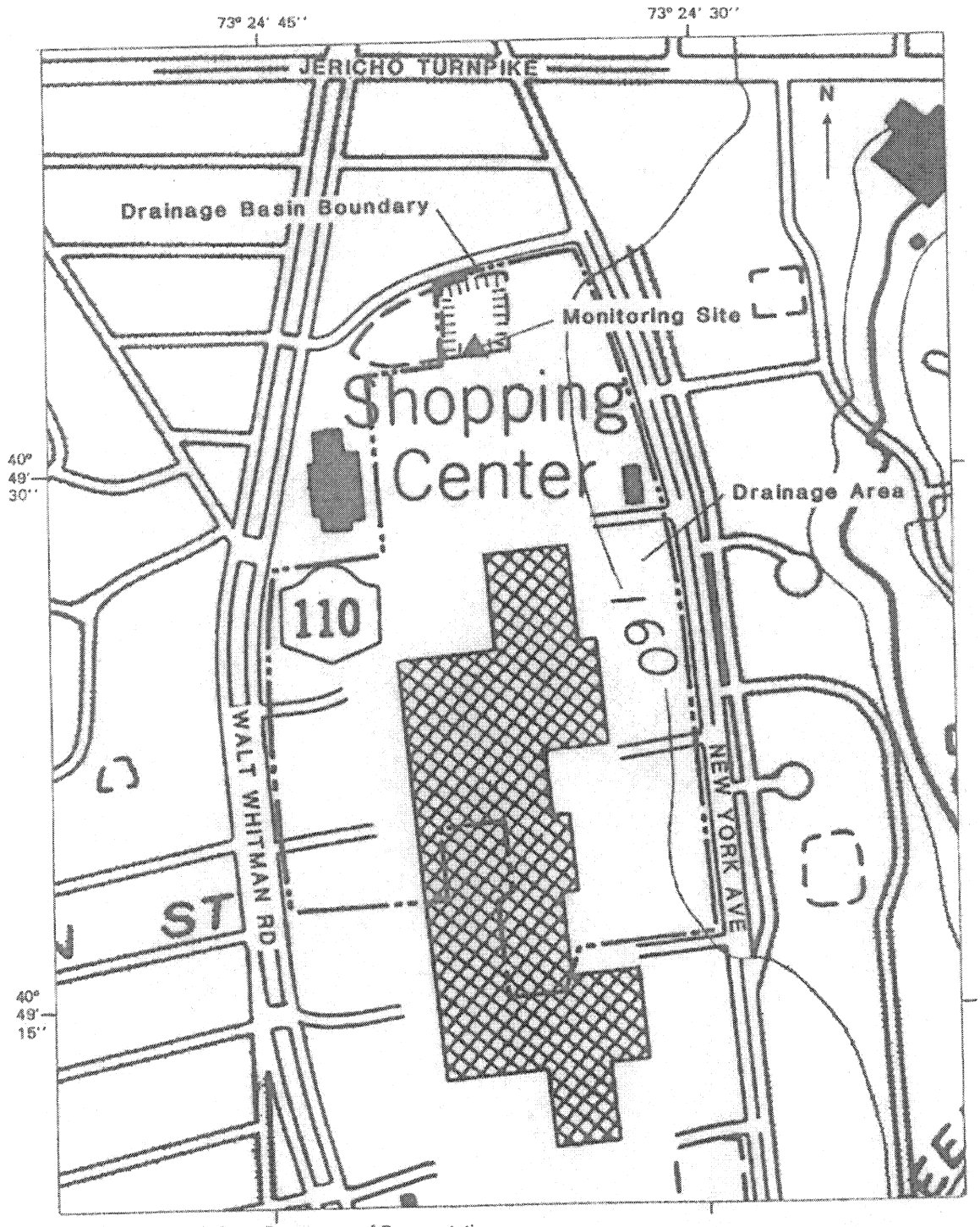
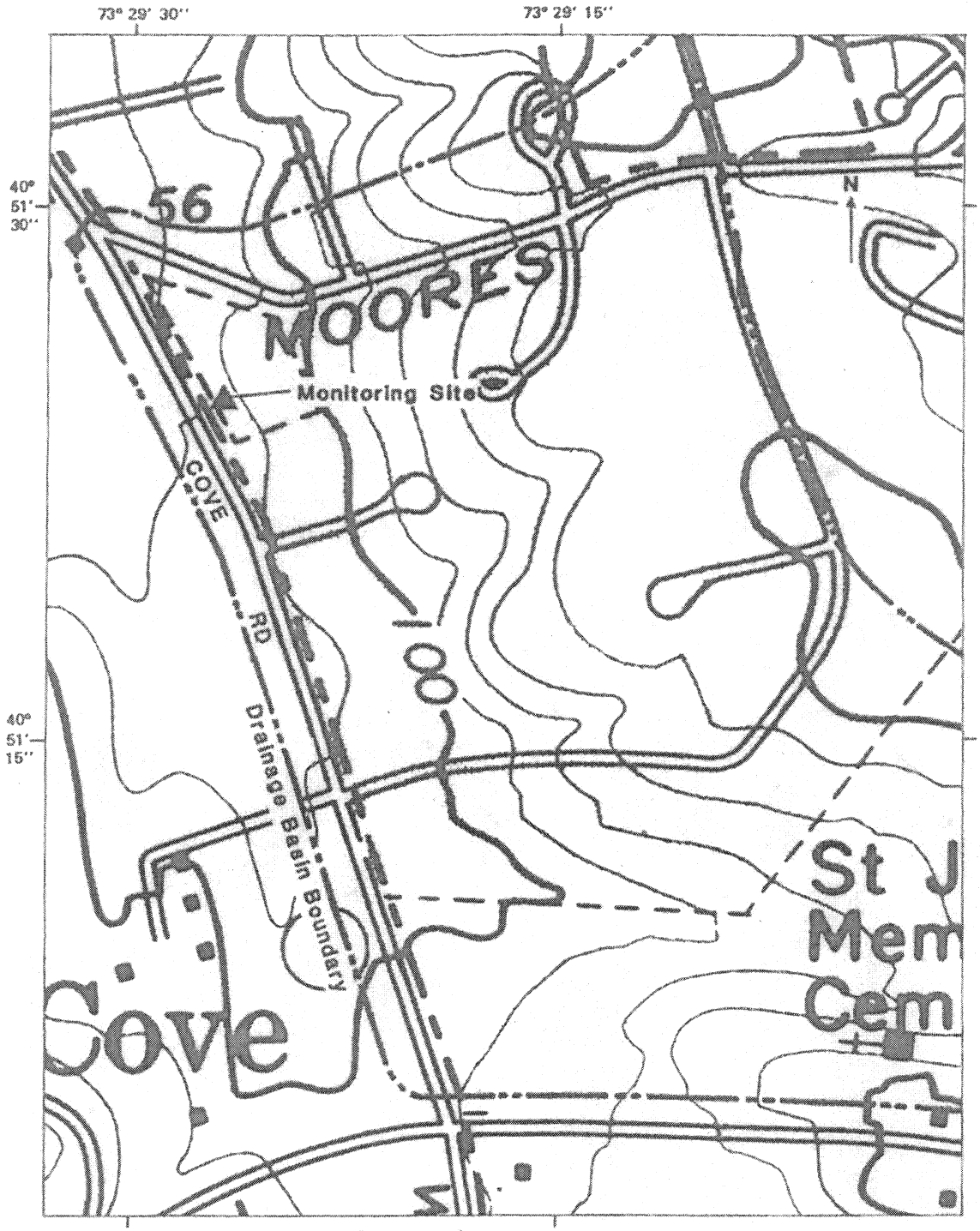



*Figure 5B.--Aerial photograph and map of drainage area*




*at Huntington. (Location is shown in fig. 2.)*

*Figure 5C.--Aerial photograph and map of drainage area*




*at Laurel Hollow. (Location is shown in fig. 2.)*

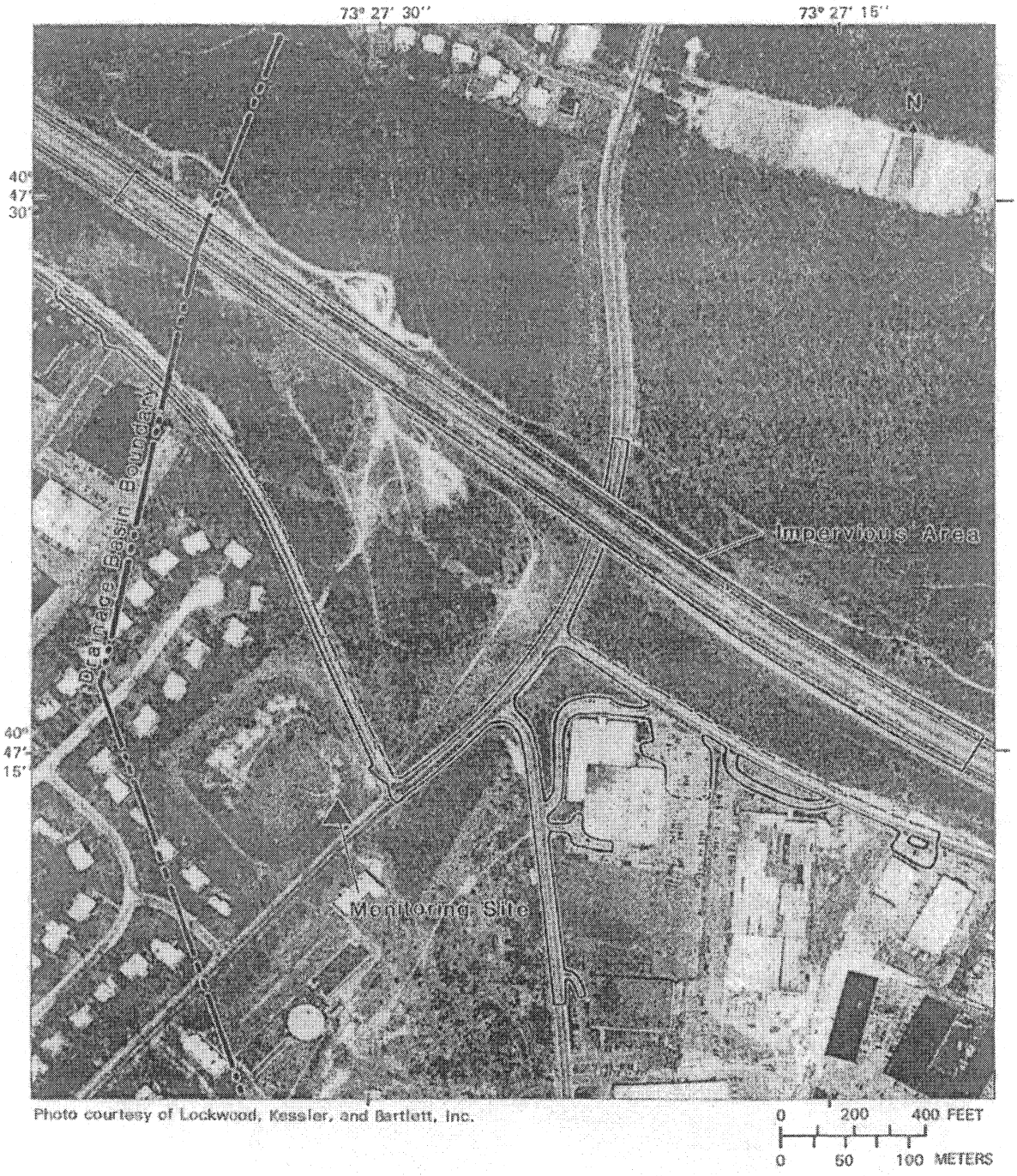
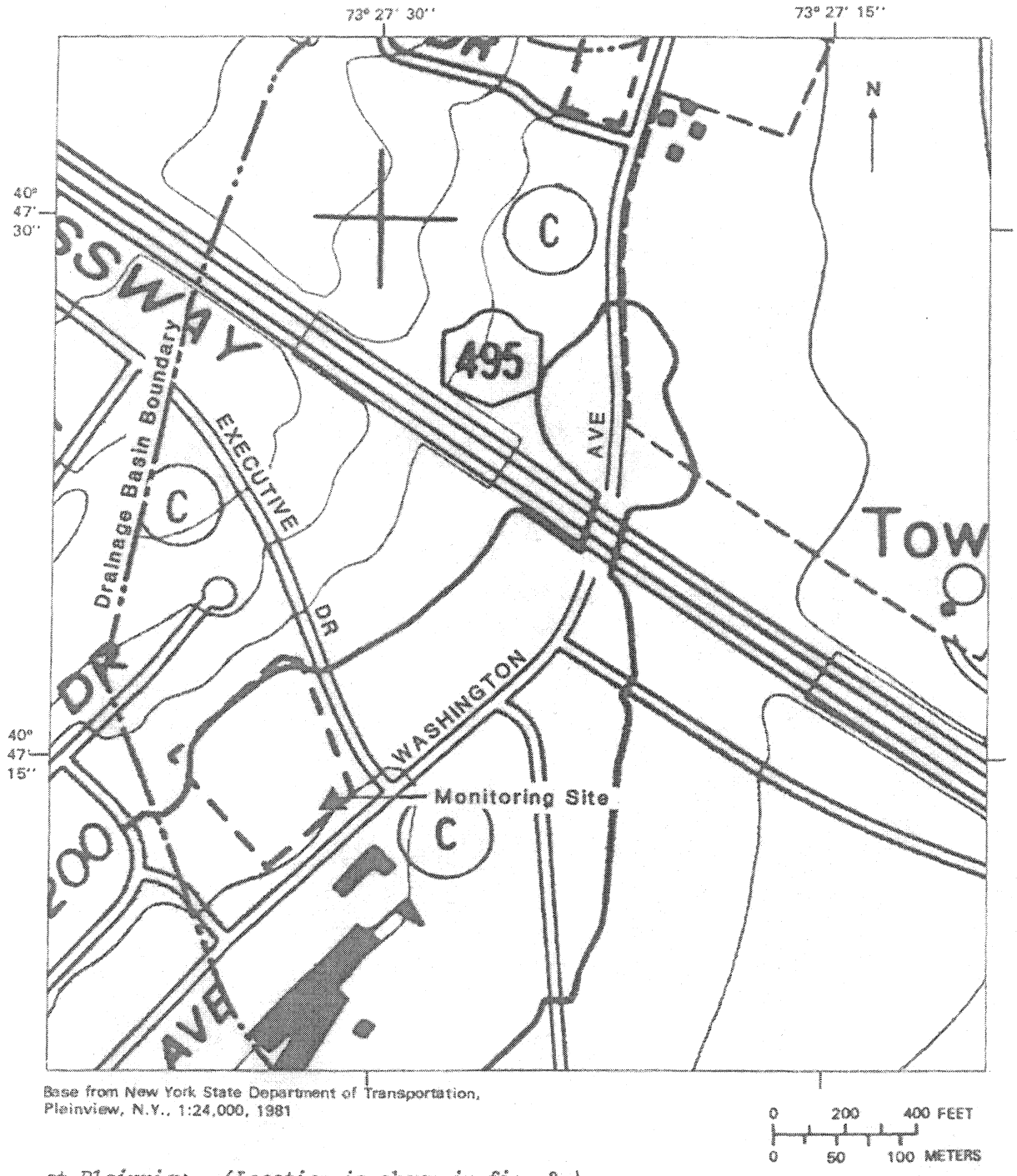
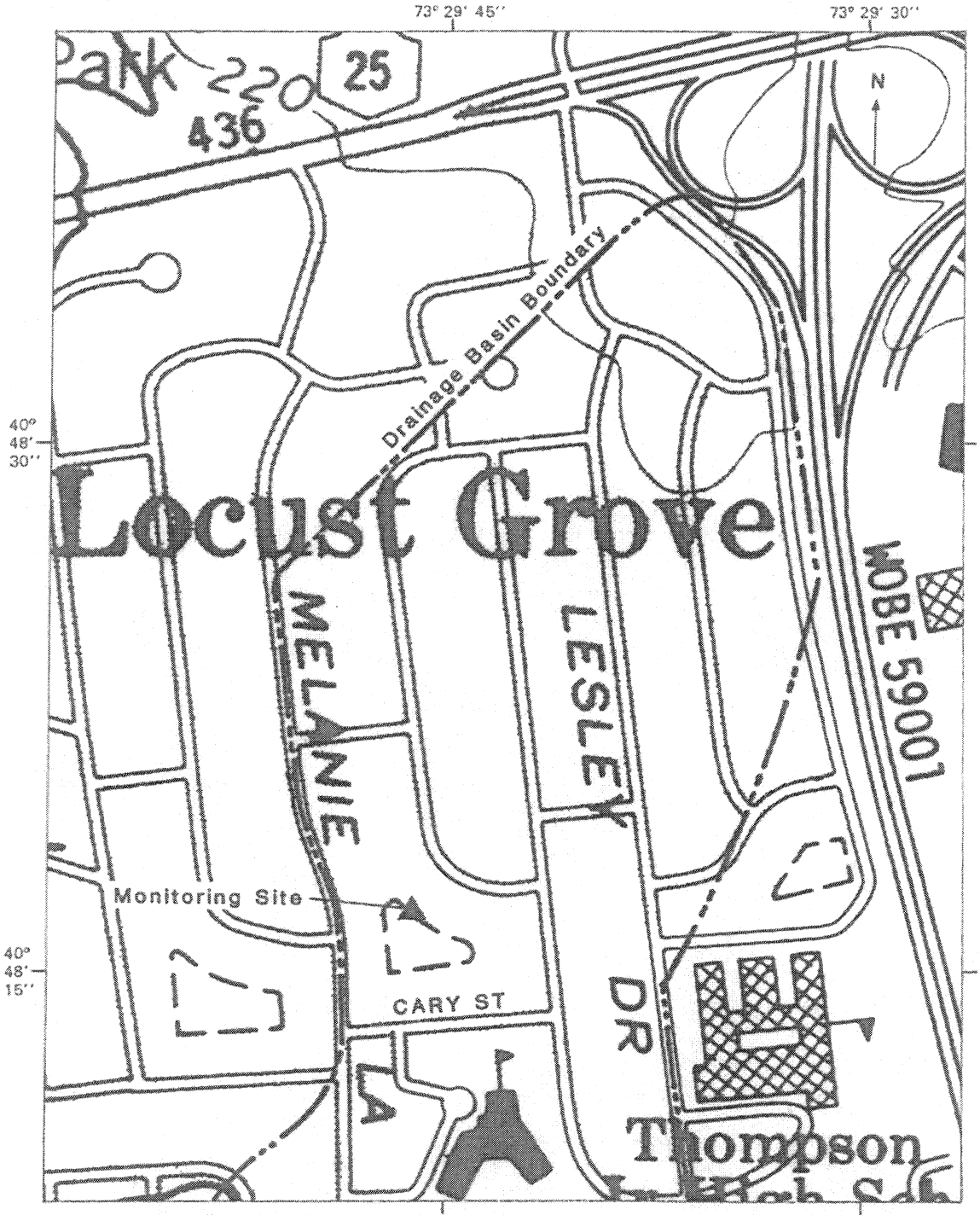



*Figure 5D.--Aerial photograph and map of drainage area*




*at Plainview. (Location is shown in fig. 2.)*

*Figure 5E.--Aerial photograph and map of drainage area*




Base from New York State Department of Transportation, Syosset, N.Y., 1:24,000, 1981

*at Syosset. (Location is shown in fig. 2.)*

*Table 2.--Physical characteristics of recharge basins studied.*

[Photographs and maps of drainage areas are given in figs. 5A-5E.]

| Site location and local basin number | Land use | Drainage area: Total (acres) | Drainage area: Impervious area (acres) | Drainage area: Impervious area (percent) | Soil type[1] | Approximate depth to water table (ft) | Remarks |
|---|---|---|---|---|---|---|---|
| Centereach NYSDOT-ERB2[2] | Strip commercial | 69 | 5.8 | 7.1 | Dukes sand | 39 | Constructed with impervious liner to hold water at all times |
| Huntington private | Shopping mall, parking lot | 35 | 35 | 100 | Sassafrass loam | 66 | Always contains water |
| Laurel Hollow NCDPW-566[3] | Low density residential[4] | 100 | 4.7 | 4.7 | Haven loam | 22 | Basin is newly constructed (1979) |
| Plainview NYSDOT-66 | Major highway | 190 | 12 | 6.3 | Haven loam | 58 | Heavy vegetation in basin |
| Syosset NCDPW-377 | Medium density residential[5] | 28 | 6.3 | 23 | Hempstead loam | 78 | Heavy vegetation in basin |

[1] Classification from Lounsbury and others (1928)
[2] New York State Department of Transportation
[3] Nassau County Department of Public Works
[4] 1-acre zoning
[5] 1/4-acre zoning

## SAMPLE COLLECTION AND DATA MANAGEMENT

This study was designed to collect a large quantity of storm-related data to define the type and quantity of contaminants in stormwater runoff and their effect on the quality of ground water beneath Long Island's recharge basins. The five recharge basins were instrumented to collect samples of precipitation, stormwater inflow into the basins, and stormwater that had infiltrated the basin floor and the unsaturated zone to become ground water.

### Sampling Equipment

A schematic diagram of the instrumentation at each of the five sites is shown in figure 6.

#### *Precipitation Measurement*

Precipitation was measured by a tipping-bucket rain gage manufactured by Weathertronics, Inc.[1], and recorded on 16-channel digital tape at 5-minute intervals by a Stevens recorder. Precipitation was collected in a large, plastic-lined bucket placed outside the instrument housing for the duration of

[1] Use of brand names is for identification only and does not imply endorsement by the U.S. Geological Survey.

the storm. In this way, information on precipitation quantity, quality, and intensity was collected during each storm.

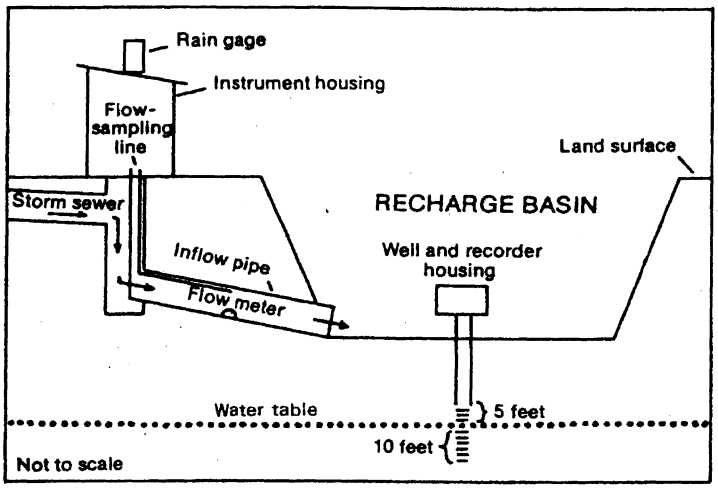



*Figure 6.*

*Schematic diagram of instrumentation at each recharge basin.*

*Stormwater and Ground-Water Measurement*

The quantity of stormwater inflow to the recharge basins was measured with a Marsh-McBirney velocity-modified flow meter, model 250, and was recorded on 16-channel paper tape at 5-minute intervals by a Stevens digital recorder. The flow rate was also recorded on a 7-day circular chart that is an integral part of the flow meter. Both devices record flow as a percentage of a user-determined maximum.

Stormwater was sampled from the storm-sewer line by a Manning S-6000 stationary discrete sampler. This sampler draws 1 liter of water through a vacuum line and discharges it into bottles in an attached refrigerated compartment. The sampler can be programmed to collect samples automatically at predetermined volume or time intervals, or it can be activated manually. This equipment allowed for the collection of data on total flow volume, flow rate, and stormwater quality.

A well in or adjacent to each recharge basin was equipped with a Stevens Type F water-level recorder that indicated when the stormwater reached the water table. Subsequent pumping and (or) bailing of the well provided samples for water-quality analysis.

Flow-meter calibration.--The flow meter is factory-calibrated for flow velocities up to 20 ft/s. The performance of each flow meter was field-calibrated against discharge measurements determined by the dye-dilution method described by Cobb and Bailey (1965). The dye used was rhodamine WT. Discharge can be computed from the following equation:

$$Q = \frac{C_1 - C_2}{C_2 - C_b} \, q$$

where: Q is discharge of stream,
q is rate of flow of injected dye solution,
$C_b$ is background concentration of dye in the stream,
$C_1$ is dye concentration of the solution injected into the stream, and
$C_2$ is measured concentration of dye in stream water during injection.

The flow meters at all basins but Huntington were calibrated. The Huntington basin, adjacent to a shopping center, is clogged and always contains water. Because the outfall pipe is always submerged, collection of dye samples at the outlet is impossible. For this reason, as well as the associated reverse flow within the pipe, this flow meter was not calibrated, and the discharges recorded at the Huntington site are assumed to be inaccurate and lower than the actual discharges.

Comparison of discharge-measurement results.--A comparison of discharge measurements made by dye-dilution methods with those made by the flow meter is given in table 3 and figure 7. The correlation coefficient relating all

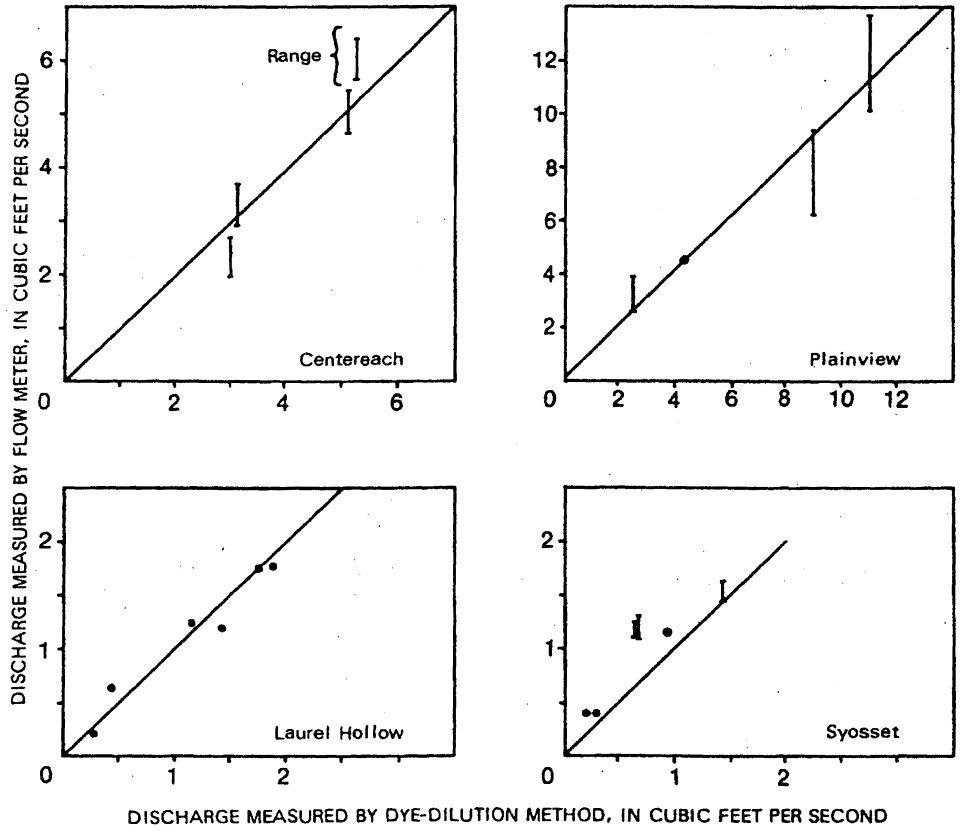



*Figure 7.--Relationship between discharge measured simultaneously by flow meter and by dye-dilution method at Centereach, Plainview, Laurel Hollow, and Syosset. (The 45° line through origin represents points at which measurements by both methods would be equal.) Explanation of ranges is given in table 3, footnote 1.*

discharge measurements obtained by dye dilution with the closer flow-meter discharge measurements is 0.997; the correlation coefficient relating dye-dilution measurements with the other flow-meter discharge measurements is 0.968. Correlation coefficients for each individual flow meter, although not statistically significant owing to the small number (4 to 6) of data points, range from 0.932 (Syosset) to 0.999 (Plainview) for the closer measurements, and from 0.843 (Centereach) to 0.920 (Syosset) for the other measurements.

Although the maximum recorded discharge at each site was greater than the maximum discharge for which the flow meter was calibrated, the plots in figure 7 show a general linearity in the relationship between results of the two measurement methods. The scatter of data points is probably due to a combination of rapid flow fluctuations and the delayed response of the flow meter to changes in flow velocity.

*Table 3.--Comparison of flow measurements recorded by flow meter with measurements obtained by dye-dilution methods.*

[Site locations are shown in fig. 2.]

| Basin | Stormwater Inflow ($ft^3/s$) | | |
|---|---|---|---|
| | Flow meter | | |
| | Start | Finish | Dye dilution |
| Centereach[1] | 5.77 | 6.55 | 5.23 |
| | 4.60 | 5.40 | 5.10 |
| | 3.08 | 3.85 | 3.11 |
| | 1.92 | 2.69 | 3.00 |
| Huntington[2] | -- | -- | -- |
| Laurel Hollow | -- | 1.76 | 1.79 |
| | | 1.69 | 1.67 |
| | | 1.26 | 1.45 |
| | | 1.32 | 1.20 |
| | | 0.73 | 0.43 |
| | | 0.22 | 0.25 |
| Plainview[1] | 10.8 | 13.9 | 11.2 |
| | 6.19 | 9.28 | 9.10 |
| | 4.64 | 4.64 | 4.57 |
| | 2.63 | 3.87 | 2.52 |
| Syosset[1] | | 0.39 | 0.29 |
| | 1.08 | 1.23 | 0.69 |
| | | 0.39 | 0.24 |
| | 1.46 | 1.62 | 1.45 |
| | | 1.15 | 0.93 |
| | 1.10 | 1.20 | 0.68 |

[1] Sampling at these sites often requires several minutes; therefore, discharge measurements recorded by the flow meter at both the start and the end of the dye sampling are listed.

[2] Dye samples cannot be collected at this basin because it always contains water, and the outflow pipe is constantly submerged.

Because the correlation coefficient between the discharge measurements obtained from the flow meter and from dye dilution is high, and because the relationship appears (from the limited number of data points) to be linear, the discharge measurements recorded by the flow meter are used in this report without correction.

## Sample Collection

Stormwater and ground-water samples were collected for analysis for chemical, bacterial, and organic constituents. Constituents included in standard chemical analysis are listed in appendix A; the compounds included in the category of "priority pollutants" are listed in appendix B.

### *Standard Chemicals*

The general procedure for collecting stormwater samples for standard chemical analysis was to collect the first sample when flow first appeared in the sewerline and registered on the circular flow chart and to collect subsequent samples at 10-, 20-, 30-, and 60-minute intervals. Hourly samples were collected thereafter when the flow was continuous. During intermittent flow, an attempt was made to collect samples near hydrograph peaks.

Sampling-well screens were positioned one-third above and two-thirds below the water table. One or two days after each storm, when the infiltrated runoff had produced a water-table mound, ground-water samples were collected from the top of the mound, just beneath the water table, with a submersible pump. The well casing was evacuated a minimum of three times before sampling.

### *Priority Pollutants*

One stormwater and two ground-water samples were collected at each site (except Centereach) for analysis for 113 of the 129 organic compounds designated "priority pollutants" by the U.S. Environmental Protection Agency. At Centereach, one stormwater sample and one ground-water sample were collected.

The stormwater samples were collected manually in a stainless-steel vessel and were poured into 1-liter pretreated glass bottles with Teflon seals. One 1-liter grab sample was collected for every 2,000 gal of stormwater inflow. Therefore, the first 32,000 gal of stormwater runoff into the basins were represented by a sample of 16 liters. One 1-liter, flow-weighted composite stormwater sample was prepared from the 16 grab samples.

Runoff in excess of 32,000 gal was not sampled because stormwater constituent concentrations are generally highest near the beginning of a storm (Wanielista, 1978, p. 240). Sampling in this way produces priority-pollutant constituent concentrations that are adequately representative of the storm, but may err on the conservative (high) side.

Samples of ground water were collected on arbitrarily selected days unrelated to particular storms to obtain information on background levels of priority pollutants. The well casing was evacuated a minimum of three times

with a submersible pump before sampling. Samples to be analyzed for volatile organic compounds were collected in a 40-mL glass vial with a Teflon seal. Other ground-water samples were collected in 1-liter pretreated glass bottles with Teflon seals.

The stormwater sample was sent as a flow-weighted composite; the ground-water sample was a grab sample. These were packaged and preserved as recommended by the U.S. Environmental Protection Agency (Versar, 1980).

### *Bacteria*

Stormwater samples to be analyzed for bacteria were collected on the same schedule as outlined above for standard chemical analysis but were collected manually in sterile bottles. They were delivered to the appropriate laboratory as described below within hours after the cessation of flow. Ground-water samples to be analyzed for bacteria (total coliforms, fecal coliforms, and fecal streptococci) were collected 1 or 2 days after the rainfall after the well casing had been evacuated a minimum of three times and after all other samples were collected.

## Sample Handling

### *Standard Chemicals*

Samples collected for standard chemical analysis (appendix A) were kept chilled at all times, including transport from the field to the laboratory. Each 1-liter sample was split into 10 parts, from which the analyses were performed. Split samples were packed with ice and sent to the U.S. Geological Survey Laboratory in Doraville, Ga., for analysis.

### *Priority Pollutants*

Ground-water and stormwater samples collected for priority pollutant analysis (appendix B) were sent overnight to one of several laboratories across the United States approved by the USEPA for analysis for organic compounds. Stormwater-runoff samples were submitted as flow-weighted composites. Samples were collected and preserved in accordance with guidelines defined by the USEPA (Versar, 1980).

### *Bacteria*

Bacteria samples were kept chilled in the field and during transport to the Nassau County Health Department Laboratory, where they were analyzed for total coliform, fecal coliform, and fecal streptococci bacteria within 24 hours of collection.

## Data Reduction

Discharge and precipitation data recorded on 16-channel digital tape were reduced to an individual hydrograph and hyetograph for each storm through a BASIC computer program written for a Tektronix 4051 graphic system.

Discharge was graphed in 5-minute increments, while rainfall was graphed in 15-minute increments. The program also calculated total rainfall, total runoff volume, and the runoff volume associated with each stormwater-quality sample.

### Data Storage

Each sampling site was assigned a station-identification number consisting of 15 digits. The first 13 digits represent the latitude and longitude of the sampling location; the last two digits, also called the sequence number, indicate the type of sample collected, such as stormwater, precipitation, or ground water. All data pertaining to stormwater at a given site, whether flow or water quality, use the same station number.

All data are stored in the U.S. Geological Survey National Water Data Storage and Retrieval System (WATSTORE) and in the U.S. Environmental Protection Agency Computerized Storage and Retrieval of Water Quality Data System (STORET). They can be retrieved from either system through the station numbers listed in appendix C.

## CHARACTERISTICS OF SAMPLED STORMS

A total of 46 storms was sampled at the five recharge basins. The choice of storms was based on seasonal distribution and an attempt to sample storms of varying intensity and duration.

Table 4 shows the number of storms sampled at each site during each season. Fewer storms were sampled during summer because thunderstorms are typically difficult to predict and are often of short duration.

Characteristics of each storm are summarized in table 5. These include precipitation duration, total precipitation, maximum intensity (maximum precipitation during a 15-minute period), total runoff, and number of antecedent dry days. (A dry day is defined as a day with less than 0.1 inches of precipitation.)

The storms sampled differed widely in duration and total precipitation. Duration ranged from 2 hours to 26 hours; precipitation ranged from 0.20 inches to 4.84 inches. Other storms during the study were of shorter duration

*Table 4.--Number of storms sampled per site, by season, 1980-82.*
[Locations are shown in fig. 2]

| | Site | | | | | |
|---|---|---|---|---|---|---|
| Season | Centereach | Huntington | Laurel Hollow | Plainview | Syosset | Total |
| autumn | 0 | 2 | 3 | 5 | 3 | 13 |
| winter | 2 | 4 | 3 | 4 | 0 | 13 |
| spring | 4 | 5 | 2 | 0 | 3 | 14 |
| summer | 0 | 1 | 1 | 1 | 3 | 6 |
| Total | 6 | 12 | 9 | 10 | 9 | 46 |

*Table 5.--Characteristics of sampled storms, 1980-82.*
[Locations are shown in fig. 2]

| Date | Site | Duration (hours) | Precipitation (in) | Maximum intensity (in/15 min) | Total runoff ($ft^3$) | Number of antecedent dry days (<0.1 in) |
|---|---|---|---|---|---|---|
| 9-18-80 | Plainview | 7 | 0.64 | 0.12 | 1,390 | 2 |
| | Huntington | 7 | .59 | .08 | [c]3,330 | 2 |
| 10-25-80 | Syosset | 7 | 1.67 | .12 | 12,300 | 5 |
| | Huntington | 9 | 1.36 | .12 | [a]-- | 5 |
| | Plainview | 8 | 1.51 | .11 | 27,600 | 5 |
| 11-18-80 | Laurel Hollow | 7 | .93 | .09 | 2,140 | 7 |
| | Plainview | 7 | .78 | .08 | 21,800 | 7 |
| 11-24-80 | Laurel Hollow | 11 | 1.48 | .33 | 7,570 | 5 |
| | Plainview | 11 | 1.37 | .17 | 55,100 | 5 |
| 12- 9-80 | Laurel Hollow | 6 | .20 | .04 | 121 | 1 |
| | Plainview | 6 | .20 | .04 | 112 | 1 |
| 12-30-80 | Plainview[a] | -- | -- | -- | -- | 1 |
| 2- 1-81 | Laurel Hollow | 18 | .85 | .06 | 6,070 | 14 |
| | Plainview | 6 | .75 | .06 | 26,500 | 14 |
| 2-11-81 | Plainview | 7 | .52 | .23 | 28,300 | 2 |
| 2-19-81 | Huntington | 22 | 1.49 | .15 | [c]17,200 | 6 |
| | Laurel Hollow | 22 | 1.80 | .06 | 10,300 | 6 |
| 2-23-81 | Huntington | 7 | .75 | .05 | [c] 6,860 | 1 |
| | Laurel Hollow | 8 | .82 | .13 | 3,940 | 1 |
| 3-30-81 | Huntington | 6 | [b] .49 | | [c] 9,230 | 12 |
| | Laurel Hollow | 6 | .40 | .04 | 1,000 | 12 |
| 4-14-81 | Huntington | 8 | [b]1.03 | | [c] 4,610 | 4 |
| | Syosset | 9 | 1.04 | .09 | 10,400 | 4 |
| 4-23-81 | Huntington | 4 | [b] .73 | .32 | [c] 650 | 8 |
| | Syosset | 8 | .98 | .32 | 9,794 | 8 |
| 5-11-81 | Huntington | [b]12 | [b]0.27 | | [c]10,500 | 6 |
| | Laurel Hollow | 13 | .26 | 0.04 | 611 | 6 |
| 5-29-81 | Huntington | | [b] .86 | | [c]21,900 | 11 |
| | Syosset | 6 | .44 | .15 | 11,400 | 11 |
| 7- 3-81 | Laurel Hollow | 2 | .88 | .26 | [c] 3,040 | 1 |
| 7-20-81 | Huntington | [b] 3 | [b] .95 | | [c]15,400 | 13 |
| | Syosset | [b]13 | [b] .85 | | 11,200 | 13 |
| 7-29-81 | Syosset | 2 | .18 | .09 | 1,640 | 1 |
| 9- 8-81 | Plainview | 3 | .69 | .23 | 21,800 | 7 |

- continued -

[a] equipment failure
[b] estimated from records from nearby precipitation gages
[c] recorded discharges--assumed to be lower than actual discharges

*Table 5.--Characteristics of sampled storms, 1980-82.--continued*

| Date | Site | Duration (hours) | Precipitation (in) | Maximum intensity (in/15 min) | Total runoff ($ft^3$) | Number of antecedent dry days (<0.1 in) |
|---|---|---|---|---|---|---|
| 9-15-81 | Huntington | [b]24 | 1.65 | | [c]112,000 | 6 |
| | Syosset | 26 | 1.77 | .10 | 31,600 | 6 |
| 12- 1-81 | Syosset | 11 | 1.12 | .12 | 33,900 | 10 |
| 12-15-81 | Syosset | 13 | 1.98 | .04 | 27,600 | 0.4 |
| 1-23-82 | Huntington | 5 | 1.33 | .18 | [c,d]56,900 | |
| 2- 2-82 | Plainview | 8 | 1.32 | .08 | 80,600 | 1 |
| 3- 4-82 | Centereach | 5 | .84 | .12 | 27,500 | 12 |
| 3-16-82 | Centereach | 3 | .65 | .07 | 7,750 | 2 |
| 4-26-82 | Centereach | 6 | [b]1.89 | | [b]31,800 | 8 |
| 6- 1-82 | Centereach | 4 | 1.55 | .25 | 57,700 | 2 |
| 6- 5-82 | Centereach | 16 | 4.84 | .24 | 191,000 | 2 |
| 6-16-82 | Centereach | 2 | .45 | .18 | 19,100 | 1 |

[b] estimated from records from nearby precipitation gages
[c] recorded discharges--assumed to be lower than actual discharges
[d] including snowmelt

and had less precipitation; these were not sampled because storms having less than 0.2 inches of continuous precipitation generally do not produce significant runoff. Because the storm characteristics differ so widely, extreme caution must be used in making comparisions between storms.

Table 6 lists the source and number of samples collected at each site as part of the conventional (other than priority pollutant) sampling program and the type of analyses performed. A total of 750 analyses was made. Precipitation was sampled for standard chemical analysis (appendix A) during each storm at each site; stormwater runoff and ground water were sampled both for bacteria and standard chemical analysis. In addition, the pond at Centereach was sampled for bacteria several days after a storm to obtain information on the effect of pond-residence time on the bacteria count.

A separate metals analysis requested by the USEPA was done on five stormwater-runoff samples from the Huntington basin during the storm of May 11, 1981. These grab samples were analyzed for concentrations of 29 metals; the results are given in Versar, Inc. (1982).

The types of samples collected for priority-pollutant analysis are listed in table 7. One stormwater sample was collected at each site, and two ground-water samples were collected at each site except Centereach, where only one was obtained.

*Table 6.--Source and type of sample, and number of each type of analysis performed.*

[P = precipitation  GW = ground water  S = standard chemical analysis  M = metals analysis]
RO = stormwater runoff  PD = ponded water  B = bacteria analysis

[Dashes indicate that no samples were collected]

| Date | Site and type of sample | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Centereach | | | | Huntington | | | Laurel Hollow | | | Plainview | | | Syosset | | |
| | P | RO | GW | PD | P | RO | GW | P | RO | GW | P | RO | GW | P | RO | GW |
| 9-18-80 | -- | -- | -- | -- | 1S | 5B, 5S | 1B,1S | -- | -- | -- | 1S | 4B, 5S | 1B,1S | -- | -- | -- |
| 10-25-80 | -- | -- | -- | -- | 1S | 7B, 7S | 1B,1S | -- | -- | -- | 1S | 9B, 9S | 1B,1S | 1S | 7B, 7S | 1B,1S |
| 11-18-80 | -- | -- | -- | -- | -- | -- | -- | 1S | 10B,10S | 1B,2S | 1S | 9B, 9S | 1B,2S | -- | -- | -- |
| 11-24-80 | -- | -- | -- | -- | -- | -- | -- | 1S | 10B, 9S | 1B,2S | 1S | 7B, 9S | 1B,2S | -- | -- | -- |
| 12-09-80 | -- | -- | -- | -- | -- | -- | -- | 1S | 2B, 2S | 1B,2S | 1S | 2B, 2S | 1B,2S | -- | -- | -- |
| 12-30-80 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1S | 3B, 3S | 2S | -- | -- | -- |
| 02-02-81 | -- | -- | -- | -- | -- | -- | -- | 1S | 15B,10S | 2B,1S | 1S | 12B,12S | 2B,1S | -- | -- | -- |
| 02-11-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1S | 9B, 9S | 2B,2S | -- | -- | -- |
| 02-20-81 | -- | -- | -- | -- | 1S | 13B,13S | 2B,2S | 1S | 12B,15S | 2B,2S | -- | -- | -- | -- | -- | -- |
| 02-23-81 | -- | -- | -- | -- | 1S | 7B, 7S | 1B,2S | 1S | 9B, 9S | 2B,2S | -- | -- | -- | -- | -- | -- |
| 03-30-81 | -- | -- | -- | -- | 1S | 7B, 7S | 1B,1S | 1S | 6B, 6S | 1B,1S | -- | -- | -- | -- | -- | -- |
| 04-14-81 | -- | -- | -- | -- | 1S | 6B, 6S | 1B,1S | -- | -- | -- | -- | -- | -- | 1S | 7B, 7S | 1B,1S |
| 04-23-81 | -- | -- | -- | -- | 1S | 6B, 6S | 1S | -- | -- | -- | -- | -- | -- | 1S | 8B, 8S | 1S |
| 05-11-81 | -- | -- | -- | -- | -- | 5B,5S,5M | 2B,2S | 1S | 4B, 4S | 2B,2S | -- | -- | -- | -- | -- | -- |
| 05-29-81 | -- | -- | -- | -- | 1S | 8B, 9S | -- | -- | -- | -- | -- | -- | -- | 1S | 5B, 5S | -- |
| 07-03-81 | -- | -- | -- | -- | -- | -- | -- | 1S | 2S | -- | -- | -- | -- | -- | -- | -- |
| 07-20-81 | -- | -- | -- | -- | 1S | 6B,6S | 1B,1S | -- | -- | -- | -- | -- | -- | 1S | 8B, 8S | 1S |
| 07-29-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1S | 3B, 3S | -- |
| 09-08-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1S | 6B, 6S | 1S | -- | -- | -- |
| 09-15-81 | -- | -- | -- | -- | 1S | 5B, 5S | 1B,1S | -- | -- | -- | -- | -- | -- | 1S | 6B, 6S | 1B,1S |
| 12-01-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1S | 7B, 7S | 1B,1S |
| 12-15-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1S | 12B, 5S | 1B,1S |
| 01-23-82 | -- | -- | -- | -- | 1S | 7S | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 02-02-82 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1S | 12B,12S | 1B,1S | -- | -- | -- |
| 03-04-82 | -- | 6B,5S | 1B,1S | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 03-16-82 | 1S | 4B,3S | 1B | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 04-26-82 | 1S | 7B,7S | 1B,1S | 5B | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 06-01-82 | -- | 6B,6S | 1B,1S | 1B | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 06-05-82 | 1S | 8S | 1S | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 06-16-82 | -- | 4B,4S | 1B,1S | 1B | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

*Table 7.--Source of samples collected for priority-pollutant analysis.*

| Site | Date | Sample source |
|---|---|---|
| Centereach | 4-26-82 | storm water |
| | 4-27-82 | ground water |
| Huntington | | |
| | 3-30-81 | storm water |
| | 5- 7-81 | ground water |
| | 9-28-81 | ground water |
| Laurel Hollow | 3-30-81 | storm water |
| | 5- 7-81 | ground water |
| | 9-28-81 | ground water |
| Plainview | 2-11-81 | storm water |
| | 5- 7-81 | ground water |
| | 9-28-81 | ground water |
| Syosset | 4-14-81 | storm water |
| | 5- 7-81 | ground water |
| | 9-28-81 | ground water |

## MODIFIED RUNOFF/PRECIPITATION RELATIONSHIP

Long Island's soil in general consists of medium- to fine-grained sand and therefore has a high infiltration rate. Seaburn (1969) showed that during the predevelopment period (1937-43) at the East Meadow Brook drainage basin, in south-central Nassau County, runoff represented only 5 to 6 percent of precipitation, which indicates rapid infiltration with little or no overland runoff during most storms.

The runoff values used in computing the modified runoff/precipitation ratios for all storms at each site in this study were obtained by dividing the runoff volume by the contributing impervious-surface area to determine runoff, in inches. The contributing impervious surface area was used instead of the topographic area, which is normally used, because (1) the topographic drainage area does not necessarily coincide with the storm-sewer drainage network, and (2) most, if not all, runoff during a typical storm consists of precipitation falling on impervious surfaces.

The median and range of the modified runoff/precipitation ratio (based on impervious surface area) for each of the five sampling sites are given in table 8; the modified runoff/precipitation ratios are given in table 9. A ratio of 100 percent or less indicates that all runoff is from precipitation falling directly on impervious surfaces. A ratio greater than 100 percent indicates overland runoff from pervious surfaces as well. The median modified runoff/precipitation ratios in table 8 show that most of the runoff into the recharge basins was derived from rain falling directly on impervious surfaces. In other words, little or no overland runoff occurred during most storms.

*Table 8.--Median and range of modified runoff/precipitation ratio, in percent.*

| Basin | Minimum | Median | Maximum |
|---|---|---|---|
| Centereach | 57 | 170 | 202 |
| Huntington | >0.7 | >13 | >53 |
| Laurel Hollow | 14 | 25 | 42 |
| Plainview | 5 | 78 | 140 |
| Syosset | 32 | 59 | 114 |

Theoretically, the Huntington site should always have a modified runoff/precipitation ratio of 100 percent because its drainage area is 100 percent impervious. Table 8, however, shows low ratios for the Huntington basin. This is probably attributable to three factors: (1) inaccurate flow data due to reverse flow in the inflow pipe, where the electromagnetic flow sensor is located; (2) possible exfiltration of runoff through manholes and storm-sewer lines before reaching the basin; and (3) possible storage and subsequent evaporation of stormwater from depressions in the drainage area.

With the exception of the Huntington basin, the lowest modified median runoff/precipitation ratio (25) was at Laurel Hollow, the low-density residential area. At Syosset, the medium-density residential area, the ratio was higher (44), and at Plainview, the predominantly paved highway area, the ratio was still higher (69).

The strip-commercial area at Centereach has high modified runoff/precipitation ratios, which may in part reflect unaccounted-for rooftop, parking, and side-street areas that may drain into the recharge basin. In addition, three of the six storms sampled at Centereach had precipitation in excess of 1.5 inches. (See table 5 for detailed storm characteristics.) During such storms, overland runoff would be significant.

Log-log plots of precipitation against runoff at each of the five sampling sites are given in figure 8. Despite the large degree of scatter, a linear relationship is evident, which is especially close in the plots for Laurel Hollow and Centereach. The scatter may be due to such factors as seasonal effects, storm duration and intensity, number of antecedent dry days, and basin slope. The small number of data points also contributes to the poor correlation.

According to the graphs in figure 8, the following amounts of runoff are derived from 1 inch of precipitation:

| | | | |
|---|---|---|---|
| Centereach | 1.7 inches | Plainview | 0.82 inches |
| Huntington | .13 inches | Syosset | .60 inches. |
| Laurel Hollow | .28 inches | | |

These data correlate reasonably well with the median values given in table 8, for reasons outlined above, and show that, in most instances, for 1 inch of precipitation, all runoff can be accounted for by the precipitation that falls directly on impervious surfaces. However, overland runoff from pervious surfaces may occur during storms of high intensity or long duration.

*Table 9.--Precipitation, runoff, and modified runoff/*

*[Locations are shown in fig. 2; dashes*

| Date | Centereach | | | | Huntington | | | | Laurel |
|---|---|---|---|---|---|---|---|---|---|
| | Precipitation (in) | Runoff ($ft^3$) | Runoff (in) | Runoff/Precipitation (percent) | Precipitation (in) | Runoff[a] ($ft^3$) | Runoff[a] (in) | Runoff/Precipitation (percent)[a] | Precipitation (in) |
| 9-18-80 | -- | -- | -- | -- | 0.59 | 3,330 | 0.03 | 4 | -- |
| 10-25-80 | -- | -- | -- | -- | 1.36 | --[b] | --[b] | --[b] | -- |
| 11-18-80 | -- | -- | -- | -- | -- | -- | -- | -- | 0.93 |
| 11-24-80 | -- | -- | -- | -- | -- | -- | -- | -- | 1.48 |
| 12- 9-80 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 12-30-80 | -- | -- | -- | -- | -- | -- | -- | -- | .20 |
| 2- 1-81 | -- | -- | -- | -- | -- | -- | -- | -- | .85 |
| 2-11-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 2-19-81 | -- | -- | -- | -- | 1.49 | 17,200 | .14 | 9 | 1.80 |
| 2-23-81 | -- | -- | -- | -- | .75 | 6,860 | .05 | 7 | .82 |
| 3-30-81 | -- | -- | -- | -- | [a] .49 | 9,230 | .07 | 14 | .40 |
| 4-14-81 | -- | -- | -- | -- | [a]1.03 | 4,610 | .03 | 3 | -- |
| 4-23-81 | -- | -- | -- | -- | [a] .73 | 650 | .005 | .7 | -- |
| 5-11-81 | -- | -- | -- | -- | [a] .27 | 10,500 | .08 | 30 | .26 |
| 5-29-81 | -- | -- | -- | -- | .86 | 21,900 | .17 | 20 | -- |
| 7- 3-81 | -- | -- | -- | -- | -- | -- | -- | -- | .88 |
| 7-20-81 | -- | -- | -- | -- | .95 | 15,400 | .12 | 13 | -- |
| 7-29-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 9- 8-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 9-15-81 | -- | -- | -- | -- | 1.65 | 112,000 | .88 | 53 | -- |
| 12- 1-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 12-15-81 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 1-23-82 | -- | -- | -- | -- | 1.33 | 56,900 | .45 | 34 | -- |
| 2- 2-82 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 3- 4-82 | 0.84 | 27,500 | 1.3 | 166 | -- | -- | -- | -- | -- |
| 3-16-82 | .65 | 7,750 | .37 | 57 | -- | -- | -- | -- | -- |
| 4-26-82 | [a]1.89 | [a]31,800 | 1.5 | 79 | -- | -- | -- | -- | -- |
| 6- 1-82 | 1.55 | 57,700 | 2.7 | 174 | -- | -- | -- | -- | -- |
| 6- 5-82 | 4.84 | 191,000 | 9.0 | 186 | -- | -- | -- | -- | -- |
| 6-16-82 | .45 | 19,100 | .91 | 202 | -- | -- | -- | -- | -- |

[a] estimated
[b] equipment failure

*recipitation ratio for sampled storms, 1980-82.*

*ndicate that no samples were collected]*

| ollow | | | Plainview | | | | Syosset | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Runoff | | Runoff/ Precipitation (percent) | Precipitation (in) | Runoff | | Runoff/ Precipitation (percent) | Precipitation (in) | Runoff | | Runoff/ Precipitation (percent) |
| ($ft^3$) | (in) | | | ($ft^3$) | (in) | | | ($ft^3$) | (in) | |
| -- | -- | -- | 0.64 | 1,390 | 0.03 | 5 | -- | -- | -- | -- |
| -- | -- | -- | 1.51 | 27,600 | .63 | 42 | 1.67 | 12,300 | 0.53 | 32 |
| 2,140 | 0.14 | 14 | .78 | 21,800 | .51 | 65 | -- | -- | -- | -- |
| 7,570 | .44 | 30 | 1.37 | 55,100 | 1.27 | 93 | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| trace | trace | | .20 | trace | trace | -- | -- | -- | -- | -- |
| 6,070 | .36 | 42 | .75 | 26,500 | .62 | 83 | -- | -- | -- | -- |
| -- | -- | -- | .52 | 28,300 | .66 | 127 | -- | -- | -- | -- |
| 10,300 | .61 | 34 | -- | -- | -- | -- | -- | -- | -- | -- |
| 3,940 | .25 | 30 | -- | -- | -- | -- | -- | -- | -- | -- |
| 1,000 | .06 | 15 | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | 1.04 | 10,400 | .45 | 43 |
| -- | -- | -- | -- | -- | -- | -- | .98 | 9,790 | .43 | 44 |
| 611 | .04 | 15 | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | .44 | 11,400 | .50 | 114 |
| 3,040 | .18 | 20 | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | .85 | 11,200 | .50 | 59 |
| -- | -- | -- | -- | -- | -- | -- | .18 | 1,640 | .07 | 39 |
| -- | -- | -- | .69 | 21,800 | .50 | 73 | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | 1.77 | 31,600 | 1.40 | 79 |
| -- | -- | -- | -- | -- | -- | -- | 1.79 | 33,900 | 1.48 | 83 |
| -- | -- | -- | -- | -- | -- | -- | 1.98 | 27,600 | 1.21 | 61 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | 1.32 | 80,600 | 1.86 | 140 | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

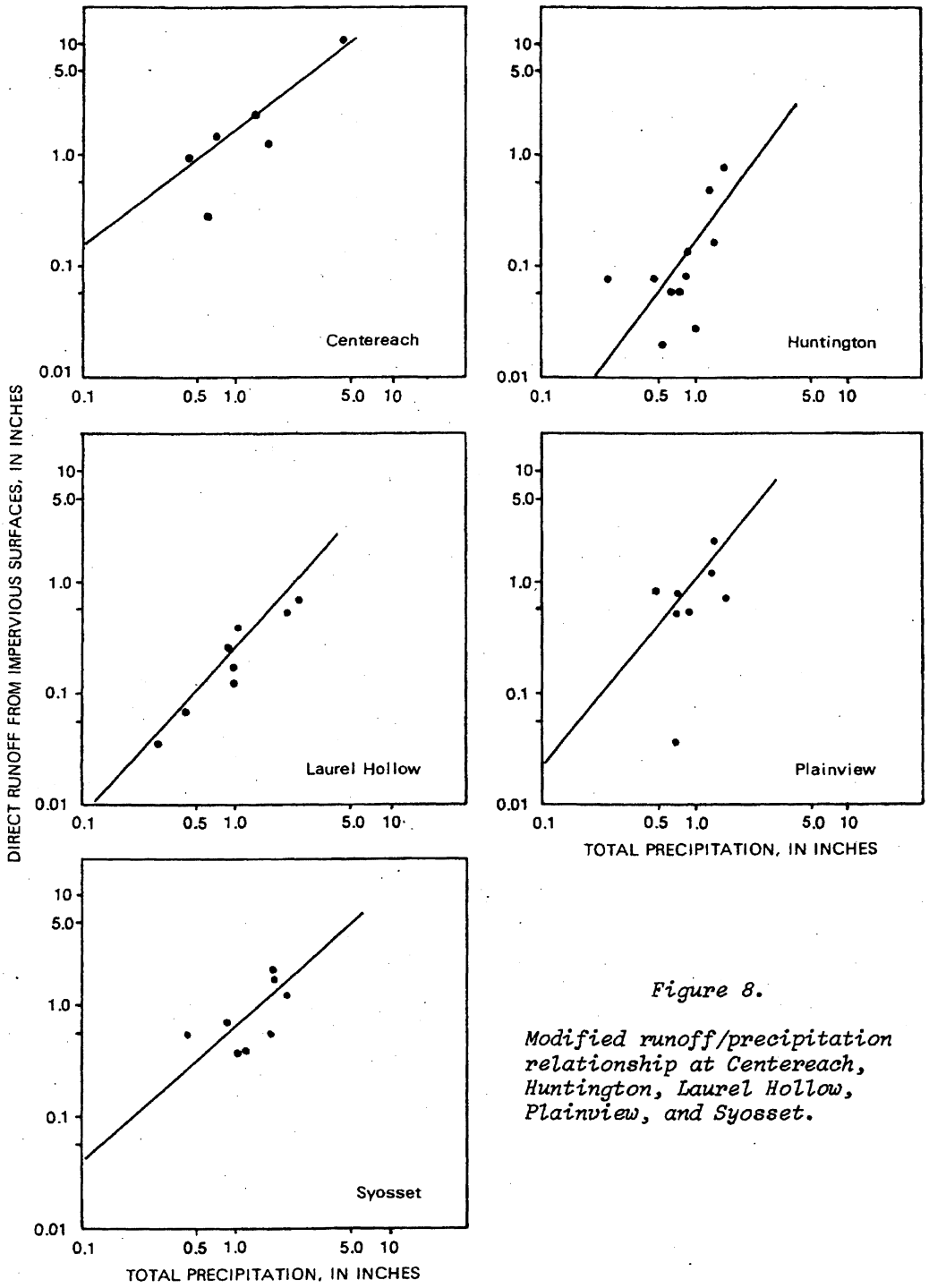



*Figure 8.*

*Modified runoff/precipitation relationship at Centereach, Huntington, Laurel Hollow, Plainview, and Syosset.*

## RELATIONSHIP OF STORMWATER QUALITY TO GROUND-WATER QUALITY

### Concentration of Selected Constituents

Median values of selected physical and chemical characteristics of stormwater, ground water, and precipitation for all storms sampled during 1980-82 at each of the five basins are given in table 10.

*Standard Chemicals*

The data in table 10 indicate that, in general, concentrations of most chemical constituents referred to herein as "standard chemicals" were relatively low and were within the standards for potable water. (Standard chemicals are listed in appendix A; State and Federal drinking-water standards are summarized in appendix D.) The exceptions can be related to specific land uses and seasonal effects. For example, the Plainview basin, which receives stormwater runoff from a major highway, had a median lead concentration of 275 µg/L and a maximum concentration of 3,300 µg/L. Chloride concentrations at all basins were generally higher during winter, with a maximum of 1,100 mg/L at Huntington, as a result of the use of salt for road deicing.

Typical hydrographs (discharge as a function of time), hyetographs (rainfall as a function of time), and plots of constituent concentrations as a function of time for each site are shown in figures 9A through 9E (p. 41-45). These graphs indicate a nearly immediate runoff response in storm-sewered areas. The constituent plots show that peak concentrations of lead, chromium, chloride, and total nitrogen coincide with the first runoff peak but not generally with later runoff peaks. This is probably due to the nearly complete removal of pollutants from the streets with the first major surge of water. During a storm of long duration (16 hours) that was sampled at Centereach on June 5, 1982, the chemical quality of the stormwater runoff gradually approached that of the precipitation. Therefore, no attempt was made here to correlate discharge with constituent concentrations because no physical relationship exists between the two.

To investigate the degree of accumulation of standard constituents in snow cover, limited snow sampling was conducted on January 10, 1981 at Huntington, Laurel Hollow, Plainview, and Syosset. The snow was taken from the recharge basin shoulder within 10 ft of the edge.

The samples represent the precipitation accumulated from January 2 through January 10, 1981. Although 6 inches of snow fell on eastern Long Island during this time (table 11, p. 46), the snow was only about 4 inches deep at the time the samples were collected. Between January 2 and January 10, maximum daily temperatures ranged from 27°F to 35°F, and minimum daily temperature ranged from 0°F to 12°F. Therefore, it can be assumed that little or no snowmelt or runoff took place.

The concentrations of most inorganic constituents in snow samples were low (less than 10 mg/L) and were similar to those found in rainfall. A comparison of median concentrations of chromium and lead in snow and in rainfall (table 12, p. 46) indicates no major difference in chromium concentrations, but the lead concentrations were slightly higher in snow at three of the four sites, which may be due to atmospheric fallout over the 8-day period.

*Table 10.--Median values of physical and chemical characteristics of stormwater, ground water, and precipitation.*

[Data collected 1980-82; locations are shown in fig. 2.]

| Site and sample type | Temperature (°C) | Turbidity (NTU)[1] | Color (platinum-cobalt units) | Specific conductance (field) (µmhos)[2] | Specific conductance lab (µmhos) | Coliform, confirmed (MPN)[3] | Coliform, fecal EC broth (MPN) |
|---|---|---|---|---|---|---|---|
| Centereach | | | | | | | |
| surface water | 5.5 | 27.0 | 15.0 | 55.0 | 60 | 4,300 | 2,100 |
| ground water | -- | 5.4 | 2.0 | 104 | 106 | 3 | 3 |
| precipitation | -- | 2.4 | 1.5 | 15.0 | 8 | -- | -- |
| Huntington | | | | | | | |
| surface water | 12.0 | 1.7 | 5.0 | 320 | 286 | 24,000 | 9,300 |
| ground water | 13.0 | .9 | 1.0 | 217 | 247 | 3 | 3 |
| precipitation | -- | .7 | 5.0 | -- | 28 | -- | -- |
| Laurel Hollow | | | | | | | |
| surface water | 9.0 | 13.0 | 30.0 | 60.0 | 56 | 4,300 | 930 |
| ground water | 11.0 | .4 | 1.0 | 61.0 | 57 | 3 | 2 |
| precipitation | -- | .4 | 5.0 | -- | 60 | -- | -- |
| Plainview | | | | | | | |
| surface water | 7.0 | 20.0 | 16.5 | 120 | 106 | 24,000 | 640 |
| ground water | 10.0 | .4 | 0 | 200 | 243 | 3 | 3 |
| precipitation | -- | .5 | 1.5 | -- | 22 | -- | -- |
| Syosset | | | | | | | |
| surface water | 19.0 | 3.6 | 15.0 | 58.5 | 54 | 24,000 | 2,400 |
| ground water | 14.0 | 26.0 | .5 | 104 | 104 | 3 | 3 |
| precipitation | -- | .9 | 1.5 | 42.0 | 27 | -- | -- |

| Site and sample type | Streptococci, fecal (MPN) | Hardness (mg/L as $CaCO_3$) | Biochemical oxygen demand, 5 day (mg/L) | pH field (units) | pH lab (units) | Cadmium, dissolved (µg/L as Cd) | Cadmium, suspended recoverable (µg/L as Cd) |
|---|---|---|---|---|---|---|---|
| Centereach | | | | | | | |
| surface water | 9,300 | 12.0 | -- | 6.8 | 6.7 | 1.0 | 1.0 |
| ground water | 3 | 33.0 | -- | -- | 6.6 | 1.0 | 0 |
| precipitation | -- | 1.0 | -- | -- | 5.8 | 2.0 | .5 |
| Huntington | | | | | | | |
| surface water | 60,500 | 12.0 | 4.5 | 6.7 | 6.7 | 0 | 0 |
| ground water | 3 | 56.0 | 1.0 | 5.4 | 6.1 | 0 | 0 |
| precipitation | -- | 2.5 | -- | -- | 5.7 | 0 | 0 |
| Laurel Hollow | | | | | | | |
| surface water | 2,400 | 14.5 | 7.0 | 7.0 | 6.7 | 0 | 0 |
| ground water | 2 | 15.0 | 2.0 | 6.1 | 6.4 | 0 | 0 |
| precipitation | -- | 2.0 | -- | 6.6 | 5.7 | 0 | .5 |
| Plainview | | | | | | | |
| surface water | 24,000 | 26.0 | 10.0 | 6.9 | 6.8 | 1.0 | 0 |
| ground water | 3 | 40.0 | 2.5 | 6.6 | 6.8 | 1.0 | 0 |
| precipitation | -- | 2.0 | -- | 7.1 | 6.0 | 0 | 0 |
| Syosset | | | | | | | |
| surface water | 24,000 | 15.0 | 9.0 | 6.9 | 6.4 | 1.0 | 1.0 |
| ground water | 3 | 16.5 | 1.0 | 5.1 | 6.0 | 2.5 | 2.5 |
| precipitation | -- | 2.0 | -- | -- | 5.4 | 1.0 | .5 |

[1] Nephelometric Turbidity Unit
[2] micromhos per centimeter at 25°C
[3] MPN, most probable number
-- data unavailable

*Table 10.--Median values of physical and chemical characteristics of stormwater, ground water, and precipitation (continued)*

[Data collected 1980-82; locations are shown in fig. 2.]

| Site and sample type | Cadmium, total recoverable (µg/L as Cd) | Chromium, dissolved (µg/L as Cr) | Chromium, suspended recoverable (µg/L as Cr) | Chromium, total recoverable (µg/L as Cr) | Lead, dissolved (µg/L as Pb) | Lead, suspended recoverable (µg/L as Pb) | Lead, total recoverable (µg/L as Pb) |
|---|---|---|---|---|---|---|---|
| Centereach | | | | | | | |
| surface water | 1.0 | 1.0 | 5.0 | 2.0 | 26.0 | 83.0 | 130 |
| ground water | 1.0 | 1.0 | 0 | 2.0 | 4.0 | 1.0 | 3.5 |
| precipitation | 3.0 | 1.0 | 2.0 | 4.5 | 3.5 | 3.0 | 13.0 |
| Huntington | | | | | | | |
| surface water | 1.0 | 2.0 | 8.0 | 11.0 | 8.0 | 24.5 | 33.0 |
| ground water | 1.0 | 2.0 | 7.5 | 9.0 | 3.0 | 2.0 | 6.0 |
| precipitation | 1.0 | 1.5 | 5.5 | 9.5 | 10.0 | 9.0 | 36.0 |
| Laurel Hollow | | | | | | | |
| surface water | 0 | 3.0 | 10.0 | 13.0 | 4.0 | 15.0 | 19.0 |
| ground water | 1.0 | 3.0 | 9.5 | 13.0 | 0 | 1.0 | 6.0 |
| precipitation | 1.0 | 2.0 | 3.0 | 5.0 | 6.5 | 2.0 | 8.0 |
| Plainview | | | | | | | |
| surface water | 1.0 | 2.0 | 15.0 | 16.0 | 35.0 | 250 | 275 |
| ground water | 1.0 | .5 | 7.0 | 7.0 | 3.5 | 1.0 | 4.0 |
| precipitation | 1.0 | 1.0 | 6.0 | 8.5 | 11.0 | 9.0 | 16.0 |
| Syosset | | | | | | | |
| surface water | 1.0 | 1.0 | 11.0 | 12.0 | 12.5 | 18.0 | 30.0 |
| ground water | 8.5 | 1.0 | 15.0 | 13.0 | 6.0 | 41.0 | 47.0 |
| precipitation | 1.0 | 1.5 | 3.0 | 5.5 | 6.5 | 6.0 | 16.0 |

| Site and sample type | Potassium, dissolved (Pci/L as K40) | Potassium, dissolved (mg/L as K) | Chloride, dissolved (mg/L as Cl) | Sulfate, dissolved (mg/L as $SO_4$) | Fluoride, dissolved (mg/L as F) | Arsenic, dissolved (µg/L as As) | Arsenic, suspended (µg/L as As) |
|---|---|---|---|---|---|---|---|
| Centereach | | | | | | | |
| surface water | -- | 0.5 | 3.3 | 4.0 | 0.1 | 1.0 | 1.0 |
| ground water | -- | 1.6 | 8.1 | 11.0 | .1 | 1.0 | -- |
| precipitation | -- | .1 | .8 | 1.1 | .1 | 1.0 | 1.0 |
| Huntington | | | | | | | |
| surface water | .4 | .5 | 71.5 | 6.6 | .1 | 0 | 0 |
| ground water | 2.3 | 3.0 | 26.0 | 28.0 | .1 | 0 | .5 |
| precipitation | .2 | .3 | 3.0 | 3.0 | .1 | 0 | 0 |
| Laurel Hollow | | | | | | | |
| surface water | 1.2 | 1.6 | 4.1 | 4.5 | .1 | .5 | 1.0 |
| ground water | .5 | .7 | 4.3 | 11.0 | .1 | 0 | 0 |
| precipitation | .1 | .2 | 1.7 | 1.6 | .1 | 0 | 0 |
| Plainview | | | | | | | |
| surface water | 1.8 | 2.3 | 10.0 | 11.0 | .1 | 1.0 | 1.0 |
| ground water | 1.2 | 1.6 | 46.0 | 16.0 | .1 | 0 | .5 |
| precipitation | .2 | .2 | 2.6 | 1.6 | .1 | 0 | 0 |
| Syosset | | | | | | | |
| surface water | 1.3 | 1.6 | 2.3 | 5.4 | .1 | 1.0 | 0 |
| ground water | 1.4 | 1.0 | 7.3 | 7.0 | .1 | 0 | 1.0 |
| precipitation | .2 | .3 | 1.6 | 2.6 | .1 | .5 | 1.0 |

-- data unavailable

*Table 10.--Median values of physical and chemical characteristics of stormwater, ground water, and precipitation (continued)*

[Data collected 1980-82; locations are shown in fig. 2.]

| Site and sample type | Arsenic, total (µg/L as As) | Phosphorus, ortho, dissolved (mg/L as P) | Carbon, organic dissolved (mg/L as C) | Carbon, organic suspended (mg/L as C) | Cyanide, total (mg/L as CN) | Calcium, dissolved (mg/L as Ca) | Magnesium, dissolved (mg/L as Mg) |
|---|---|---|---|---|---|---|---|
| Centereach | | | | | | | |
| surface water | 1.0 | 0.02 | 6.4 | 5.6 | -- | 3.5 | 0.69 |
| ground water | 1.0 | .01 | 2.5 | .6 | -- | 7.5 | 1.4 |
| precipitation | 1.0 | .02 | 2.7 | .7 | -- | .20 | .10 |
| Huntington | | | | | | | |
| surface water | 0 | .03 | 3.4 | 4.0 | .011 | 3.7 | .7 |
| ground water | 0 | .01 | 1.3 | .9 | ND | 17.0 | 3.5 |
| precipitation | .5 | .02 | 3.5 | 2.0 | — | .49 | .26 |
| Laurel Hollow | | | | | | | |
| surface water | 1.0 | .06 | 5.8 | 6.9 | .02 | 4.3 | .8 |
| ground water | 0 | .01 | 1.8 | 1.6 | ND | 4.5 | .9 |
| precipitation | 0 | .01 | 1.0 | .7 | -- | .30 | .10 |
| Plainview | | | | | | | |
| surface water | 1.5 | .05 | 6.9 | 7.3 | ND | 7.85 | 1.2 |
| ground water | 1.0 | .01 | 2.4 | .9 | ND | 9.0 | 3.6 |
| precipitation | 1.0 | .02 | 1.8 | 1.6 | — | .4 | .2 |
| Syosset | | | | | | | |
| surface water | 1.0 | .09 | 6.3 | 5.1 | ND | 3.7 | 1.25 |
| ground water | 1.0 | .01 | 1.1 | 1.3 | ND | 4.85 | 1.2 |
| precipitation | 1.0 | .03 | 2.6 | 1.6 | -- | .50 | .18 |

| Site and sample type | Sodium, dissolved (mg/L as Na) | Nitrogen, dissolved (mg/L as N) | Nitrogen, organic dissolved (mg/L as N) | Nitrogen, ammonia dissolved (mg/L as N) | Nitrogen, ammonia + organic dissolved (mg/L as N) | Nitrogen, $NH_4$ + organic suspended (mg/L as N) | Nitrogen, ammonia + organic total (mg/L as N) | Nitrogen $NO_2$ + NO dissolve (mg/L as N) |
|---|---|---|---|---|---|---|---|---|
| Centereach | | | | | | | | |
| surface water | 3.5 | 1.9 | 0.86 | 0.08 | 0.96 | 0.20 | 1.15 | 0.42 |
| ground water | 9.5 | .91 | .43 | .05 | .5 | -- | .10 | .31 |
| precipitation | .3 | 1.2 | .46 | .08 | .78 | .15 | .60 | .10 |
| Huntington | | | | | | | | |
| surface water | 40.0 | .9 | .33 | .15 | .49 | .17 | .65 | .34 |
| ground water | 19.0 | 6.3 | .20 | .02 | .28 | .02 | .32 | 5.8 |
| precipitation | 1.8 | .80 | .26 | .13 | .58 | .01 | .67 | .26 |
| Laurel Hollow | | | | | | | | |
| surface water | 3.3 | 1.0 | .44 | .08 | .55 | .70 | 1.5 | .44 |
| ground water | 3.7 | 1.0 | .17 | .02 | .19 | .23 | .41 | .82 |
| precipitation | 1.1 | .29 | .13 | .04 | .16 | .01 | .20 | .16 |
| Plainview | | | | | | | | |
| surface water | 8.5 | 1.3 | .58 | .12 | .7 | 1.35 | 2.3 | .49 |
| ground water | 27.0 | 1.3 | .20 | .02 | .24 | 0 | .15 | .82 |
| precipitation | .5 | .59 | .10 | .08 | .16 | 0 | .32 | .28 |
| Syosset | | | | | | | | |
| surface water | 1.5 | 1.35 | .60 | .09 | .76 | .6 | 1.35 | .34 |
| ground water | 4.2 | 2.55 | .38 | .02 | .39 | .04 | .40 | 1.60 |
| precipitation | 1.0 | 1.20 | .29 | .16 | .66 | .02 | .64 | .42 |

-- data unavailable
ND, not detected

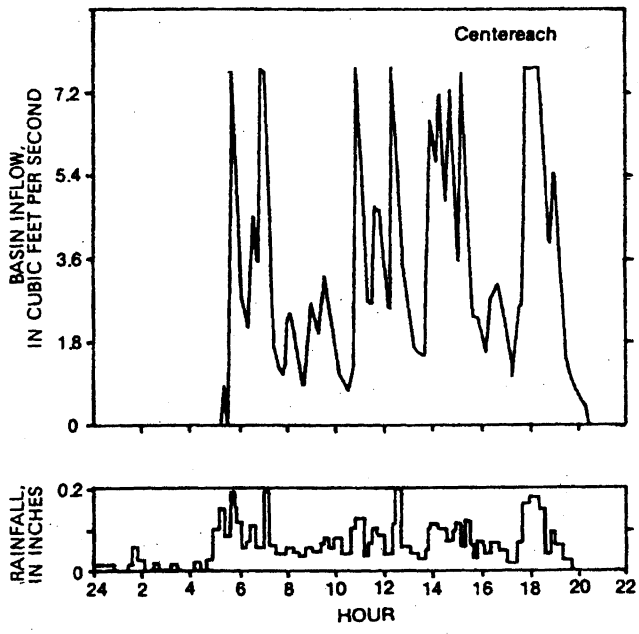
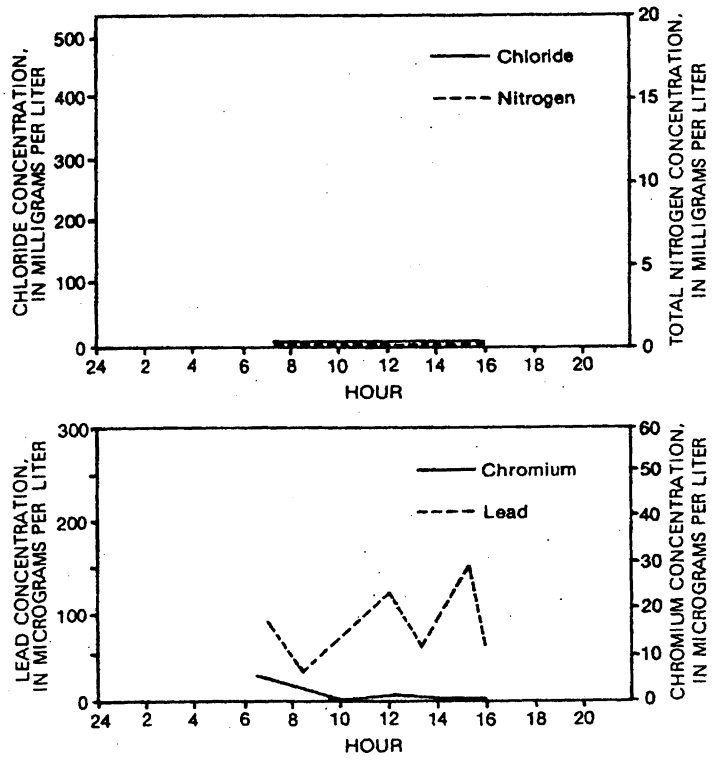



*Figure 9A. Hydrograph and hyetograph (above), and constituent concentrations through time (below) during storm of June 5, 1982, at Centereach.*



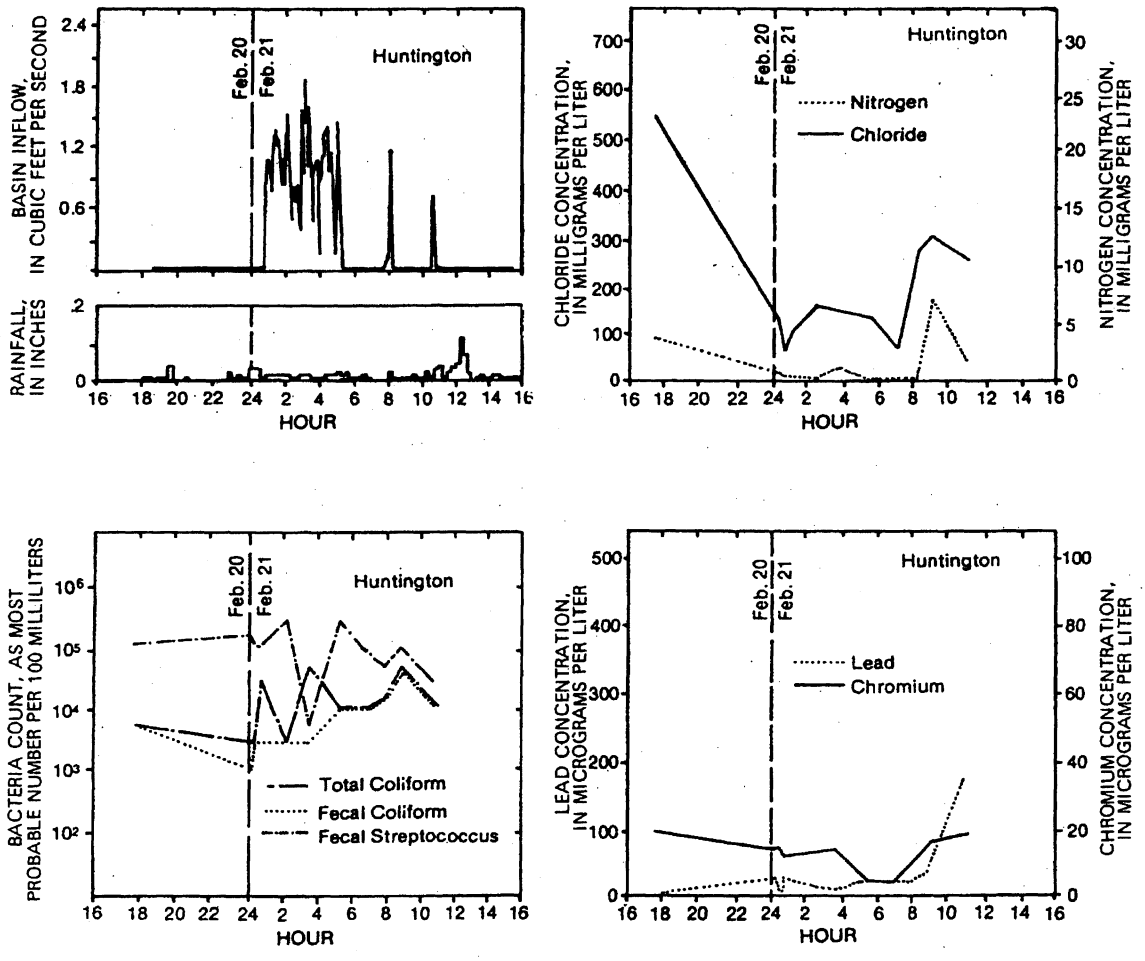



*Figure 9B.--Hydrograph and hyetograph (upper left) and constituent concentrations through time during storm of February 20, 1981 at Huntington.*

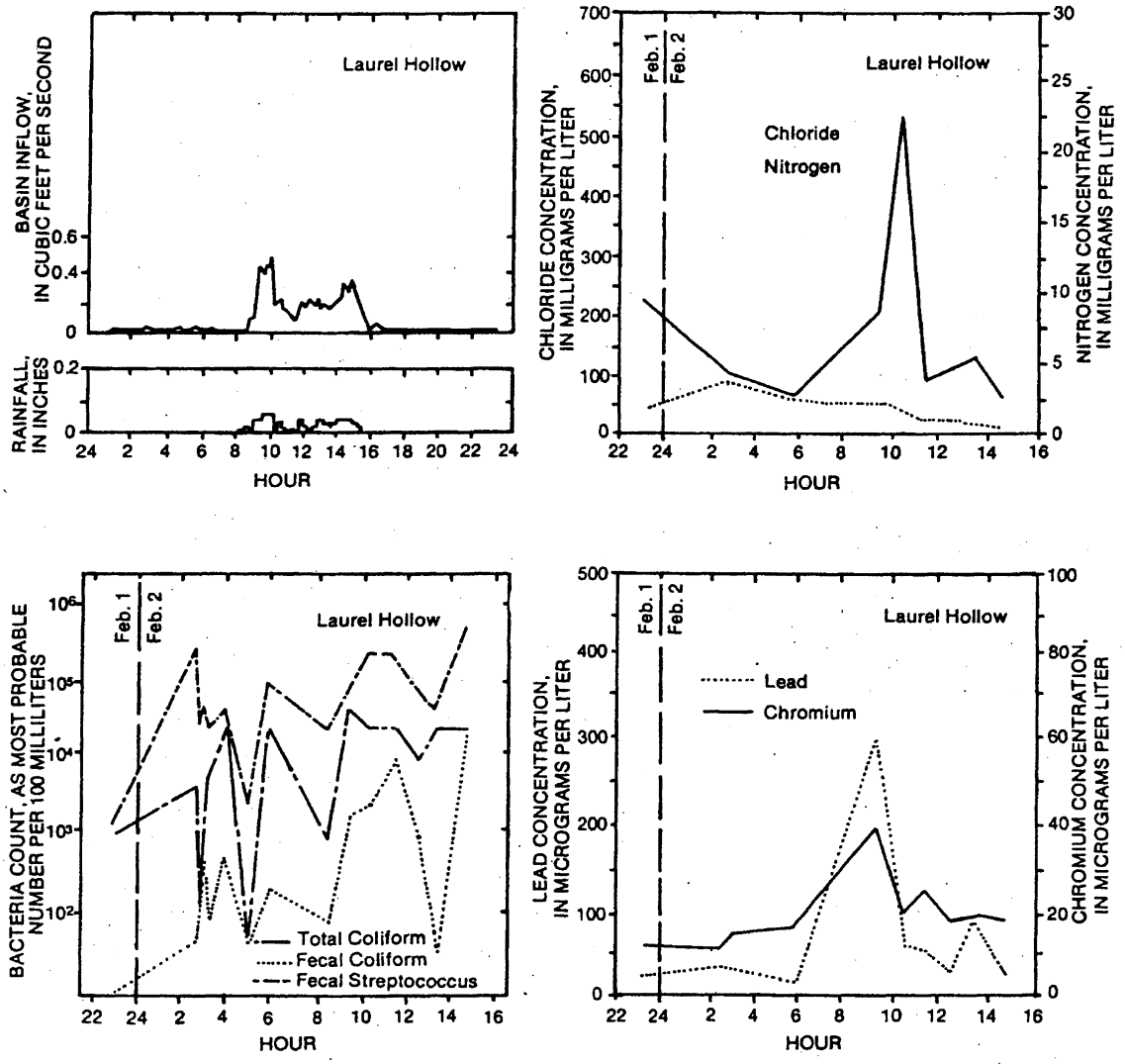



*Figure 9C.--Hydrograph and hyetograph (upper left) and constituent concentrations through time during storm of February 1, 1981 at Laurel Hollow.*

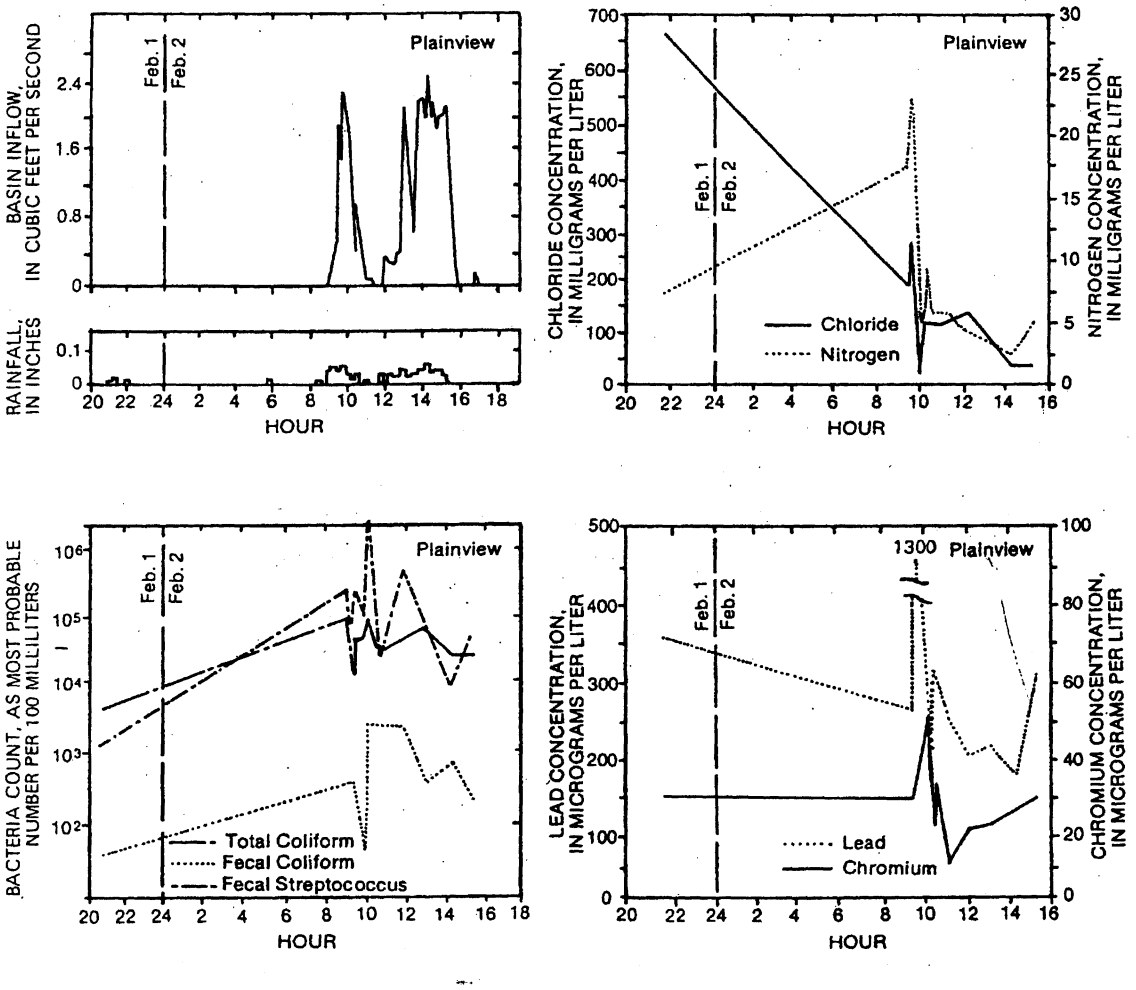



*Figure 9D.--Hydrograph and hyetograph (upper left) and constituent concentrations through time during storm of February 1, 1981 at Plainview.*

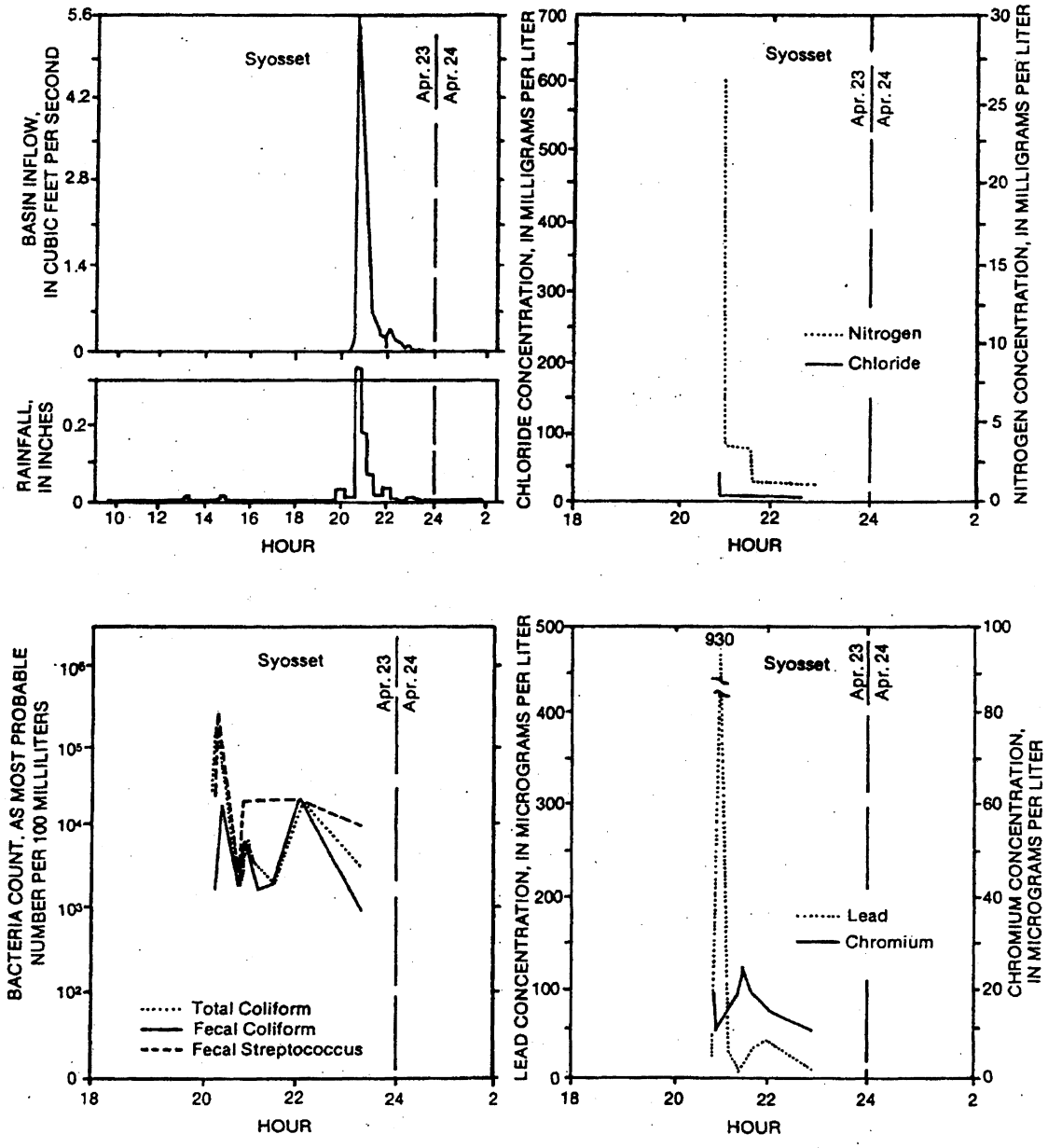



*Figure 9E.--Hydrograph and hyetograph (upper left) and constituent concentrations through time during storm of April 23, 1981 at Syosset.*

*Table 11.--Total daily snowfall, eastern Long Island, January 2-10, 1981.*

| Date | Total daily snowfall (inches) | Date | Total daily snowfall (inches) |
|---|---|---|---|
| 1- 2-81 | 1.50 | 1- 7-81 | 3.00 |
| 1- 3-81 | 0 | 1- 8-81 | 0 |
| 1- 4-81 | 1.53 | 1- 9-81 | 0 |
| 1- 5-81 | 0 | 1-10-81 | 0 |
| 1- 6-81 | 0 | | |

*Table 12.--Comparison of median lead and chromium concentrations in rainfall (1980-82) and accumulated snow, January 10, 1981.*

[All values are in µg/L]

| | Centereach | | Huntington | | Laurel Hollow | | Plainview | | Syosset | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Snow | Median precip. | Snow | Median precip. | Snow | Median precip. | Snow | Median precip. | Snow | Median precip. |
| Lead | -- | 13 | 24 | 36 | 28 | 8 | 33 | 16 | 18 | 16 |
| Chromium | -- | 4.5 | 8 | 9.5 | 4 | 5 | 10 | 8.5 | 6 | 5.5 |

-- not sampled

*Priority Pollutants*

The results of the priority pollutant (organic chemical) analyses are summarized in table 13. Only compounds detected in the samples are included; most compounds were below detection limits. Table 13A lists the concentrations of the acid- and base/neutral-extractable compounds in the stormwater and ground-water samples; table 13B lists the concentrations of the volatile compounds, phenols, and cyanide. Replicate samples were collected on each sampling day for quality assurance. These results are also included in the tables, as are analyses of room air (in the analyzing laboratory), trip blanks (distilled water carried during sampling) and deionized water blanks. These additional values are presented for comparison with regular sample analyses.

New York State Department of Health guidelines for organic chemicals in drinking water recommend no more than 50 µg/L for an individual constituent, 100 µg/L for total organic chemical constituents, and 5 µg/L for vinyl chloride and benzene, known carcinogens. (See appendix D.) Of the 14 samples analyzed for 113 of the priority pollutants, three contained one or two substances in concentrations exceeding the guidelines for a single organic chemical constituent (table 14). These samples also contained a combination of substances that exceeded the guidelines for total organic constituents.

The most common organic compounds (those found in at least 50 percent of the samples collected) were:

benzene
bis (2-ethylhexyl) phthalate
chloroform
methylene chloride
toluene
1,1,1-trichloroethane

Of these, only methylene chloride was consistently found in concentrations greater than 8 µg/L.

### *Bacteria*

Total coliforms, fecal coliforms, and fecal streptococci are known as "indicator" organisms because they are often considered to indicate the presence of sewage and, ideally, are correlated with the number of pathogens in a water sample. Although the use of coliforms as an indicator has been criticized, the U.S. Environmental Protection Agency's safe drinking-water standards are written in terms of coliforms rather than pathogens, as are standards for recreational waters and shellfishing areas (Mallard, 1980).

Most total coliform bacteria in runoff are native soil organisms that are washed off soil particles by water running over the land surface. Fecal coliforms and fecal streptococci, however, are contributed by warm-blooded animals. In urban areas, these bacteria are most likely derived from fecal material from dogs, cats, rodents, and other small animals. On Long Island, ducks and seagulls are also significant contributors of bacteria to surface water (Koppelman, 1982).

Counts (MPN) of total coliforms, fecal coliforms, and fecal streptococci in stormwater, compiled by Mallard (1980) from several references, range as follows:

| | |
|---|---|
| total coliforms | $10^3$ to $10^5$ per 100 mL; |
| fecal coliforms | $10^2$ to $10^4$ per 100 mL; |
| fecal streptococci | $10^2$ to $10^5$ per 100 mL. |

The minimum, maximum, and median values of the three indicator bacteria at each of the five sites studied are listed in table 15. These bacteria counts, from 306 stormwater samples, were generally within the above-listed ranges, although values an order of magnitude above or below these range limits were common.

Geldreich and Kenner (1969) found that the ratio of fecal coliforms to fecal streptococci (FC:FS) in human feces and in water polluted with human waste is always greater than 4.0, whereas the FC:FS ratio in feces from farm animals, cats, dogs, and rodents, and in separate stormwater systems and farmland drainage, is less than 0.7.

Although the FC:FS ratio gives some indication of the source of the bacteria, Mallard (1980) warns that factors such as temperature, pH, metal concentration, nutrient availability, and other environmental factors will alter the ratio once the organisms enter the receiving water. These effects can be minimized by collecting water samples as soon as possible, near the source of the contamination, before the bacteria reach the receiving-water body. Also, the FC:FS ratio for samples that contain water from a mixture of nonpoint sources must be interpreted with caution. For example, if most of the bacteria in a sample came from nonhuman sources, a small amount of human sewage might not cause a sufficient upward shift in the overall ratio to indicate the possible presence of human pathogens.

*Table 13A.--Concentration of acid- and base/neutral-extractable priority pollutants at recharge basins, 1981-82.*

[R, replicate sample; D, deionized water blank; SW, storm water; GW, ground water]
Concentrations are in µg/L; locations are shown in fig. 2; dashes indicate compound not detected.

| | Centereach | | Huntington | | | Laurel Hollow | | | Plainview | | | Syosset | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4/26/82 | 4/27/82 | 3/30/81 | 5/7/81 | 9/28/81 | 3/30/81 | 5/7/81 | 9/28/81 | 2/11/81 | 5/7/81 | 9/28/81 | 4/14/81 | 5/7/81 | 9/28/81 |
| Constituent | SW | GW | SW | GW | GW | SW | GW | GW | SW | GW | GW | SW | GW | GW |
| 2,4,6-trichlorophenol | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- |
| p-chloro-m-cresol | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 79 | 2<br>1R | -- | -- |
| 2-chlorophenol | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16 | -- | -- | -- |
| 2,4-dichlorophenol | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- |
| 2,4-dimethylphenol | <1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 96 | -- | -- | -- |
| 2-nitrophenol | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- |
| 4-nitrophenol | -- | -- | -- | -- | 58<br>174R | -- | -- | -- | -- | -- | 35 | 4<br>4R | -- | -- |
| 2,4-dinitrophenol | -- | -- | -- | -- | 5<br>20R | -- | -- | -- | -- | -- | 12 | -- | -- | -- |
| pentachlorophenol | 1 | -- | -- | -- | 5<br>7R | -- | -- | -- | 1<br>4R | -- | -- | 3 | -- | -- |
| phenol | 1 | <1<br><1R | -- | -- | -- | -- | -- | -- | -- | -- | 26 | -- | -- | -- |
| bis (2 ethylhexyl) phthalate | 18 | 1<br>6R | 5<br>9R | -- | 3,6R<br>47D | 10 | 9 | 13 | 3<br>15R | 5 | -- | 1,1R<br>6D | 5<br>4D | 5 |
| 2,6-dinitrotoluene | -- | -- | -- | -- | 4R | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| di-n-butyl phthalate | <1 | 2<br><1R | 11D | -- | 3R<br>4D | -- | -- | -- | -- | -- | -- | -- | 3<br>3D | 3 |
| diethyl phthalate | 2 | 4<br>2R | 4D | -- | 1R<br>1D | -- | -- | -- | -- | -- | -- | 1<br>1R | -- | 2 |
| chrysene | -- | -- | -- | -- | 1R | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| anthracene | -- | -- | -- | -- | 2R | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| phenanthrene | -- | -- | -- | -- | 2R | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| naphthalene | -- | -- | 1R | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |
| di-n-octylphthalate | -- | -- | -- | -- | 8D | -- | -- | -- | -- | -- | -- | -- | -- | -- |

*Table 13B.--Concentration of volatile priority pollutants, pesticides, phenols, and cyanide at recharge basins, 1981-82.*

[R, replicate sample; MB, method blank; B, trip blank; D, deionized water; RA, room air; SW, storm water; GW, ground water]
Concentrations are in µg/L; locations are shown in fig. 2; dashes indicate compound not detected.

| | Centereach | | Huntington | | | Laurel Hollow | | | Plainview | | | Syosset | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4/26/82 | 4/27/82 | 3/30/81 | 5/7/81 | 9/28/81 | 3/30/81 | 5/7/81 | 9/28/81 | 2/11/81 | 5/7/81 | 9/28/81 | 4/14/81 | 5/7/81 | 9/28/81 |
| Constituent | SW | GW | SW | GW | GW | SW | GW | GW | SW | GW | GW | SW | GW | GW |
| benzene | 1 | 1<br>1R | 4,2MB<br>2B | 3 | 2<br>1B | -- | 2 | 2 | 2<br>3R | 1,1R<br>5B | 2 | 1,2B<br>1R | 2 | 2 |
| 1,1,1-tri-chloroethane | 2 | 2<br>2R | 3 | 23 | 36<br>24B | 3 | 3 | 2 | -- | 2<br>2R | 2 | 1<br>1R | 5 | 6 |
| 1,1-dichloro-ethane | -- | -- | 2 | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| chloroform | -- | -- | 2 | 2 | 3<br>2B | -- | 1 | 2 | -- | -- | 2 | -- | -- | 3 |
| methylene chloride | 10 | 9<br>13R | 9,10MB<br>13B | 20 | 7<br>20B | 10 | 19 | 6 | 230,300R<br>26B,17RA | 21,24R<br>40B | 6 | 8,35B<br>8R | 19 | 6 |
| toluene | 3 | 2<br>3R | 5,3B<br>4MB | 5 | 3<br>3B | 2 | 3 | 3 | 4<br>3R | 3,3R<br>8B | 3 | 3,3B<br>2R | 3 | 4 |
| 1,1,2,2-tetra-chloroethane | -- | -- | 2 | 3 | 9 | 3 | -- | -- | -- | -- | -- | -- | 1 | -- |
| 1,1-dichloro-ethylene | -- | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| carbon tetra-chloride | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| trichloro-fluoromethane | -- | -- | 1 | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| trichloro-ethylene | -- | 41R | 1 | 1 | -- | -- | -- | -- | -- | 1<br>1R | -- | -- | -- | -- |
| 1,1,2-tri-chloroethane | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ethylbenzene | 1 | 1R | -- | 1 | -- | -- | -- | -- | -- | 2B | -- | -- | -- | -- |
| tetrachloro-ethylene | -- | <1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| aldrin | .059 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| endrin aldehyde | .084 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Y-BHC | -- | .005 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| phenols | 42 | <2 | 5<br><5R | <100 | <100<br>1,000D | 10<br><5R | <100 | <100 | <5 | <100<br><100R | <100 | 6<br><5R | <100 | <100 |
| cyanide | 5 | <5 | 10<br>20R | <100 | <100 | 20<br>10R | <100 | <100 | <10 | <100<br><100R | <100 | <10<br><10R | <100 | <100 |

*Table 14.--Priority pollutants exceeding New York State drinking-water standards at study sites.*

(Locations are shown in fig. 2.)

| Basin | Date | Source | Constituent | Concentration (µg/L) |
|---|---|---|---|---|
| Plainview | 9-28-81 | ground water | p-chloro-m-cresol | 79 |
| Plainview | 9-28-81 | ground water | 2,4-dimethylphenol | 96 |
| Huntington | 9-28-81 | ground water | 4-nitrophenol | 58 |
| Plainview | 2-11-81 | storm water | methylene chloride | 230 |

*Table 15.--Minimum, maximum, and median number of bacteria in stormwater for all samples.*

[Values are MPN per 100 milliliters]

| Bacteria | Minimum | Maximum | Median |
|---|---|---|---|
| **Centereach** | | | |
| Total coliforms | 240 | 43,000 | 4,300 |
| Fecal coliforms | 4 | 43,000 | 930 |
| Fecal streptococci | 640 | 46,000 | 24,000 |
| **Huntington** | | | |
| Total coliforms | 2,400 | 1,100,000 | 24,000 |
| Fecal coliforms | 6 | 240,000 | 9,300 |
| Fecal streptococci | 2,400 | 1,100,000 | 126,650 |
| **Laurel Hollow** | | | |
| Total coliforms | 240 | 43,000 | 4,300 |
| Fecal coliforms | 4 | 43,000 | 930 |
| Fecal streptococci | 640 | 460,000 | 24,000 |
| **Plainview** | | | |
| Total coliforms | 240 | 1,100,000 | 24,000 |
| Fecal coliforms | 43 | 43,000 | 640 |
| Fecal streptococci | 150 | 2,400,000 | 24,000 |
| **Syosset** | | | |
| Total coliforms | 240 | 1,100,000 | 24,000 |
| Fecal coliforms | 9 | 240,000 | 2,400 |
| Fecal streptococci | 430 | 1,100,000 | 24,000 |

Table 16 shows the minimum, maximum, and median FC:FS ratios for stormwater runoff samples collected at each of the five sites, along with the number of samples from which these statistics were derived. In each case, the median ratio is well below 0.7, which indicates that the probable source of the bacteria is animal waste. Two of the maximum values, 5.6 for Laurel Hollow and 16.0 for Huntington, are above 4.0. FC:FS ratios of this magnitude were extremely rare, however, and occurred in only 7 of the 279 samples (2.5 percent). Ratios exceeding 4.0 were found in only 1 of 58 samples from Laurel Hollow (1.7 percent) and in only 6 of 77 samples from Huntington (7.8 percent).

Soil is generally effective in removing bacteria from water, both by the filtering action of soil particles at land surface and by the adsorptive capacity of clay particles (Mallard, 1980). Thus, contamination of ground water by bacteria is unlikely.

All five recharge basins were found to be effective in removing bacteria from stormwater before it reached the water table. Nearly all values of total coliforms, fecal coliforms, and fecal streptococci in ground water beneath the recharge basins, sampled 1 to 2 days after a storm, were less than 3.0 MPN/100 mL.

*Table 16.--Ratio of fecal coliform to fecal streptococci in stormwater*[1].

[Site locations are shown in fig. 2]

| Site | Minimum | Maximum | Median | Number of Samples |
|---|---|---|---|---|
| Centereach | 0 | 1.8 | 0.10 | 27 |
| Huntington | 0 | 16.0 | .20 | 77 |
| Laurel Hollow | 0 | 5.6 | .05 | 58 |
| Plainview | 0 | 1.8 | .03 | 60 |
| Syosset | 0 | 1.0 | .10 | 57 |
| TOTAL | | | | 279 |

[1] FC:FS > 4.0 generally indicative of human waste as bacteria source; FC:FS < 0.7 generally indicative of animal waste as bacteria source (Geldreich and Kenner, 1969).

## Loads of Selected Constituents

Stormwater constituent loads were calculated by multiplying the constituent concentration in each stormwater sample by the runoff volume in the associated storm segment, and then taking the sum of the individual storm-segment loads. Constituent loads were converted to flow-weighted concentrations by dividing by the total runoff volume (table 5) for the appropriate storm. Constituent loads in ground water were calculated by multiplying the observed constituent concentration in the infiltrated water by the total storm inflow volume.

*Standard Chemicals*

Flow-weighted concentrations of selected constituents in stormwater inflow and observed concentrations in water that infiltrated through the recharge-basin floor to the water table are listed by basin and by storm in table 17A; constituent loads are shown in table 17B. The chemical constituents selected for this analysis were chromium and lead, which are associated with gasoline and industry, and chloride and nitrogen, which are associated with fertilizers and animal waste. Chloride is also derived from road salt used during winter.

Loads of chromium and lead in stormwater were generally low, ranging from virtually none (0.001 and 0.003 lb, respectively) to tenths of a pound. Where a large influx into the basin was noted, as at Plainview (table 17B), a large degree of removal also occurred. For example, the lead load in stormwater on February 11, 1981 at Plainview was 2.03 lb, but when the same water reached the water table, it contained only 0.01 lb, a decrease of 2 orders of magnitude. (A difference of less than an order of magnitude may be within the range of analytical precision.) The same is true of chromium, although the largest influx of chromium into a basin was only 0.152 lb (June 16, 1982 at Centereach).

A comparison of chloride and nitrogen loads in stormwater with those in ground water shows little or no removal of these constituents within the unsaturated zone. In fact, the loads in the ground water after some storms were greater than those in the stormwater (table 17B), presumably because they enter the ground water from other sources such as septic-tank and cesspool effluent and fertilizers (Ku and Sulam, 1979). Figure 10 uses the Plainview site as an example to show that nitrogen concentrations in ground water were

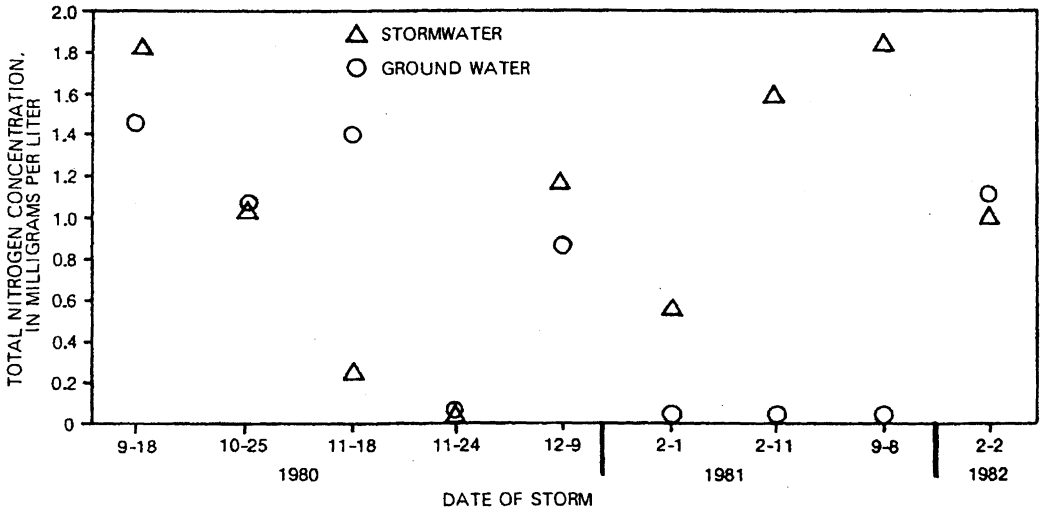



*Figure 10.--Flow-weighted average concentrations of nitrogen in stormwater and observed concentrations in ground water at Plainview, 1980-82.*

also occasionally greater than those in stormwater runoff. This indicates that the ground water sampled after a storm was not derived entirely from infiltrated stormwater produced by the immediately preceding storm, and that some mixing of the infiltrated stormwater with the shallow ground water inevitably occurred during collection of the ground-water sample. Therefore, ground-water constituent loads in table 17B should be regarded as a general, not absolute, indicator of the degree of constituent removal during infiltration.

The chloride load in stormwater in the strip-commercial and shopping-center recharge basins was sometimes extremely high, especially during winter--118 lb at Centereach on March 4, 1982; 163 lb at Huntington on February 19, 1981; and 1,558 lb at Huntington on January 23, 1982 (table 17B). The highway basin had the largest inflow of lead (2.03 lb at Plainview on February 11, 1981), followed by the strip commercial basin (1.05 lb at Centereach on June 5, 1982). The low-density residential area at Laurel Hollow and the medium-density residential area at Syosset contributed relatively small loads of all four constituents.

These data suggest that land use is a major factor in constituent loading to the basins and that seasonal variability is also important.

### *Priority Pollutants*

Loads of the priority pollutants were not computed because the concentrations of these constituents were obtained from single grab samples only.

### *Bacteria*

The median and range of the three indicator bacteria in all sampled storms are given in table 18 in units of number of bacteria per acre of impervious area per inch of precipitation. Low-density residential (Laurel Hollow) and nonresidential (Huntington, Plainview) areas appear to contribute the least amount of bacteria to stormwater, whereas medium-density residential (Syosset) and strip commercial (Centereach) areas contribute the most.

As stated previously, flow data from the Huntington site were difficult to obtain because the electromagnetic flow sensor in the inflow pipe was often submerged and because reverse flow sometimes occurred in the pipe during storms. Even though the concentration of bacteria at Huntington (table 15) was relatively high, the calculated load of bacteria (table 18) was relatively low. It is therefore probable that the discharge volume used in computing bacteria loads at Huntington was lower than the actual value and that bacteria loads at that site are probably higher than those shown in table 15.

The median and range of the three indicator bacteria for all five sites are listed by season in table 19. Although the total coliforms show no significant difference between the warm and cool season, fecal coliforms and fecal streptococci in stormwater increase by one to two orders of magnitude during the warm season. This analysis is in agreement with the seasonal variations in indicator bacteria reported by Mallard (1980, p. 6).

*Table 17A.--Flow-weighted concentrations of selected constituents in stormwater and observed concentrations in water reaching the water table at recharge basins.*

[All values are in milligrams per liter. Site locations are shown in fig. 2]

| Date | Chromium, total | | Lead, total | | Chloride, dissolved | | Nitrogen, total | |
|---|---|---|---|---|---|---|---|---|
| | Storm-water | Ground water | Storm-water | Ground water | Storm-water | Ground water | Storm-water | Ground water |
| **A. CENTEREACH** | | | | | | | | |
| 3- 4-82 | 0.008 | 0.016 | 0.43 | 0.35 | 68.7 | 7.5 | 3.15 | 0.76 |
| 3-16-82 | .025 | -- | .22 | -- | 4.2 | -- | [a] 1.15 | -- |
| 4-26-82 | [a].005 | .006 | [a].171 | .005 | [a] 9.3 | 8.1 | .62 | .44 |
| 6- 1-82 | .003 | [a].001 | .025 | .002 | .6 | 9.9 | [a] .16 | [a] .39 |
| 6- 5-82 | [a].002 | .002 | .088 | .002 | 1.4 | 7.2 | [a] .53 | [a] .31 |
| 6-16-82 | [a].013 | .0002 | [a].015 | .001 | [a] .2 | 1.3 | [a] .12 | .02 |
| **B. HUNTINGTON*** | | | | | | | | |
| 9-18-80 | .019 | .005 | .115 | .005 | 4.6 | 21.0 | 2.28 | 8.51 |
| 2-19-81 | .013 | .006 | .022 | .006 | 152 | 4.9 | .67 | .61 |
| 2-23-81 | .007 | .004 | .065 | .007 | 121 | 38.1 | .45 | 6.07 |
| 3-30-81 | .007 | .009 | .005 | .009 | 22.7 | 20 | .09 | 6.51 |
| 4-14-81 | .003 | .010 | .010 | 0 | 102 | 18.8 | 1.68 | 5.7 |
| 4-23-81 | .025 | 0 | .025 | 0 | 23.4 | 12 | 1.38 | 10.4 |
| 5-11-81 | .015 | .008 | .197 | .002 | 33.3 | 24.1 | 1.57 | 7.29 |
| 5-29-81 | -- | -- | -- | -- | -- | -- | 1.62 | -- |
| 7-20-81 | .022 | .03 | .107 | .044 | 3.8 | 28 | 1.87 | 4.47 |
| 9-15-81 | [a].009 | .007 | [a].014 | .006 | 1.3 | 46.9 | 4.18 | 6.24 |
| 1-23-82 | .034 | -- | .262 | -- | 439 | -- | [a]14.8 | -- |
| **C. LAUREL HOLLOW** | | | | | | | | |
| 11-18-80 | 0 | [a]0 | .015 | .015 | 2.31 | 5.0 | 1.55 | .67 |
| 11-24-80 | .048 | -- | .183 | -- | 2.3 | -- | .37 | -- |
| 12- 9-80 | 0 | [a]0 | 0 | [a]0 | 2.2 | 3.2 | .13 | 1.06 |
| 2- 1-81 | .02 | .01 | .108 | .008 | 32.7 | 10 | 8.02 | 1.0 |
| 2-19-81 | .016 | .005 | .032 | .006 | 4.3 | 3.0 | 3.62 | 1.2 |
| 2-23-81 | [a].024 | .012 | .02 | .008 | 3. | 2.8 | .76 | .84 |
| 3-30-81 | 0 | [a]0 | .06 | [a]0 | 14.1 | 5.6 | 3.64 | .64 |
| 5-11-81 | 0 | [a]0 | 0 | [a]0 | 1. | .5 | .55 | .32 |
| 7- 3-81 | 0 | -- | .08 | -- | 1.5 | -- | 2.86 | -- |
| **D. PLAINVIEW** | | | | | | | | |
| 9-18-80 | .011 | .011 | .346 | [a]0 | 4.2 | 28.1 | [a] 1.8 | 1.45 |
| 10-25-80 | .016 | .001 | .177 | .001 | 5.6 | 32.0 | 1.0 | 1.1 |
| 11-18-80 | .011 | .011 | .129 | .003 | 4.5 | 44.1 | [a] .28 | 1.4 |
| 11-24-80 | .028 | .002 | .314 | .003 | 3.1 | 50 | [a] .20 | [a] .80 |
| 12- 9-80 | 0 | [a]0 | .143 | [a]0 | 9.2 | 48.3 | 1.14 | .89 |
| 2- 1-81 | .027 | .01 | .70 | .004 | 8.1 | 4.5 | .52 | .12 |
| 2-11-81 | .04 | .009 | 1.15 | .006 | 30.8 | 37 | 10.9 | .89 |
| 9- 8-81 | -- | .012 | -- | .008 | -- | 48 | 1.87 | .97 |
| 2- 2-82 | 0 | 0 | .176 | 0 | 8.2 | 78.5 | [a] 1.17 | [a]1.5 |
| **E. SYOSSET** | | | | | | | | |
| 10-25-80 | .011 | .016 | .017 | 0 | 3.4 | 19.9 | 1.17 | 24 |
| 4-14-81 | .008 | .008 | .018 | .002 | 5.7 | 10 | 1.76 | 2.86 |
| 4-23-81 | .016 | .013 | .286 | .024 | 6.1 | 12.0 | 9.44 | 2.52 |
| 5-29-81 | [a].01 | -- | [a].10 | -- | [a] 3.2 | -- | 4.48 | -- |
| 7-20-81 | .043 | -- | .107 | .129 | 2.7 | 4.4 | 3.80 | 1.47 |
| 7-29-81 | .01 | -- | .039 | -- | 1.8 | -- | 2.21 | -- |
| 9-15-81 | .009 | .007 | .019 | .052 | 1.4 | 1.3 | 1.09 | .98 |
| 12- 1-81 | .013 | .001 | .026 | .379 | 3.0 | 6.2 | .28 | 2.59 |
| 12-15-81 | .002 | .01 | .016 | .047 | 1.8 | 6.3 | [a] .19 | [a]1.1 |

-- data unavailable
[a] estimated value
* Because of difficulties in obtaining accurate runoff measurements at this site, all flow values are low and all flow-weighted concentrations are presumed to be underestimated.

*Table 17B.--Loads of selected constituents in stormwater and in water reaching the water table at recharge basins.*

[All values are in pounds. Site locations are shown in fig. 2]

| Date | Chromium, total | | Lead, total | | Chloride, dissolved | | Nitrogen, total | |
|---|---|---|---|---|---|---|---|---|
| | Storm-water | Ground water | Storm-water | Ground water | Storm-water | Ground water | Storm-water | Ground water |
| **A. CENTEREACH** | | | | | | | | |
| 3- 4-82 | 0.015 | 0.027 | 0.740 | 0.710 | 118 | 12.8 | 5.40 | 1.30 |
| 3-16-82 | .012 | -- | .107 | -- | 2.05 | -- | [a] .549 | -- |
| 4-26-82 | [a].009 | .012 | [a].340 | .010 | [a]18.5 | 16.1 | 1.23 | .873 |
| 6- 1-82 | .010 | [a].004 | .089 | .007 | 2.05 | 35.7 | [a] .586 | [a]1.41 |
| 6- 5-82 | [a].025 | .024 | 1.05 | .024 | 17.1 | 85.8 | [a]6.30 | [a]3.69 |
| 6-16-82 | [a].152 | .002 | [a].173 | .007 | [a] 2.54 | 15.5 | [a]1.40 | .251 |
| **B. HUNTINGTON*** | | | | | | | | |
| 9-18-80 | .004 | .001 | .024 | .001 | .958 | 4.37 | .474 | 1.77 |
| 2-19-81 | .014 | .006 | .024 | .006 | 163 | 5.30 | .720 | .650 |
| 2-23-81 | .003 | .002 | .028 | .003 | 51.6 | 16.3 | .192 | 2.60 |
| 3-30-81 | .004 | .005 | .003 | .005 | 13.1 | 11.5 | .050 | 3.75 |
| 4-14-81 | .001 | .003 | .003 | 0 | 29.2 | 5.47 | .483 | 1.64 |
| 4-23-81 | .001 | 0 | .001 | 0 | .949 | .811 | .056 | .422 |
| 5-11-81 | .010 | .005 | .129 | .001 | 21.8 | 15.8 | 1.03 | 4.78 |
| 5-29-81 | -- | -- | -- | -- | -- | -- | 2.22 | -- |
| 7-20-81 | .021 | .029 | .103 | .042 | 3.73 | 26.9 | 1.80 | 4.30 |
| 9-15-81 | [a].066 | .049 | [a].099 | .042 | 9.06 | 238 | 29.2 | 43.6 |
| 1-23-82 | .120 | -- | .931 | -- | 1560 | -- | [a]52.7 | -- |
| **C. LAUREL HOLLOW** | | | | | | | | |
| 11-18-80 | 0 | [a]0 | .002 | .002 | .309 | .668 | .207 | .090 |
| 11-24-80 | .025 | -- | 0.096 | -- | 1.2 | -- | .192 | -- |
| 12- 9-80 | 0 | [a]0 | 0 | [a]0 | .017 | .024 | .001 | .008 |
| 2- 1-81 | .008 | .004 | .041 | .003 | 12.4 | 3.79 | 3.04 | .375 |
| 2-19-81 | .010 | .003 | .021 | .004 | 2.75 | 1.93 | 2.33 | .771 |
| 2-23-81 | [a].006 | .003 | .005 | .002 | .760 | .688 | .187 | .206 |
| 3-30-81 | 0 | [a]0 | .004 | [a]0 | .883 | .350 | .227 | .040 |
| 5-11-81 | 0 | [a]0 | 0 | [a]0 | .041 | .020 | .021 | .016 |
| 7- 3-81 | 0 | -- | .015 | -- | .284 | -- | .542 | -- |
| **D. PLAINVIEW** | | | | | | | | |
| 9-18-80 | .001 | .001 | .030 | [a]0 | .364 | 2.44 | [a] .154 | .126 |
| 10-25-80 | .027 | .002 | .305 | .002 | 9.66 | 55.2 | 1.72 | 1.90 |
| 11-18-80 | .016 | .015 | .176 | .005 | 6.1 | 60.0 | [a] .385 | 1.9 |
| 11-24-80 | .095 | .007 | 1.08 | .010 | 10.8 | 172 | [a] .696 | [a]2.75 |
| 12- 9-80 | 0 | [a]0 | .001 | [a]0 | .064 | .388 | .008 | .006 |
| 2- 1-81 | .044 | .017 | 1.16 | .007 | 13.4 | 7.45 | .859 | .199 |
| 2-11-81 | .071 | .016 | 2.03 | .01 | 54.5 | 65.3 | 19.2 | 1.58 |
| 9- 8-81 | -- | .016 | -- | .011 | -- | 65.3 | 2.55 | 1.32 |
| 2- 2-82 | 0 | 0 | .88 | 0 | 41.0 | 392 | [a]5.90 | [a]7.60 |
| **E. SYOSSET** | | | | | | | | |
| 10-25-80 | .008 | .012 | .013 | 0 | 2.63 | 15.3 | .895 | 18.4 |
| 4-14-81 | .005 | .005 | .012 | .001 | 3.72 | 6.51 | 1.14 | 1.86 |
| 4-23-81 | .010 | .008 | .175 | .015 | 3.73 | 7.34 | 5.77 | 1.54 |
| 5-29-81 | [a].007 | -- | [a].068 | -- | [a] 2.30 | -- | 3.19 | -- |
| 7-20-81 | .030 | -- | .075 | .090 | 1.89 | 3.10 | 2.66 | 1.03 |
| 7-29-81 | .001 | -- | .004 | -- | .179 | -- | .226 | -- |
| 9-15-81 | .017 | .014 | .037 | .103 | 2.67 | 2.56 | 2.16 | 1.93 |
| 12- 1-81 | .028 | .002 | .056 | .803 | 6.37 | 13.1 | .593 | 5.49 |
| 12-15-81 | .003 | .017 | .028 | .081 | 3.12 | 10.9 | [a] .323 | [a]1.89 |

-- data unavailable
[a] estimated value
* Because of difficulties in obtaining accurate runoff measurements at this site, all flow values are low and all load values are presumed to be underestimated.

*Table 18.--Minimum, maximum, and median number of bacteria per storm for all sampled storms, per acre per inch of precipitation.*

[Locations are shown in fig. 2.]

| Bacteria | Minimum | Maximum | Median |
|---|---|---|---|
| | Centereach | | |
| Total coliforms | $1.1 \times 10^9$ | $2.2 \times 10^{11}$ | $1.2 \times 10^{10}$ |
| Fecal coliforms | $8.2 \times 10^8$ | $7.5 \times 10^{10}$ | $1.5 \times 10^9$ |
| Fecal streptococci | $3.4 \times 10^9$ | $9.4 \times 10^{10}$ | $3.7 \times 10^{10}$ |
| | Huntington | | |
| Total coliforms | $1.0 \times 10^8$ | $7.1 \times 10^{10}$ | $2.8 \times 10^9$ |
| Fecal coliforms | $1.5 \times 10^8$ | $1.2 \times 10^{10}$ | $5.6 \times 10^8$ |
| Fecal streptococci | $4.8 \times 10^7$ | $9.4 \times 10^{10}$ | $9.7 \times 10^9$ |
| | Laurel Hollow | | |
| Total coliforms | $1.4 \times 10^7$ | $7.0 \times 10^9$ | $5.1 \times 10^8$ |
| Fecal coliforms | $1.6 \times 10^6$ | $4.3 \times 10^9$ | $1.0 \times 10^8$ |
| Fecal streptococci | $2.4 \times 10^8$ | $8.9 \times 10^{10}$ | $3.0 \times 10^9$ |
| | Plainview | | |
| Total coliforms | $1.3 \times 10^7$ | $5.3 \times 10^{10}$ | $1.7 \times 10^8$ |
| Fecal coliforms | $3.4 \times 10^6$ | $5.2 \times 10^9$ | $7.4 \times 10^8$ |
| Fecal streptococci | $1.3 \times 10^8$ | $1.3 \times 10^{11}$ | $1.2 \times 10^{10}$ |
| | Syosset | | |
| Total coliforms | $8.4 \times 10^8$ | $2.1 \times 10^{11}$ | $3.0 \times 10^{10}$ |
| Fecal coliforms | $4.2 \times 10^8$ | $4.4 \times 10^{10}$ | $7.5 \times 10^9$ |
| Fecal streptococci | $8.0 \times 10^9$ | $3.2 \times 10^{11}$ | $4.6 \times 10^{10}$ |

*Table 19.--Seasonal comparison of minimum, maximum, and median number of bacteria per storm for all sampled storms, per acre per inch of precipitation.*

| Bacteria | Minimum | Maximum | Median |
|---|---|---|---|
| | A. Cool Season (October through March) | | |
| Total coliforms | $1.3 \times 10^7$ | $7.4 \times 10^{11}$ | $1.9 \times 10^9$ |
| Fecal coliforms | $1.6 \times 10^6$ | $5.2 \times 10^9$ | $6.1 \times 10^8$ |
| Fecal streptococci | $1.3 \times 10^8$ | $1.2 \times 10^{11}$ | $8.0 \times 10^9$ |
| | B. Warm Season (April through September) | | |
| Total coliforms | $7.1 \times 10^7$ | $2.2 \times 10^{11}$ | $2.3 \times 10^9$ |
| Fecal coliforms | $1.5 \times 10^6$ | $7.5 \times 10^{10}$ | $1.2 \times 10^{10}$ |
| Fecal streptococci | $4.8 \times 10^7$ | $3.2 \times 10^{11}$ | $4.2 \times 10^{10}$ |

## REMOVAL OF CHEMICAL CONSTITUENTS OF RUNOFF BY SOILS

To investigate the removal of stormwater constituents by soil during infiltration, basin-bottom soil samples were collected from the Huntington, Laurel Hollow, Plainview, and Syosset basins on June 5, 1981 for metals and pesticide analysis. (Sampling at Centereach was not begun until 1982.)

The soil samples were collected at two arbitrarily chosen spots approximately 5 ft from the concrete apron at the end of the basin inflow pipe. Because the basin at Huntington contains at least 2 ft of water at all times, the soil was taken from two points just above the water line at the base of the service ramp. Each sample was taken from the top few inches of soil. Samples for pesticide analysis were placed in a pretreated 1-liter glass jar with a Teflon seal; those for metals analysis were placed in 1-liter plastic containers. The samples were sent to the U.S. Geological Survey sediment laboratory for analysis. The results of these analyses are shown in table 20.

### Metals

Chromium concentrations (table 20) ranged from 10 µg/g to 20 µg/g. Lead concentrations ranged from a low of 70 µg/g at Laurel Hollow to a high of 1,200 µg/g at Plainview. The other metals found in significant concentrations--iron, manganese, and zinc--are native to the soil (Ku and others, 1978).

The concentration of chromium in basin-bottom soil seems fairly uniform (20 µg/g at Huntington, 10 µg/g at Laurel Hollow, Plainview, and Syosset). The highest chromium concentration, 20 µg/g at Huntington, is near the 19 mg/kg that was theorized by Ku and others (1978) to represent the maximum sorption capacity of the soil. (Soil containing that concentration of chromium was found near the source of a chromium-rich plume from a metal-plating plant that had been discharging effluent to disposal basins for more than 30 years.) This is not certain, however, because sorption capacity varies with soil properties such as grain size and lithology (Ku and others, 1978).

The concentration of lead was highest (1,200 µg/g) at the Plainview basin, which receives storm runoff from a highway, and lowest (70 µg/g) at the Laurel Hollow basin, which is newer (1979) and drains a low-density residential area. These findings support the assumption that the metals in the dissolved form are probably removed from stormwater by adsorption onto near-surface soil particles in the unsaturated zone and that those in particulate form are simply filtered out by the soil.

### Pesticides

These substances (table 20) are used by local residents, exterminators, and government agencies, especially during spring and early summer. They are generally nearly insoluble in water but are moderately to freely soluble in organic solvents. They can enter recharge basins mixed with water or sorbed on sediment particles and can also enter as dry fallout.

The time required for total decomposition of these compounds in soil and water ranges from days to many years. Breakdown and mechanical dispersion rates depend on such factors as temperature, light, humidity, air movement, volatility of the compounds, and especially microbiologic activity (Seaburn and Aronson, 1974).

*Table 20.--Concentrations of metals, pesticides, and polychlorinated aromatic hydrocarbons in basin soil samples, June 1981.*

[Soil samples collected on June 5, 1981. All concentrations are in (µg/kg). Site locations are shown in fig. 2]

| Substance | Huntington | Laurel Hollow | Plainview | Syosset |
|---|---|---|---|---|
| Metals | | | | |
| Arsenic | 0 | 0 | 0 | 0 |
| Cadmium | 0 | 2 | 2 | 2 |
| Chromium | 20 | 10 | 10 | 10 |
| Copper | 8 | 8 | 28 | 25 |
| Iron | 4,900 | 4,700 | 8,300 | 4,000 |
| Lead | 89 | 70 | 1,200 | 550 |
| Manganese | 41 | 97 | 93 | 85 |
| Mercury | 0 | 0 | 0 | 0 |
| Zinc | 35 | 18 | 130 | 132 |
| Pesticides and polychlorinated aromatic hydrocarbons | | | | |
| Aldrin | <0.1 | <0.1 | <0.1 | <0.1 |
| Chlordane | 14 | <1 | 270 | 2,700 |
| DDD | 71 | <0.1 | <0.1 | <0.1 |
| DDE | 2.1 | 1.5 | <0.1 | 0.0 |
| DDT | 7.1 | 31 | 71 | 1,400 |
| Diazinon | <0.1 | 0.1 | 1.6 | 18 |
| Dieldrin | 0.6 | 0.1 | 5.8 | 15 |
| Endosulfan | <0.1 | <0.1 | 11 | <0.1 |
| Endrin | <0.1 | <0.1 | <0.1 | <0.1 |
| Ethion | <0.1 | <0.1 | <0.1 | <0.1 |
| Gross PCB | 16 | 2 | 100 | <1 |
| Gross PCN | <1 | <1 | <1 | <1 |
| Heptachlor epoxide | <0.1 | <0.1 | <0.1 | 24 |
| Heptachlor | <0.1 | <0.1 | <0.1 | <0.1 |
| Lindane | <0.1 | <0.1 | <0.1 | <0.1 |
| Malathion | <0.1 | <0.1 | <0.1 | <0.1 |
| Methyl trithion | <0.1 | <0.1 | <0.1 | <0.1 |
| Methylparathion | <0.1 | <0.1 | <0.1 | <0.1 |
| Mirex | <0.1 | <0.1 | <0.1 | <0.1 |
| Methoxychlor | <0.1 | <0.1 | <0.1 | <0.1 |
| Parathion | <0.1 | <0.1 | <0.1 | <0.1 |
| Perthane | <0.1 | <0.1 | <0.1 | <0.1 |
| Silvex | 0 | 0 | 0 | 0 |
| Toxaphene | <1 | <1 | <1 | <1 |
| Trithion | <0.1 | <0.1 | <0.1 | <0.1 |
| 2,4-D | 0 | 0 | 0 | 0 |
| 2,4-DP | 0 | 0 | 0 | 0 |
| 2,4,5-T | 0 | 0 | 0 | 0 |

Most of the 28 pesticides and polychlorinated aromatic hydrocarbons for which samples were analyzed were either not present or were below detectable limits. The exceptions were chlordane, DDD, DDE, DDT, diazinon, dieldrin, endosulfan, gross PCB, and heptachlor epoxide; these were found in concentrations ranging from 0.6 µg/kg (dieldrin at Huntington) to 2,700 µg/kg (chlordane at Syosset). However, concentrations in stormwater and groundwater samples were below detectable limits in all but two instances, where total pesticide concentrations were less than 0.2 µg/L. (See appendix B and table 13B.)

These results are supported by a similar study by Seaburn and Aronson (1974), who found low concentrations (up to 0.08 µg/L) of DDD, DDT, and silvex in stormwater and much higher concentrations in basin soil. For example, the DDT content of soil from each of the three basins they sampled ranged from 18,000 to 300,000 times the concentration in stormwater inflow.

The presence of pesticides in basin soil in concentrations several orders of magnitude higher than those in inflow samples indicates that the pesticides are probably sorbed or filtered out in the soil layer and effectively removed from the infiltrating water (Seaburn and Aronson, 1974). Also, because the use of some pesticides has been curtailed in recent years, most of the pesticides in basin soil are probably derived from past use.

## SUMMARY AND CONCLUSIONS

Recharge basins have been used on Long Island since 1935 to collect urban storm runoff and to recharge the ground-water reservoir, which is the sole source of public supply for the residents of Nassau and Suffolk Counties. The Long Island Comprehensive Waste Treatment Management Study (Koppelman, 1978) implicated recharge basins as a possible major cause of ground-water contamination and suggested that they may concentrate undesirable urban runoff constituents and convey them to the underlying aquifers.

The objectives of this study, which was conducted during 1979-83 as part of the U.S. Environmental Protection Agency's Nationwide Urban Runoff Program, were to:

1. determine the source, type, quantity, and fate of contaminants in urban stormwater runoff; and

2. assess the effects of runoff on the chemical and microbiological quality of ground-water beneath the basins.

Forty-six storms at five recharge basins in representative land-use areas (strip commercial, shopping-mall parking lot, major highway, low-density residential, and medium-density residential) were monitored. Modified runoff/precipitation ratios indicate that all storm runoff consists of precipitation that falls on impervious surfaces in the drainage area except during storms of high intensity or long duration.

Samples were analyzed for standard constituents (listed in appendix A), heavy metals, organic compounds, and bacteria. In addition, soil and snow samples were collected to investigate the removal of selected stormwater constituents by soil during infiltration and the accumulation of some of these constituents on snow cover.

Concentrations of most measured constituents in individual stormwater samples were within Federal and State drinking-water standards. Exceptions were attributed to specific land uses and seasonal effects. Lead was present in highway runoff in concentrations up to 3,300 µg/L, and chloride in parking lot runoff was detected in concentrations up to 1,100 mg/L during winter, when salt is used for deicing.

Most of the load of heavy metals was removed during infiltration through the unsaturated zone, but neither nitrogen nor chloride was removed. Nitrogen concentrations in ground water often exceeded those in stormwater because the ground water contains nitrogen from other sources, including cesspools, septic tanks, and lawn fertilizers.

Of the five stormwater and nine ground-water samples that were analyzed for 113 USEPA-designated "priority pollutants," three contained a total of four constituents in concentrations exceeding New York State guidelines for a single organic compound in drinking water--namely, p-chloro-m-cresol (79 µg/L) and 2,4-dimethylphenol (96 µg/L) in ground water at the highway basin; 4-nitrophenol (58 µg/L) in ground water at the parking lot basin; and methylene chloride (230 µg/L) in stormwater at the highway basin. These samples also contained a combination of substances exceeding the guidelines for total organic constituents in drinking water. The presence of these constituents is attributed to point sources rather than to urban runoff; they are unrelated to the land use in the drainage area.

The median number of indicator bacteria in stormwater ranged from $10^8$ to $10^{10}$ MPN/100 mL. Fecal coliforms and fecal streptococci increased by 1 to 2 orders of magnitude during the warm season, but total coliform concentrations showed no significant seasonal differences.

Low-density residential and nonresidential (highway and parking lot) areas seemed to contribute the fewest bacteria to stormwater, and medium-density residential and strip commercial areas contributed the most. Virtually no bacteria were detected in the ground water beneath the recharge basins, which indicates complete removal during the infiltration of stormwater through the unsaturated zone.

Concentrations of lead in basin-bottom soil samples (70 µg/g at the low-density residential basin; 1,200 µg/g at the highway basin) reflect the land use in the drainage area and support the assumption that the metals dissolved in runoff are removed by adsorption onto near-surface soil particles in the unsaturated zone, and that those in particulate form are filtered out by the soil during infiltration.

Concentrations of pesticides in basin-bottom soil samples were generally much higher than those in stormwater, ranging from 0.6 µg/kg (dieldrin at the shopping-center basin) to 2,700 µg/kg (chlordane at the medium-density residential basin). This suggests that the pesticides are probably sorbed or

filtered out in the soil layer and are effectively removed from infiltrating water. Also, because pesticide use has been curtailed in recent years, most of the pesticides in basin soil are probably derived from past use.

In terms of the chemical and microbiological constituents of stormwater studied, the use of recharge basins on Long Island to dispose of storm runoff and to recharge the ground water does not appear to have significant adverse effects on ground-water quality.

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*Appendix A.--Standard chemical analysis.*

| | |
|---|---|
| Arsenic, dissolved | Lead, total |
| Arsenic, suspended | Magnesium, dissolved |
| Arsenic, total | Nitrogen, dissolved ($NO_2$ + $NO_3$ -N) |
| Cadmium, dissolved | Nitrogen, dissolved ($NH_4$ as N) |
| Cadmium, suspended | Nitrogen, dissolved ($NH_4$ + Organic -N) |
| Cadmium, total | Nitrogen, total ($NH_4$ + Organic -N) |
| Calcium, dissolved | Nitrogen, dissolved ($NH_4$ as $NH_4$) |
| Carbon, organic dissolved | pH, field |
| Carbon, organic suspended | pH, lab |
| Chloride, dissolved | Phosphate, ortho, dissolved -$PO_4$ |
| Chromium, dissolved | Phosphorous, orthophosphate, dissolved as P |
| Chromium, suspended | Potassium, dissolved |
| Chromium, total | Potassium 40, dissolved, PCI/L[1] |
| COD (chemical oxygen demand) | Sodium, dissolved |
| Color | Specific conductance, field |
| Fluoride, dissolved | Specific conductance, lab |
| Hardness, total | Sulfate, dissolved |
| Lead, dissolved | Turbidity (NTU)[2] EPA |
| Lead, suspended | Water temperature (°C) |

[1] Picocuries per liter
[2] Nephelometric Turbidity Units

*Appendix B.--U.S. Environmental Protection Agency Priority Pollutants.*

BASE/NEUTRAL-EXTRACTABLE COMPOUNDS

| | |
|---|---|
| acenaphthene | nitrobenzene |
| benzidine | N-nitrosodimethylamine |
| 1,2,4-trichlorobenzene | N-nitrosodiphenylamine |
| hexachlorobenzene | N-nitrosodi-n-propylamine |
| hexachloroethane | bis (2-ethylhexyl) phthalate |
| bis (2-chloroethyl) ether | butyl benzyl phthalate |
| 2-chloronapthalene | di-n-butyl phthalate |
| 1,2-dichlorobenzene | di-n-octyl phthalate |
| 1,3-dichlorobenzene | diethyl phthalate |
| 1,4-dichlorobenzene | dimethyl phthalate |
| 3,3'-dichlorobenzidine | benzo (a) anthracene |
| 2,4-dinitrotoluene | benzo (a) pyrene |
| 2,6-dinitrotoluene | 3,4-benzofluoranthene |
| 1,2-diphenylhydrazine (as azobenzene) | benzo (k) fluoranthene |
| | chrysene |
| fluoranthene | acenaphthylene |
| 4-chlorophenyl phenyl ether | anthracene |
| 4-bromophenyl phenyl ether | benzo (g,h,i) perylene |
| bis (2-chloroisopropyl) ether | fluorene |
| bis (2-chloroethoxy) methane | phenanthrene |
| hexachlorobutadiene | dibenzo (a, b) anthracene |
| hexachlorocyclopentadiene | indeno (1,2,3-cd) pyrene |
| isophorone | pyrene |
| naphthalene | 2,3,7,8-tetrachlorodibenzo-p-dioxin |

*Appendix B.--U.S. Environmental Protection Agency Priority Pollutants. (continued)*

VOLATILE ORGANIC COMPOUNDS

acrolein
acrylonitrile
benzene
carbon tetrachloride
chlorobenzene
1,2-dichloroethane
1,1,1-trichloroethane
1,1-dichloroethane
1,1,2-trichloroethane
1,1,2,2-tetrachloroethane
chloroethane
bis (chloromethyl) ether
2-chloroethylvinyl ether
chloroform
1,1-dichloroethylene
1,2-trans-dichloroethylene
1,2-dichloropropane
1,3-dichloropropylene
ethylbenzene
methylene chloride
methyl bromide
bromoform
dichlorobromomethane
trichlorofluoromethane
dichlorodifluoromethane
chlorodibromomethane
tetrachloroethylene
toluene
trichloroethylene
vinyl chloride

ACID-EXTRACTABLE COMPOUNDS

2,4,6-trichlorophenol
p-chloro-m-cresol
2-chlorophenol
2,4-dichlorophenol
2,4-dimethylphenol
2-nitrophenol
4-nitrophenol
2,4-dinitrophenol
4,6-dinitro-o-cresol
pentachlorophenol
phenol

PESTICIDES

aldrin
dieldrin
chlordane
4,4'-DDT
4,4'-DDE
4,4'-DDD
alpha-endosulfan
beta-endosulfan
endosulfan sulfate
endrin
endrin aldehyde
heptachlor
heptachlor epoxide
alpha-BHC
beta-BHC
gamma-BHC
delta-BHC
PCB-1242 (aroclor-1242)
PCB-1254 (aroclor-1254)
PCB-1221 (aroclor-1221)
PCB-1232 (aroclor-1232)
PCB-1248 (aroclor-1248)
PCB-1260 (aroclor-1260)
PCB-1016 (aroclor-1016)
toxaphene

*Appendix C.--Data-retrieval information.*

The following station-identification numbers can be used to retrieve stormwater flow and quality data, ground-water quality data, and precipitation quality data from the U.S. Geological Survey WATSTORE and EPA STORET data bases:

| Site | Station Number | Sample Type |
|---|---|---|
| Centereach | 405135073055101 | storm water |
| | 405135073055102 | ground water |
| | 405135073055103 | ground water |
| | 405135073055104 | precipitation |
| Huntington | 404932073243701 | storm water |
| | 404932073243702 | ground water |
| | 404932073243704 | precipitation |
| Laurel Hollow | 405124073292601 | storm water |
| | 405124073292602 | ground water |
| | 405124073292604 | precipitation |
| Plainview | 404713073273001 | storm water |
| | 404713073273002 | ground water |
| | 404713073273004 | precipitation |
| Syosset | 404815073294601 | storm water |
| | 404815073294603 | ground water |
| | 404815073294604 | precipitation |

*Appendix D.--Drinking-water standards of New York State, U.S. Public Health Service, and U.S. Environmental Protection Agency.*

[Values for inorganic chemical constituents are in mg/L; values for organic chemicals and pesticides are in µg/L]

| Constituent | Proposed New York State Drinking Water Standards (1977)[a] | Public Health Service Drinking Water Standards (1962)[b] | EPA National Interim Primary Drinking Water Regulations (1977)[c] |
|---|---|---|---|
| | A. INORGANIC CHEMICALS | | |
| Arsenic (As) | .05 | .05 | .05 |
| Barium (Ba) | 1.00 | 1.00 | 1.00 |
| Cadmium (Cd) | .01 | .01 | .01 |
| Chloride (Cl) | 250 | [d]250 | — |
| Chromium ($Cr^{+6}$) | .05 | .05 | [e].05 |
| Copper (Cu) | 1.00 | [d]1.00 | — |
| Cyanide (CN) | .20 | .20 | — |
| Fluoride (F) | 1.5 | [f]1.7 | [g]2.4 |
| Iron (Fe) | [h].30 | .30 | — |
| Lead (Pb) | .05 | .05 | .05 |
| Manganese (Mn) | [h].30 | [d].05 | — |
| Mercury (Hg) | .002 | — | .002 |
| Nitrate (as N) | 10.0 | 10.0 | 10.0 |
| Selenium (Se) | .01 | .01 | .01 |
| Silver (Ag) | .05 | .05 | .05 |
| Sodium (Na) | [i]20;270 | — | — |
| Sulfate ($SO_4$) | 250 | [d]250 | — |
| Total dissolved solids (TDS) | — | [d]500 | — |
| Zinc (Zn) | 5.00 | 5.00 | — |
| | B. ORGANIC CHEMICALS | | |
| Phenols | 1.0 | 1.0 | — |
| Vinyl chloride | 5.0 | — | — |
| Benzene | 5.0 | — | — |
| Individual organic | 50.0 | — | — |
| Total organics | 100.00 | — | — |
| | C. PESTICIDES | | |
| Aldrin | ND | — | [k]1.0 |
| Chlordane | 3.0 | — | 3.0 |
| DDT | ND | — | [k]50 |
| Dieldrin | ND | — | [k]1.0 |
| Endrin | .2 | — | .2 |
| Heptachlor | .1 | — | [k].1 |
| Heptachlor epoxide | — | — | [k].1 |
| Lindane | 4.0 | — | 4.0 |
| Methoxychlor | 100.0 | — | 100.0 |
| Toxaphene | 5.0 | — | 5.0 |
| 2,4-D | 100.0 | — | 100.0 |
| 2,4,5-TP (Silvex) | 10.0 | — | 10.0 |
| 2,4,5-T | — | — | [k]2.0 |

[a] From New York State Department of Environmental Conservation, 1977.
[b] From U.S. Public Health Service, 1962.
[c] From U.S. Environmental Protection Agency, 1976.
[d] This value should not be exceeded if more suitable water supplies are available.
[e] Total chromium.
[f] Standard ranges from 0.6 to 1.7 mg/L, depending on annual average of maximum daily air temperature.
[g] Standard ranges from 1.4 to 2.4 mg/L, depending on annual average of maximum daily air temperature.
[h] Combined concentration of iron and manganese shall not exceed 0.3 mg/L.
[i] Applicable to drinking water for those on severely and moderately sodium-restricted diets, respectively.
[j] Not detectable.
[k] U.S. Environmental Protection Agency (1973).

# APPENDIX 4.5-8

## Tables 4.5-35 and 4.5-36

**Table 4.5-35**
**Juvenile Justice Center Water Balance**

| Water Year | JJC Water Balances | | | |
|---|---|---|---|---|
| | Detention Basin Water Balance (AFY) | Dormant Agriculture (AFY) | Average Irrigation Recharge (AFY) | JJC Total (AFY) |
| 1979-1980 | 41 | 10 | 8 | 59 |
| 1980-1981 | 17 | 2 | 8 | 27 |
| 1981-1982 | 19 | 1 | 8 | 28 |
| 1982-1983 | 48 | 11 | 8 | 68 |
| 1983-1984 | 20 | 2 | 8 | 30 |
| 1984-1985 | 17 | 0 | 8 | 25 |
| 1985-1986 | 35 | 7 | 8 | 50 |
| 1986-1987 | 13 | 0 | 8 | 21 |
| 1987-1988 | 19 | 0 | 8 | 27 |
| 1988-1989 | 12 | 0 | 8 | 20 |
| 1989-1990 | 7 | 0 | 8 | 16 |
| 1990-1991 | 20 | 4 | 8 | 32 |
| 1991-1992 | 29 | 7 | 8 | 45 |
| 1992-1993 | 43 | 12 | 8 | 63 |
| 1993-1994 | 18 | 2 | 8 | 27 |
| 1994-1995 | 45 | 12 | 8 | 66 |
| 1995-1996 | 20 | 3 | 8 | 32 |
| 1996-1997 | 22 | 4 | 8 | 34 |
| 1997-1998 | 62 | 17 | 8 | 86 |
| 1998-1999 | 14 | 0 | 8 | 23 |
| Minimum | 7 | 0 | 8 | 16 |
| Maximum | 62 | 17 | 8 | 86 |
| 20-Year Ave | 26 | 5 | 8 | 39 |

**Table 4.5-36**
**Cumulative Impacts on Water Quantity**
**RiverPark Development and Juvenile Justice Center Development**

| Water Year | Existing Conditions Water Balance (AFY) | Project Water Balance (AFY) | Comparison of Project to Existing Conditions (AFY) | JJC Water Balance (AFY) |
|---|---|---|---|---|
| 1979-80 | 216.00 | 14,986.47 | 14,770.47 | 59.11 |
| 1980-81 | -461.00 | 7,359.33 | 7,820.33 | 27.38 |
| 1981-82 | -880.00 | 7,897.75 | 8,777.75 | 27.91 |
| 1982-83 | -414.00 | 13,957.96 | 14,371.96 | 67.64 |
| 1983-84 | -1,489.00 | 3,523.78 | 5,012.78 | 29.60 |
| 1984-85 | -1,160.00 | 81.21 | 1,241.21 | 25.27 |
| 1985-86 | -455.00 | 11,249.31 | 11,704.31 | 50.36 |
| 1986-87 | -1,185.00 | 2,458.68 | 3,643.68 | 20.80 |
| 1987-88 | -785.00 | 2,553.25 | 3,338.25 | 26.88 |
| 1988-89 | -668.00 | 632.78 | 1,300.78 | 20.47 |
| 1989-90 | -583.00 | 269.41 | 852.41 | 15.51 |
| 1990-91 | -516.00 | 3,889.64 | 4,405.64 | 32.33 |
| 1991-92 | -28.00 | 13,398.15 | 13,426.15 | 44.71 |
| 1992-93 | 136.00 | 15,293.78 | 15,157.78 | 63.15 |
| 1993-94 | -852.00 | 9,663.97 | 10,515.97 | 27.47 |
| 1994-95 | 99.00 | 14,099.52 | 14,000.52 | 66.08 |
| 1995-96 | -780.00 | 9,593.05 | 10,373.05 | 31.99 |
| 1996-97 | -867.00 | 8,969.45 | 9,836.45 | 34.25 |
| 1997-98 | 343.00 | 5,595.97 | 5,252.97 | 86.36 |
| 1998-99 | -1,130.00 | 3,054.32 | 4,184.32 | 22.69 |
| Minimum | -1,489.00 | 81.21 | 852.41 | 15.51 |
| Maximum | 343.00 | 15,293.78 | 15,157.78 | 86.36 |
| 20-Year Average | -572.95 | 7,426.39 | 7,999.34 | 39.00 |