Rainbow Valley Basin
Groundwater Management Plan

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Acronyms and Abbreviations

Basin – Rainbow Valley Basin
bgs – below ground surface
BMPs – best management practices
Caltrans – California Department of Transportation
CUWCC – California Urban Water Conservation Council
CWC – California Water Code
cfs – cubic feet per second
District – Rainbow Municipal Water District
DWR – Department of Water Resources
EC – electrical conductivity
ELAP – Environmental Laboratory Accreditation Program
EPA – Environmental Protection Agency
gpm – gallons per minute
GMP – Groundwater Management Plan
MCL – maximum contaminant level
msl – mean sea level
MOU – memorandum of understanding
MWD – Metropolitan Water District
umhos/cm – micromhos per centimeter
MRCD – Mission Resource Conservation District
mg/l – milligrams per liter
ml – milliliter
MPN – most probable number
ppm – parts per million
RWQCB – Regional Water Quality Control Board
SANDAG – San Diego Association of Governments
SDCWA – San Diego County Water District
TDS – total dissolved solids
TMDL – total maximum daily load
ULFT – ultra low flow toilet
USGS – United States Geological Survey
WRCC – Western Regional Climate Center

EXECUTIVE SUMMARY

The Rainbow Municipal Water District (District) is considering ways to manage and use groundwater, primarily within the area of Rainbow Valley located east of Interstate 15 (I-15). This Groundwater Management Plan (GMP) has been prepared by Dudek & Associates (Dudek) on behalf of the District in accordance with Assembly Bill 3030 (AB 3030). The Rainbow Valley Watershed described in this report represents a small portion of the District's service area; however it is an area where the District currently imports approximately 1500 acre-feet of water per year for customers. As a result of the import of water since the 1950s in combination with the characteristics of Rainbow Valley Basin (Basin), groundwater has accumulated in the Basin, and it is now essentially full. This GMP describes work done by Dudek on the behalf of the District to evaluate the hydrologic conditions and to assess potential groundwater use and management options.

ES-1 Background

Rainbow Valley (Valley) is located in San Diego County, adjacent to Riverside County (Figure 1). Rainbow Valley Watershed is a 5864-acre watershed that includes Rainbow Valley Basin (the groundwater basin of Rainbow Valley located east of I-15). Rainbow Valley Basin is generally surrounded by foothills composed of granitic rock. The geology and shape of the Valley is such that the large quantities of water imported to the Valley are now stored in the Basin. This has led to a high water table in the Valley floor, which, in turn, has led to failed septic systems and a resultant ban on new construction in the Valley floor. It has also likely led to year-round (perennial) flow of water in Rainbow Creek east of I-15.

Land use in Rainbow Valley consists mostly of agricultural uses. Between 1095 and 3818 acre-feet of water have been imported into the Rainbow Creek Sub-Watershed, which includes the Basin, on an annual basis since 1966 (Watermaster 2004). The majority of water imported to Rainbow Valley is applied as irrigation to agricultural land and the remainder is used for residential and other limited commercial uses. Agricultural irrigation water adds to both groundwater in the Basin through infiltration and to surface water in Rainbow Creek through surface runoff. Also, since there is no sewer collection system in the Basin, additional water enters the groundwater system from septic discharge.

Agricultural irrigation runoff and septic systems add nitrogen and phosphorous to surface water and groundwater. These chemicals are referred to as nutrients since they promote aquatic and terrestrial plant growth. These nutrients, among other contaminants, have led to the degradation of groundwater and surface water quality. Rainbow Creek, which flows through Rainbow Valley (Figure 2) to the Santa Margarita River, is listed on the Clean Water Act Section 303(d) list of impaired water bodies due to elevated nutrient concentrations. This listing has led to the development of Total Maximum Daily Loads (TMDLs) for Rainbow Creek by the San Diego Regional Water Quality Control Board

(RWQCB). The TMDLs may ultimately lead to additional land use or operational constraints imposed by the RWQCB.

ES-2 Objectives

This GMP has been prepared in order to address three main issues related to groundwater in Rainbow Valley Basin; the use of only imported water, the high water table, and poor water quality.

The objectives of the GMP are to evaluate means to:

- Provide a safe, reliable local water supply
- Reduce dependence on imported water by developing a local groundwater supply
- Lower the groundwater table within Rainbow Valley east of I-15
- Improve water quality (both surface and groundwater)
- Educate the agricultural and residential communities regarding best management practices they can implement

To date there has been no comprehensive evaluation of hydrologic conditions with the groundwater basin. Thus, preparation of this GMP required the compilation and analysis of previously-collected data and has led to recommendations for further data collection and monitoring since extensive data gaps were determined to exist. Additionally, Dudek has conducted an initial evaluation of potential projects that could be implemented in the Basin in order to address these objectives. The Potential Projects report presents groundwater extraction and treatment options and wastewater disposal options (Dudek 2005a).

ES-3 Conceptual Model

Physical Setting

The Rainbow Valley Watershed (Watershed) includes the approximately 500-acre Rainbow Valley Basin located east of I-15, located within the unincorporated community of Rainbow. The Basin is located within Rainbow Valley and is bounded by foothills. The majority of Rainbow Creek is located within the Rainbow Valley Watershed. After exiting the Rainbow Valley Watershed approximately 2 miles east of I-15, Rainbow Creek receives additional flow from tributaries outside of the District service area and eventually flows into the Santa Margarita River (Figure 2).

In order to evaluate the groundwater basin and the Watershed, Dudek compiled data from numerous sources; however, very limited data were available. The data included one period of groundwater monitoring, which included four groundwater quality samples collected in April 1989, approximately three years of periodic surface water monitoring, and very limited geologic and hydrogeologic information. Based on the limited data Dudek made several assumptions that included the locations of where Rainbow Creek is

a gaining stream, the location of a groundwater divide, and the shape and size of the groundwater basin. These assumptions were used in order to evaluate the basin with regard to the overall water balance, estimating contributions to poor water quality, the cause of high water levels, and the overall potential to produce groundwater, lower water levels, and improve water quality.

Figure 3 illustrates the conceptual model for the Basin and the components of the water balance. The geology in the Basin is shown as including a thin layer of alluvium, underlain by a large bowl of residuum, which includes decomposed and weathered granite. The residuum is in contact with fractured granitic rocks. The water table is located within a few feet of the surface due to the shape of the Basin and the cumulative effect of of imported water delivered to the Valley since the 1950s.

Imported water return flow from residential and agricultural uses and precipitation contribute water to the Basin. Data suggest the existence of a fully-saturated aquifer system and that the Basin is essentially full. Water leaves the Basin through evapotranspiration and stream flow out of the Basin. Water in Rainbow Creek represents a combination of storm water runoff, irrigation runoff, and groundwater.

Water Balance and Storage

A water balance has been calculated for the Watershed. It is based on limited data for 1990 to 1991 as follows:

Water Balance (values in acre-feet per year for October 1990 - 1991)

Inflows		Outflows		Change in Storage	
Precipitation[1]	9054	Evapotranspiration[4]	8564	Water Level Rise[8]	11
Imported Water[2]	1168	Stream Flow[5]			
Groundwater Inflow[3]	0	Runoff	1473		
		GW Baseflow	164		
		Pumping[6]	10		
		Other GW Outflow[7]	0		
TOTAL	10222	-	10211	=	11

Notes: 1) Estimated rainfall of 18.5 inches over 5864 acres (Section 2.3)
2) Estimated from District Delivery Records by applying a ratio of water delivered to the Watershed area to water delivered to the entire District service area for 1999-2003 to the reported values of water delivered to the entire District service area for October 1990-1991.
3) No net groundwater inflow to Watershed assumed
4) Determined from water balance, compares favorable with calculated value (Section 2.5.2.3)
5) Total stream flow from USGS Station daily stream flow. Groundwater baseflow was estimated to account for 10 percent of stream flow (Section 2.5.1).
6) Estimate of 20 dwelling units extracting 0.5 acre-feet per year each
7) Groundwater outflow from Basin assumed as groundwater discharge to Rainbow Creek (Section 2.5.2.2)
8) Calculated based on depth to groundwater in four wells in the Basin (Section 2.5.2.3)

Based on assumptions regarding the geology of the Basin, the groundwater storage in the residuum was calculated as potentially ranging from approximately 11,900 to 59,500 acre-feet.

Existing Groundwater Production

Groundwater wells have been installed in the Watershed. Based on driller's logs obtained from the Department of Water Resources, several existing, private wells pump groundwater from the fractured granitic rocks at rates typically less than 25 gallons per minute. The total depths of the majority of these wells were between 400 and 1000 feet below ground surface. An annual extraction of 10 acre-feet has been estimated, but no direct measurements appear to be available.

Water Quality

Water quality is of great importance in determining the usability of the groundwater resource. One measure of water quality is the total dissolved solids (TDS) contents of the water. State drinking water regulations recommend a limit of 500 milligrams per liter (mg/l) TDS with an upper limit of 1,000 mg/l due to taste considerations. For reference, water imported by the District has a TDS of 436 to 563 mg/l (RMWD 2003). Water used for irrigation should generally not exceed 450 to 2000 mg/l depending on water chemistry and intended use. Although limited data are available, the Basin appears to have high TDS water. Groundwater samples obtained from shallow wells in 1989 indicate a range of 370 to 2330 mg/l TDS. Samples from Rainbow Creek during low flow (base flow) conditions demonstrate a range of 793 to 1325 mg/l.

Nutrients, primarily nitrate and phosphate, are of concern in Rainbow Creek. Surface water quality has been monitored by Camp Pendleton between 1970 and 1988, by Mission Resource Conservation District in 1995/1996 and 1998/1999, and by the Regional Water Quality Control Board in 2000. According to these data, concentrations of nitrate as nitrogen peaked in the mid 1980s at 77 mg/l. Average wet-weather concentrations of nitrate as nitrogen between 1995 and 2000 ranged from 3 to 17 mg/l in the Valley. Average dry-weather concentrations at Station 3, just downstream of the Valley floor, ranged from 0.3 to 8 mg/l. Average wet-weather phosphate as phosphorus concentrations ranged from 0.96 to 1.9 mg/l.

Concentrations of nitrate as nitrogen in groundwater averaged 228 mg/l in 1989. Concentrations of TDS averaged 1430 mg/l in 1989. These groundwater data are the average of one sample collected from each of four wells in April of 1989; therefore, the data are very limited. Additional water quality data are required to further develop the GMP and to evaluate potential projects.

ES-4 Potential Groundwater Management Actions

Currently the District only supplies imported water. Therefore, the District does not currently have a need to manage the groundwater basin in Rainbow Valley. However,

this GMP evaluates future options for groundwater production and groundwater basin management because the District has a right to recover and re-use imported water that accumulates in the Basin.

Potential Projects

The District may implement projects to meet GMP objectives. Potential projects could include groundwater extraction and treatment for domestic or irrigation purposes or groundwater extraction and blending with the raw water supply to reduce TDS. Depending on the subsurface conditions, which have not yet been fully defined, potential projects could also include wet season storage of imported water in the aquifer for use during summer months when costs to import water are higher. Additional data and information are needed prior to evaluation of specific potential projects.

Groundwater production projects could result in a lower water table. A lower water table could result in the proper function of septic systems, which, in turn could result in an improvement in water quality.

Recommended Actions

Future data collection and feasibility studies for projects, such as groundwater production projects, are recommended to fill many of the data gaps noted in this report and to better understand the potential to effectively extract and use groundwater from the residuum in the Basin. Additionally, the effectiveness of extraction and treatment methods, the sustainability of groundwater extraction, and the potential restrictions, such as biological impacts associated with decreased dry season stream flow (west of I-15), should be evaluated. Data collection should include boring logs from the Basin, pump tests, water elevation data, water quality data, and stream flow and quality data.

Evaluation Monitoring

Prior to and during implementation of a project, surface water and groundwater levels and quality should be monitored on a regular basis. The data would be collected and evaluated to determine the state of the Basin and assess the effectiveness of the potential project in meeting GMP objectives.

Best Management Practices

Groundwater production in the Basin would likely lower the water table, which would likely lead to improved groundwater quality if septic systems are allowed to work properly. Greater improvements in water quality would likely be the result of the implementation of best management practices (BMPs), such as those for agricultural irrigation and domestic septic systems. Additionally, BMPs for conservation would be an important part of managing the Basin.

ES-5 Continued Stakeholder Involvement

The main purpose of this GMP is to identify potential groundwater use and management options available to the District. Once additional data are obtained to support a refinement of the options presented in this GMP, the District will be in a position to propose specific GMP projects.

Updates to this GMP should occur every five years, or more frequently if a specific project or management plan is to be implemented. Updates should include an evaluation of new data collected and the status of studies, implementation, and/or effectiveness of potential projects. Stakeholders will be involved in this process. Additionally, an advisory committee will be formed following adoption of the plan to manage and provide further development of the GMP.

1 INTRODUCTION

1.1 Plan Authority and Administration

The Rainbow Municipal Water District Board of Directors formally approved Resolution No. 02-18 on November 6, 2002. The Resolution directed the District to submit a grant application to the California Department of Water Resources (DWR) pursuant to the Local Groundwater Management Assistance Act of 2000, Assembly Bill 303 (Grant). Following acceptance of the Grant by DWR on July 9, 2003, the Resolution directed the District to enter an agreement with DWR to receive the Grant for development of the Rainbow Valley Basin Groundwater Management Plan in accordance with the provisions of Assembly Bill 3030. On November 5, 2003, the District Board adopted Resolution No. 03-27 for the intention of drafting the Rainbow Valley Basin Groundwater Management Plan.

The Rainbow Valley Basin is a groundwater basin underlying Rainbow Valley, located in the northern San Diego County near the San Diego County and Riverside County line (Figure 1). The Basin is located within the unincorporated community of Rainbow and is surrounded by the neighboring communities including Fallbrook, Pala, and Bonsall. The Basin is located within Rainbow Valley and is bounded by foothills to the north and east and in some areas to the west and south. The land uses in the Valley include orchards, commercial nurseries, and rural residential areas.

The Basin is located in the eastern portion of the Vallecitos Hydrologic Subarea within the DeLuz Hydrologic Area. The DeLuz Hydrologic Area is part of the Santa Margarita Hydrologic Unit.

1.2 Plan Objectives

The Rainbow Valley Basin GMP was developed collectively with input from the community, local regulatory agencies, and the District. The GMP is intended to provide the basis for long-term management of the Rainbow Valley Basin to benefit current and future agricultural, environmental, rural, and urban needs and seeks to establish a local, safe, and reliable water resource alternative. The objectives of the Rainbow Valley Groundwater Management Plan and potential management actions are listed in Table 1, below.

Table 1 – Management Objectives

Management Objective	Rationale	Potential Management Actions
Provide a safe, reliable local groundwater supply and reduce	The District receives 100 percent of its water supply from imported water. Supplementing the water supply with local water would • potentially lower the cost of water	Potential projects for groundwater production are discussed in the Potential Projects in Rainbow Valley Basin Report (Dudek 2005a).

dependence on imported water	for the District, • meet San Diego County Water Authority and Metropolitan Water District recommendations to seek local water supply, • provide additional resources for emergency use and critical water shortages, and • meet CALFED objectives	Water conservation measures could reduce the dependence on imported water. Conservation measures are discussed in Section 3. Best management practices can be implemented to help maintain water quality in the Basin. BMPs are discussed in Section 3.
Lower the groundwater table within Rainbow Valley	The high water table in Rainbow Valley has led to septic system failure and ground saturation in the Valley floor.	Potential projects that would result in the lowering of the groundwater table are discussed in the Potential Projects in Rainbow Valley Basin Report (Dudek 2005a). Best management practices for septic systems can be implemented to help maintain proper septic system operation. Groundwater elevations in the Valley can be measured quarterly.
Improve surface and groundwater quality	Rainbow Creek is listed on the Clean Water Act Section 303(d) list of impaired water bodies due to elevated nutrient concentrations. Additionally, very limited groundwater data indicate high concentrations of nutrients and total dissolved solids (TDS).	Best management practices can be implemented to help maintain surface and groundwater quality in the Basin. Lowering of the groundwater table would lead to improved septic tank operation and improved water quality. Groundwater and surface water monitoring can be conducted to measure changes in water quality over time.
Educate the agricultural and residential communities regarding reducing discharges to the surface and groundwater	The Rainbow Creek TMDLs, adopted by the San Diego RWQCB in February 2005, lists limits for nitrate, nitrogen, and phosphorus in Rainbow Creek and sites agricultural and residential communities as contributing to the nutrient load in Rainbow Creek.	Best management practices for septic systems and agricultural land can be implemented to help maintain water quality in Rainbow Creek. Mission Resource Conservation District and the United States Department of Agriculture currently organize BMPs for agricultural developments and residences. Additionally, the County of San Diego has plans to implement BMPs for residential septic tanks.

1.3 Regulatory Setting

This GMP has been prepared in accordance with AB 3030 and California Water Code (CWC) requirements. These requirements are discussed further in Section 1.4.

The GMP management objectives are intended to provide a local groundwater supply and improve surface and groundwater quality. These two main objectives involve several regulatory agencies and orders, as follows:

Developing a local groundwater supply

Rainbow Municipal Water District is a special district, organized under the California Water Code. The District purchases water from the San Diego County Water Authority (SDCWA), which purchases the water from the Metropolitan Water District (MWD).

Groundwater production from Rainbow Valley is subject to the existing water rights. If the District were to reduce dependence on imported water supplied by SDCWA and MWD by developing a groundwater supply, a number of water rights-related conditions would apply. The Rainbow Valley Basin is a part of the Santa Margarita Watershed, which has been adjudicated. The water rights for the Rainbow Creek Sub-Watershed were defined by the United States District Court in the October 1962 Interlocutory Judgment No. 42. The judgment stated that, as of the 1962 judgment, there were no presently vested or inchoate appropriative rights to any of the waters of the Rainbow Creek Sub-Watershed and that water rights of the Santa Margarita River system are subject to the continuing jurisdiction of the Court, as handled by the Santa Margarita River Watermaster. Additional information on water rights is included in Section 2.6.4.

If the District were to produce groundwater from the Basin and flow in Rainbow Creek was affected, agencies such as the Army Corps of Engineers, the United States Fish and Wildlife Service, the California Department of Fish and Game, and the RWQCB may be involved in potential mitigation measures or permitting, as discussed in the Biological Constraints Report (Dudek 2005b).

Improving water quality

Rainbow Creek is listed on the Clean Water Act Section 303(d) list of impaired water bodies due to elevated nutrient concentrations. Section 303(d) establishes the TMDL process to provide controls to improve water quality. The San Diego RWQCB developed and adopted TMDLs for Rainbow Creek (RWQCB 2005). San Diego County was directed by the RWQCB in the TMDLs to monitor groundwater and surface water along Rainbow Creek Watershed. Although the District was not directed by the RWQCB to conduct monitoring, it is in the District's best interest to manage the Basin and the water quality of the Basin.

1.4 Plan Development Process and Components

The Rainbow Valley Basin Groundwater Management Plan includes required, recommended, and voluntary components as listed in CWC 10750 et seq. and DWR Bulletin 118-223. The following table presents the Plan components and identifies the location where individual components are presented in the Plan. The GMP development process is described in California Water Code 10753.2-10753.6.

Table 2 – GMP Components

Plan Component	GMP Section
CWC Section 10750 et seq., Mandatory Components	
1. Documentation of public involvement statement (CWC 10753.4(b))	5.2
2. Establish management objectives (CWC 10753.7 (a)(1))	1.2
3. Establish monitoring plan (CWC 10753.7 (a)(1))	3.3, 3.4
4. Involvement of other agencies (CWC 10753.7 (a)(2))	3.3, 5.1
5. Adoption of monitoring protocols (CWC 10753.7 (a)(4))	3.3, 3.4
6. Map of groundwater basin, showing local agency boundaries and boundary as defined in DWR Bulletin 118 (CWC 10753.7 (a)(3))	Figure 2, Figure 4, Figure 5
7. For agencies not overlying groundwater basins, prepare GMP using appropriate geologic and hydrogeologic principles (CWC 10753.7 (a)(5))	1.1
CWC Section 10750 et seq., Voluntary Components	
8. Administration of well abandonment and well destruction program	3.3
9. Monitoring of groundwater levels and storage	3.3.1
10. Identification of well construction policies	3.3
11. Construction and operation by local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	3.2
12. Development of relationships with state and federal regulatory agencies	1.3, 5.1
DWR Bulletin 118 Suggested Components	
13. Manage with guidance of advisory committee	1.5, 5.3
14. Describe area to be managed under GMP, including the physical setting and historical and projected water demands and supply	2
15. Create link between management objectives and actions of GMP	1.2
16. Describe GMP monitoring program	3.3, 3.4
17. Describe integrated water management planning efforts	2.6.3
18. Report on implementation of GMP	3.3, 3.4, 3.5, 6
19. Evaluate GMP periodically	6

1.5 Public Outreach and Education

Public outreach and education is one of the defined goals of the GMP. Public outreach required under CWC 19753.2-10753.6 is ongoing. The initial work was completed thorough public meetings, informational mailings, website and newspaper notices, and public workshops.

An advisory committee will be formed following adoption of the plan to manage and provide further development of the GMP. The advisory committee members will include

members of the residential and business communities, Mission Resources Conservation District, and other stakeholders.

Data presentations and public workshops were held on 2/15/05, 3/17/05, and 5/5/05 to discuss development of the GMP. The purpose of these meetings and workshops was to share data and obtain input for the development of the GMP from local residents, businesses, community groups and other stakeholders.

1.6 Organization of AB3030 Groundwater Management Plan

The Groundwater Management Plan is organized as follows:

Section 1.0	Introduction
Section 2.0	Physical Setting
Section 3.0	Plan Implementation
Section 4.0	Groundwater Sustainability
Section 5.0	Stakeholder Involvement
Section 6.0	Groundwater Management Plan Reporting and Updating
Section 7.0	Recommendations
Section 8.0	References

Documents produced in support of or otherwise related to this GMP are the March 2005 Biological Constraints Report and the April 2005 Potential Projects in Rainbow Valley Basin.

2. PHYSICAL SETTING

2.1 Introduction

The Rainbow Valley Watershed is located in northern San Diego County and Southern Riverside County along the San Diego County and Riverside County line (Figure 1). The Rainbow Valley Watershed is located in Township 9S, Range 3W, Sections 1, 2, 3, 4, 9, 10, 11, 12, and 16, Township 9S, Range 2W, Sections 5, 6, and 7, Township 8S, Range 3W, Section 36, and Township 8S, Range 2W, Sections 31 and 32. The Rainbow Valley Watershed comprises approximately 5864 acres (Figure 2).

The Watershed boundary presented in Figure 2 and used for this study is the boundary defined by the RWQCB in the January 27, 2005 Redline Draft TMDL Report, east of the Rainbow Municipal Water District and Fallbrook Public Utilities District Boundary. Figure 4 presents other boundaries previously identified for the Rainbow Creek area. These are watershed boundaries defined by Camp Pendleton and referenced in Interlocutory Judgment No. 42 and the hydrologic sub-units defined by the RWQCB (RWQCB 1994). The watershed boundaries differ most in areas north of Gomez Creek (southeast portion of the Watershed) and along the southern portion of Rainbow Valley, just east of I-15. These are two areas with relatively flat topography. According to the Interlocutory Judgment No. 42, "Due to the generally level terrain of Rainbow Valley, the watershed divide is not readily identifiable from surface inspection, and its exact location can only be determined by engineering means" (US District Court 1962).

The Rainbow Valley Watershed includes the Rainbow Valley Basin (Basin; groundwater basin), which is located within the unincorporated community of Rainbow. The Basin is located within Rainbow Valley and is bounded by foothills. Due to the limited availability of boring logs within the Basin and until additional data is obtained, the Basin is approximated by the boundary of the Valley floor (Figure 5).

The majority of Rainbow Creek is located within the Rainbow Valley Watershed. Rainbow Creek headwaters begin in the hills east of Rainbow Valley, run through Rainbow Valley Basin, exit the Valley near the I-15, and flow through the hilly area west of the I-15. After exiting the Rainbow Valley Watershed, Rainbow Creek receives additional flow from tributaries outside of the District service area and eventually flows into the Santa Margarita River. Rainbow Creek and associated streams are shown on Figure 2.

Within Rainbow Valley Basin, data suggests the existence of a fully saturated aquifer system. The combination of the geology of the area, which is assumed to be a bowl-shaped contact of residuum with fractured granite with one main exit for groundwater flow out of the Basin (Figure 3), and heavy agricultural use, which results in the addition of imported water to the subsurface, has resulted in a water level in the majority of the Basin that is within a few feet of the ground surface.

This section presents data and information that was compiled in an attempt to understand the physical setting in the Basin. The data may also be used to evaluate potential projects that may address the goals discussed in Section 1. The goals include lessening the dependence of the District on imported water, lowering the water level in the Basin, and improving water quality.

Data and information compiled during the preparation of this GMP included:

Table 3 – Compiled Data Sources

Report/Information	Author	Date
Precipitation and Evaporation		
Escondido2 Daily Precipitation	Western Regional Climate Center (WRCC)	1979-2004
Fallbrook and Hines Precipitation	National Weather Service and Hines Nursery	2000
Precipitation at Rainbow Conservation Camp	California Department of Forestry	1988-1993
Red Mountain Reservoir Precipitation and Evaporation Data	Fallbrook Public Utilities District	1997, 2003-2004
Evaporation from Water Surfaces in California	DWR	Nov 1979
Geology		
Drillers Well Logs	DWR	Various
Cross Section at I-15 and Rainbow Creek	Caltrans	1981
Stream Flow		
Rainbow Creek Daily Stream Flow Data	United States Geological Survey (USGS)	11/89 – 2004
2000 Stream Flow Data	RWQCB	2000
Groundwater Levels		
Water Level Measurements	San Diego County	1987-1992
Ground-Water Levels for California	USGS Water Resources	1950s – 1970s
Water Rights		
Findings of Fact, Conclusions of Law and Interlocutory Judgment: Rainbow Creek Sub-Watershed	United States District Court	Oct 1962
Santa Margarita Watershed Annual Watermaster Report	Santa Margarita Watershed Watermaster	August 2004
Surface Water Quality		
Willow Glen Basin Non-Point Source Nitrate Reduction Program	Mission Resource Conservation District (MRCD)	Nov 1999
Surface Water Quality Field Data	MRCD	1998-1999
Basewide Water Requirement/Availability Study	Camp Pendleton/Leedshill Herkenhoff	1988
Rainbow Creek TMDL Study Surface Water Data	RWQCB	2000

Groundwater Quality		
Groundwater Evaluation of Rainbow Valley	John Peterson, San Diego County	April 1989

2.2 Topography

The elevations within the Rainbow Valley Watershed range from approximately 2100 feet above mean sea level (msl) at the eastern edge of the Watershed to approximately 700 feet msl at the western edge of the Watershed (USGS 1975). The topography slopes steeply from Mt. Olympus, at the eastern edge, toward the valley that contains the Rainbow Conservation Camp at approximately 1550 feet msl. The ground surface elevation rapidly decreases between the Rainbow Conservation Camp and Rainbow Valley. The elevation of Rainbow Valley ranges from 1100 to 1050 feet msl; however, the elevation in the majority of the Valley is between 1060 and 1050 feet msl. West of the freeway, the elevation of Rainbow Creek ranges from approximately 1000 to 700 feet msl while the surrounding hills reach approximately 1300 feet msl.

2.3 Climate

Rainbow has a mild climate, with warm summers and mild winters. Summer highs and lows in near-by Fallbrook average 89 and 61 degrees Fahrenheit and winter highs and lows in Fallbrook average 64 and 44 degrees according to combined information from WorldClimate and the National Weather Service. Data from the Western Regional Climate Center "Escondido 2" station yield similar average temperatures.

Rainfall generally occurs during the months of November through March. Average annual rainfall based on a correlation of limited data from Rainbow Conservation Camp with the Escondido 2 data for the period of record (between 1980 and 2003) is 18.4 inches per year, with approximately 85 percent occurring during November through March. Rainbow Conservation Camp is located near the eastern portion of the Watershed and Escondido 2 is located approximately 20 to 25 miles south of Rainbow.

Pan evaporation data from near-by reservoirs Red Mountain Reservoir, Lake Wohlford, and Vail Lake were used to estimate the evaporation in the irrigated areas of the Rainbow Valley Watershed. Data from Red Mountain Reservoir from 1997 was used (Nehan pers. com. 2004). Red Mountain reservoir is located approximately 2 miles southwest of Rainbow Valley Basin, at an elevation of approximately 1100 feet msl. Data from Lake Wohlford from the years 1941 to 1946 was used (DWR 1979). Lake Wohlford is located approximately 19 miles south of Rainbow Valley Basin, at an elevation of approximately 1500 feet msl. Data from Vail Lake from the years 1952 to 1976 was used (DWR 1979). Vail Lake is located approximately 15 miles east of Rainbow Valley Basin, at an elevation of approximately 1350 feet msl. The data were averaged to estimate the evaporation in the irrigated areas of the Rainbow Valley Watershed as approximately 52.85 inches per year. Calculations and pan coefficients used are included in Appendix A.

2.4 Geology

The Rainbow Valley Basin is located within the Peninsular Ranges geomorphic province that extends from the Los Angeles Basin into Baja California, Mexico. The Peninsular Ranges are underlain primarily by plutonic rocks formed by the cooling of molten magmas deep within the earth's crust during a subduction of an oceanic crustal plate with the North American Plate between 140 and 90 million years ago. Metamorphic rocks were also produced over this period of time when the intense heat of magmas metamorphosed older sedimentary rocks.

Surficial geologic maps from the USGS Southern California Areal Mapping Project available for the Rainbow Watershed reveal the existence of the Granodiorite of Rainbow formation (Kr), a plutonic rock that comprises most of the slopes of the eastern portion of the Watershed from Mt. Olympus to the slopes surrounding the Rainbow Valley. The Granodiorite of Rainbow is described as being Cretaceous in age (138-63 million years) and comprised of leucocratic hornblende-biotite granodiorite with medium to coarse grains and massive. The USGS geologic map describes the majority of the surficial soils in Rainbow Valley (Qoa) as older alluvial flood plain deposits; Pleistocene in age, younger than 500,000 years (USGS 2000; Figure 6). The alluvium is further described as being mostly well consolidated, poorly sorted, permeable flood plain deposits. Active alluvial flood plain deposits (Qa) are mapped in association with those undergoing deposition by Rainbow Creek and are described as late Holocene in age (less than 10,000 years), unconsolidated sand and gravel deposits in active alluvial flood plains. Further west of the Rainbow Valley and I-15, the slopes transition from the Rainbow Granodiorite into Gabbro undivided (Kgb) of Cretaceous age. The Gabbro undivided is also a plutonic rock comprised of mostly biotite-hornblende-hypersthene gabbro and is coarse grained, dark gray, and massive. Other rock types in the Watershed include a Tonalite undivided (Kt) formation, Cretaceous in age and located immediately to the south of the Rainbow Valley. Additionally, metavolcanic and metasedimentary rocks (KJm) of Cretaceous and Jurassic age exist to the southwest of Rainbow Valley.

The well logs obtained from the DWR provide information about the geology and soils beneath the surface in the Watershed (Figure 7). In general, sandy loam, also referred to as topsoil was reported between 0 and 3 feet below ground surface. However, this varied greatly depending on location. Some well logs reported little to no topsoil whereas others reported as much as 9 feet of topsoil including loose soil and rocks. In general, the steeper upper slope areas are expected to have thinner soil accumulation than the intermediate or lower slope areas. For example, the driller's log for one well located within the Valley floor (P-19), reported 3 feet of sandy loam. Decomposed granite, or residuum, is reported in varying thicknesses between 0 and 128 feet below ground surface, beneath the topsoil and loose soil and rocks (alluvium). Residuum is defined by H.E. LeGrand as weathered material, including the soil, down to fresh, unweathered rock (Dictionary Page-Geology 2005). According to the log for well P-19, decomposed granite (residuum) is reported between 3 and 48 feet below ground surface. Underlying the decomposed granite, weathered granitic rocks (also residuum) are generally found in

varying thicknesses between 11 and 367 feet thick. Weathered granitic rocks were reported in the log for well P-19 between 48 and 415 feet below ground surface. Basement rock or unaltered granitic rock is first encountered at varying depths throughout the watershed between 0 and 415 feet below ground surface. The basement rock also contains water-bearing fractures. According to the log for well P-19, basement rock was encountered at 415 feet below ground surface. These observations support the generalization that basement rock will be encountered at shallower depths in the steeper upslope areas and at deeper depths in the lower slope areas and valleys.

Figure 3 presents a conceptual model of the subsurface conditions along Rainbow Creek in the Valley. The interpreted thicknesses of the alluvium and residuum are generally based on the review of the sparse well logs.

Surficial soils in the Rainbow Valley are mainly comprised of sandy loam that forms from the granitic alluvium in alluvial fans. According to the Rainbow Community Plan, the sandy loam is underlain at a shallow depth in many places with hardpan exacerbating drainage problems for crops and residences (San Diego County 1988). For a more thorough description of soils in Rainbow Valley and Rainbow Creek, refer to the Biological Constraints Report by Dudek completed in March 2005 (Dudek 2005b).

2.5 Hydrology

Rainbow Creek flows through Rainbow Valley Basin, exits the Basin at I-15, and flows west-southwest until it joins the Santa Margarita River (Figure 2). Based on measurements and observations by the RWQCB and MRCD at several locations along Rainbow Creek, during times of minimal storm water flow (during the dry season of June to October), Rainbow Creek is often dry in areas east of I-15 while flow is maintained in areas west of I-15 (Table 4).

Table 4 – Dry Weather Flow

Date	Precip (Esc2)	Station 1 (Jubilee)	Station 2 (Hines)	Station 3 (Oak Crest)	Station 4 (Willow Glen)
6/4/1996	0	slow	0	slow trickle	slow
6/11/1996	0	2-3 gpm	0	low	good
6/18/1996	0	2-3 gpm	0	low	good
6/25/1996	0	2-3 gpm	0	very low	moderate/ low
7/2/1996	0	1-2 gpm	0	0	low
7/9/1996	0	0	0	0	moderate
7/16/1996	0	0	0	0	low-moderate
7/23/1996	0	0	0	0	low
7/30/1996	0	0	0	0	slow

Date	Precip (Esc2)	Station 1 (Jubilee)	Station 2 (Hines)	Station 3 (Oak Crest)	Station 4 (Willow Glen)
8/6/1996	0	0	0	0	moderate/high
8/13/1996	0	0	0	0	slow
8/20/1996	0	0	0	0	slow
8/27/1996	0	0	0	0	slow
9/3/1996	0	0	0	0	slow
9/10/1996	0	0	0	0	slow
9/17/1996	0	0	0	0	slow
9/24/1996	0	0	moderate	slow	moderate
7/14/1998	0	moderate	no flow -pooled	moderate	moderate
7/21/1998	0	slow	very slow	moderate	moderate
7/28/1998	0	low	low	low	low
8/4/1998	0	low	no flow	low	low
8/11/1998	0	low	low	low	low
8/18/1998	0	no flow	very low	low	low
8/25/1998	0	no flow	low	low	low
9/1/1998	0	no flow	moderate	slow-moderate	moderate
9/15/1998	0	very low	very low	low	low
9/18/1998	0	no flow	very slow	very slow	moderate
9/22/1998	0	very slow	moderate	slow	moderate
9/29/1998	0	slow	moderate-fast	moderate	moderate
6/1/1999	0	moderate	moderate (flood)	moderate slow	moderate
6/8/1999	0	slow	dry	very slow	moderate
6/15/1999	0	very slow	dry	moderate-slow	very slow
6/22/1999	0	very slow	dry	slow	slow
6/29/1999	0	dry	dry	very slow	slow
7/6/1999	0	0	0	very slow	0.1 cfs
8/22/2000	0	0	0	0.03 cfs	0.07 cfs
8/29/2000	0	0	0	0.03 cfs	0.06 cfs
9/5/2000	0	0	0	0.06 cfs	0.05 cfs
9/12/2000	0	0	0	0.03 cfs	0.05 cfs
9/19/2000	0	0	0.41 cfs	0.01 cfs	0.05 cfs
9/26/2000	0	0	0	-	0.06 cfs

Table Notes: Data Source 1996-1999 – MRCD (flow descriptions were not quantified in 1996-1999)
Data Source 2000 – RWQCB
Data Source Precipitation – WRCC Escondido 2 daily data
Station 4 (2000) data from USGS Willow Glen Station
Station 1, 2, 3 (2000) data using Parshall flume
cfs – cubic feet per second
gpm – gallons per minute

Based on these observations, it appears that the groundwater gradient and the slope of the Creek are such that groundwater generally contributes (discharges) to Rainbow Creek in areas west of I-15 (Figure 3). The contribution of groundwater to the surface water flow in Rainbow Creek is called baseflow. During times of precipitation, both storm water flow and baseflow contribute to the stream flow west of I-15. East of I-15, storm water flow typically comprises the stream flow in Rainbow Creek. Due to limited data, it is

unclear whether surface water flow noted east of I-15 during dry weather periods was due to surface water flow from irrigation runoff or from groundwater.

According to the data tables included in Appendix B of the RWQCB TMDL Report, on four dates in September and October 2000, Rainbow Creek at Station 1 (Jubilee) was dry; however, groundwater was found surfacing upstream of Station 1 (Jubilee). Therefore, groundwater may also contribute to Rainbow Creek in areas of the Creek east of I-15.

Within Rainbow Valley Basin, Rainbow Creek is an intermittent stream. The sources of groundwater recharge include storm water, irrigation water, and septic leachate. Due to the large volume of recharge in the Basin and due to the inferred bowl-shaped contact of residuum with fractured granite, groundwater accumulates in the Basin and is located within several feet of the Valley floor. Groundwater exists within the alluvium, residuum, and fractured granite (Figure 3).

2.5.1 Surface Water Flow

Rainbow Creek is shown on Figure 2. Rainbow Creek is an intermittent stream east of approximately the I-15 underpass and is a gaining, perennial stream west of I-15. Several creeks flow into Rainbow Creek within the Rainbow Valley Watershed. According to the Interlocutory Judgment No. 42 for the Rainbow Creek Sub-Watershed, these creeks are all intermittent. After exiting the Rainbow Valley Watershed, Rainbow Creek is joined by several tributaries prior to joining the Santa Margarita River.

Daily stream flow measurements have been recorded by the USGS in Rainbow Creek at Willow Glen since November 1989. The USGS Willow Glen Station is just downstream from the western end of the Rainbow Valley Watershed and receives surface water from one tributary to Rainbow Creek outside of the Rainbow Valley Watershed.

The average annual stream flow measured at the USGS Willow Glen station is 1540 acre-feet for the period of record (from 1990 to 2003). The average annual stream flow measured between 1999 and 2003 is 740 acre-feet, indicating that the flow during the period of 1999-2003 was approximately half of the average flow. A similar ratio was calculated for precipitation (rainfall) between these time periods.

Stream flow data from the USGS Willow Glen station indicate that Rainbow Creek is a perennial stream at this location, with summer flows typically ranging from 0.1 to 1 cfs between July and October. During the winter and early spring, rain events have created peak flows as high as 129 cfs (measurement recorded March 27, 1991). This measurement followed five days of one inch or more of rain within one week. Typical winter and early spring flows, that don't correspond with rain events, are between one and two cfs.

Surface water flow was also measured or described by MRCD and RWQCB at five stations along Rainbow Creek in the 1990s and in 2000 (Figure 5). At the USGS Willow

Glen Station, groundwater discharge in the year 2000 appeared to account for approximately 10 percent of wet weather flow in Rainbow Creek. The baseflow was calculated by projecting the average dry weather flow throughout the year at the USGS Willow Glen Station in 2000 and dividing that by the actual total annual flow for 2000 (calculation shown in Appendix A).

A comparison of surface water flow in Stations 2 and 3 (Hines and Oak Crest) and the USGS Willow Glen Station versus precipitation measured at the Rainbow Conservation Camp and less often at a Hines rain gauge is presented as Figure 8. The comparison shows that the flow during rain events at the USGS Willow Glen Station (Station 4) is generally higher than the flow at Station 3 (Oak Crest), which is generally higher than the flow at Station 2 (Hines).

Little to no flow occurred at Station 2 (Hines) during the summer of 2000. The flow at Station 2 (Hines) spikes during rain events. For example, less than 0.2 inches of rain on September 22 and 23, 2000 led to a peak flow at Station 2 (Hines) of 0.54 cfs. However, the stream flow at Station 2 (Hines) also peaked during times of no precipitation. During these peaks, stream flow at Station 3 (Oak Crest) also peaked, although less than the flow at Station 2 (Hines). During these peaks, the flow at the USGS Willow Glen Station did not increase. The peaks at Station 2 (Hines) during periods of no precipitation indicate that surface water, other than that caused by precipitation, from the Hines Nursery area or upstream from Hines periodically contributes to the Rainbow Creek flow.

A peak similar to that discussed for Hines during periods of no precipitation occurred at Station 3 (Oak Crest) on October 18, 2000. During this time period, when the flow at Station 3 (Oak Crest) peaked to 0.35, the flow at the USGS Willow Glen Station increased slightly. The flow at Station 2 (Hines) showed no change.

2.5.1.1 Biological Constraints

Changes in stream flow could have biological impacts. Dudek conducted biological surveys within Rainbow Valley and along Rainbow Creek west of I-15 to identify potential constraints to implementing potential GMP projects. The biological surveys included mapping the potential for sensitive plant and wildlife species. Within Rainbow Valley, sensitive vegetation and wetlands occur as relatively small patches. Sensitive upland, riparian, and wetlands vegetation were identified throughout most of the area of Rainbow Creek that was surveyed (Dudek 2005b). Portions of the Valley and Rainbow Creek may provide habitat for threatened and endangered species (Dudek 2005b).

If potential GMP projects would result in direct or indirect impacts to the sensitive species discussed in the Biological Constraints Report, then permits would be required from the U.S. Army Corps of Engineers, the RWQCB, and/or the California Department of Fish and Game and mitigation would need to occur. A constraints analysis and recommendations for avoidance and mitigation measures are presented in the Biological Constraints Report (Dudek 2005b).

Rainbow Creek and adjacent riparian habitat may be affected by lowering of the groundwater table. Upland habitats are not expected to be affected by potential project activities.

As stated in Section 2.5.1, based on data from 2000, groundwater contributes approximately 10 percent of the wet weather flow at Station 4 (Willow Glen). Dry weather flow consists of groundwater and irrigation runoff. Based on the data compiled to date, it is not known what projects might be implemented, what impact on the groundwater level within the Basin will result from the potential project, and what impact on stream flow will result.

The Biological Constraints Report lists potential adverse impacts primarily to arroyo willows and western sycamores. Additional ecological impacts could include the loss of open sandy terraces, reduction of size of pools and the width and depth of the Creek, and a decrease in downstream connectivity. These ecological impacts could potentially impact species such as the Arroyo chub, red-legged frog, and Least Bell's vireo, among other species.

The potential impacts could be mitigated by the creation of habitat as discussed in the Biological Constraints Report (Dudek 2005b). Permits and/or consultation with various regulatory agencies may also be necessary.

The reduction in stream flow that may occur due to implementation of a specific project should be estimated during feasibility studies. Potential biological impacts should be reviewed for specific projects at that time.

2.5.2 Groundwater Hydrology

The Rainbow Valley Basin is surrounded by foothills to the north, east, and west. The granitic rocks in the foothills, including a portion of the area south of Rainbow Valley, confine groundwater flow in these directions. There are limited data regarding groundwater flow within Rainbow Valley. Dudek assumes that there is one main exit, located in the area of the I-15 overpass at Rainbow Creek, for groundwater flow out of the Valley. According to the 1962 Interlocutory Judgment No. 42 for the Rainbow Creek Sub-Watershed, there is a surface divide near the southern end of Rainbow Valley. At the location of the surface divide, there is a lip of basement complex material that rises to an elevation of 1015 feet msl and prevents the movement of groundwater south of Rainbow Valley, except when the groundwater level is higher than 1015 feet msl (US District Court 1962). According to boring logs from Caltrans from the I-15 bridge area, basement rock also exists at approximately 1010 to 1015 feet msl in this area.

Although, based on groundwater elevations measured between 1988 and 1992, the groundwater elevation is higher than this basement complex lip, Dudek assumes that there is a groundwater divide near the area of the surface divide.

Groundwater within Rainbow Valley Basin occurs within a few feet of the ground surface and discharges to Rainbow Creek. Groundwater exists within the alluvium, residuum, and fractured granite. The contact among the alluvium, residuum and basement rock has not been defined; however, Dudek has estimated the contact between the alluvium and residuum to be approximately 3 to 10 feet below ground surface (bgs) within the Valley and the contact between the residuum and the fractured granite to be approximately 550 feet bgs in the center of Rainbow Valley. This estimate is based on the lithology of well logs in the vicinity of Rainbow Valley that were obtained from the Department of Water Resources (Figure 7). For the one well within the Valley floor (P-19) the contact between the residuum (decomposed and weathered granite) and fractured granite was 415 feet below ground surface. This well was located near the edge of the Valley and it has been assumed that the thickness of the alluvium and residuum is greater in the center of the valley floor.

The 550-foot depth interval for the contact of the residuum and fractured granite was estimated to facilitate an estimate of the potential size of the groundwater basin. The size of the groundwater basin was estimated by assuming the residuum in Rainbow Valley is situated in a fashion that resembles a circular ellipsoid, or a bowl. Approximate aquifer storage capacities based on the estimated volumes calculated using this method are discussed in Section 2.5.2.3.

2.5.2.1 Groundwater Levels

Four shallow wells located in the Basin were monitored by the County of San Diego Department of Planning and Land Use from late 1987 until 1992 (Figure 9). The wellheads were not surveyed; however the estimated groundwater elevation was calculated based on an estimated ground elevation interpolated from topographic maps and the measured depth to water. Estimated groundwater elevations range from 1033 to 1068 feet above mean sea level. Near Rainbow Creek, groundwater elevations in wells C-1 and C-3 averaged approximately 5.25 feet below ground surface and approximately 1044 feet above mean sea level during this time period.

Water levels in the four wells were measured in 1990 and 1991. Groundwater levels in all but one of the wells (C-3) show seasonal trends, but almost no change over the period of 10/90 to 9/91 (Figure 10). Seasonally, water levels vary by approximately 2 feet. Measurements taken from Well C-6 show slightly larger variations, with up to approximately 5 feet of seasonal variation during the measurement period.

Groundwater levels were also measured in a few wells and several locations described as “holes” by the USGS in the late 1960s and the early 1970s. The majority of the wells were located in the eastern portion of the watershed and none of the wells were located within the Valley floor. Many of the holes, however, were located in the Valley floor. Each hole location was only measured once during that time period. Therefore, it appears that one-time groundwater grab samples were collected from the holes. Some of the holes were located near the “C” wells, located in the Valley floor. It is difficult to compare one-time water levels from the 1960s and 1970s with the water level

measurements in the 1980s and 1990s. For example, a hole near well C-1 had a water level of 1042 feet above msl in March 1972, whereas the water level in C-1 was approximately 1038 in February 1988.

Dudek has not reviewed any data that indicates the existence of a perched aquifer. However, Dudek has received verbal communication about a Soil Conservation Service report, which has not been located, that apparently presents evidence for a perched aquifer (Mitchell, pers. com. 2005). Dudek has also received verbal communication that the perched aquifer is caused by a clay hardpan a few feet below ground surface (Smothers, pers. com. 2005). Additionally, Hines Nursery apparently operates an irrigation well that reportedly has a static water level several hundred feet deep (Westrup, pers. com. 2005). However, Dudek was not supplied a copy of water level data or well logs for the Hines well.

2.5.2.2 Groundwater Movement

Based on the assumed bowl-shaped contact of residuum and fractured granite in Rainbow Valley and the groundwater exit near the I-15 overpass, Dudek presumes that groundwater generally flows to the west-southwest. Specifics of groundwater elevation data and hence inferred groundwater movement within Rainbow Valley are difficult to determine based on limited data. The groundwater elevation data collected from four wells in the Valley (Figure 9) between 1988 and 1992 were collected from mostly hand-dug wells with no surveyed reference point. Therefore, it is difficult to relate one well (and groundwater level) to another.

Additional groundwater elevation data obtained from the California Department of Transportation (Caltrans) from the Foundation Investigation for the Rainbow Creek Bridge was used to estimate groundwater flow direction and hydraulic conductivity. Based on the water levels measured in borings B-1, B-2 and B-3 located to the north of Rainbow Creek in May of 1980, the horizontal hydraulic gradient is 0.17 feet per feet, and the direction of groundwater flow is to the south (Appendix B). This suggests that in May 1980, Rainbow Creek is a gaining stream (i.e., groundwater is flowing into the stream). Using Darcy's Law, with the cross-sectional area corresponding to the thickness of alluvium between boreholes B-2 and B-3, and assuming a baseflow of 0.03 cfs, the calculated hydraulic conductivity is 7.75 feet per day (calculation included in Appendix A).

Based on knowledge of the basement rock location and general water level information, groundwater moves west-southwest from the Valley. The remainder of the area surrounding the Valley consists of granite hills, which limit groundwater flow, and an assumed groundwater divide south of Rainbow Valley.

2.5.2.3 Groundwater Storage

Based on the high water levels and the lack of evidence of a perched aquifer, the Basin is presumed to consist of a single, fully saturated, unconfined aquifer system. The groundwater located within the alluvium and residuum can be considered the stored groundwater. Change in groundwater storage within the alluvium and residuum is affected by precipitation, evaporation, groundwater pumping, surface water and groundwater leaving the Valley, and water imported to the Valley. Groundwater levels indicate the amount of groundwater storage. As stated in Section 2.5.1, groundwater levels appear to fluctuate seasonally, but are fairly consistent year to year. Therefore, the amount of groundwater storage is expected to change seasonally, but have little net change over an entire water year.

In order to evaluate the change in available groundwater storage, the change in water levels between October 1990 and October 1991 for four wells was plotted on a map. Based on the changes in water levels, the Basin, approximated as the extent of surficial mapped alluvium, was divided into six areas. Some of the areas experienced increases in water levels while some areas experienced decreases in water levels. Based on the approximate changes in water levels in these six areas and using an available storage of 25 percent, there is an estimated net increase in storage of approximately 11 acre-feet. Using an available storage of 5 percent, the net increase in storage is approximately 2 acre-feet (Appendix A). Overall, the change in storage is relatively negligible, compared to the volume of imported water and precipitation discussed below.

Based on data from October 1990 to October 1991, there was approximately 9054 acre-feet of precipitation over the Watershed area, 1168 acre-feet of water was delivered to the Watershed area by RMWD, approximately 1637 acre-feet of water left the Watershed as surface water flow, and approximately 10 acre-feet were pumped each year for domestic use (based on an average of ½ acre-ft per year for and estimated 20 domestic wells; Figure 7). Based on this data and the estimated increase in storage of 11 acre-feet, the approximate amount of water that left the Watershed area as evapotranspiration is calculated to be 8564 acre-feet per year. This calculation is shown below in Table 5 and in more detail in Appendix A.

Table 5 – Water Balance (values in acre-feet per year for October 1990 - 1991)

Inflows		Outflows		Change in Storage	
Precipitation[1]	9054	Evapotranspiration[4]	8564	Water Level Rise[8]	11
Imported Water[2]	1168	Stream Flow[5]			
Groundwater Inflow[3]	0	Runoff	1473		
		GW Baseflow	164		
		Pumping[6]	10		
		Other GW Outflow[7]	0		
TOTAL	10222	-	10211	=	11

Table 5 Notes: 1) Estimated rainfall of 18.5 inches over 5864 acres (Section 2.3)
2) Estimated from District Delivery Records by applying a ratio of water delivered to the Watershed area to water delivered to the entire District service area for 1999-2003 to the reported values of water delivered to the entire District service area for October 1990-1991.
3) No net groundwater inflow to Watershed assumed
4) Determined from water balance, compares favorable with calculated value
5) Total stream flow from USGS Station daily stream flow. Groundwater baseflow was estimated to account for 10 percent of stream flow (Section 2.5.1).
6) Estimate of 20 dwelling units extracting 0.5 acre-feet per year each
7) Groundwater outflow from Basin assumed as groundwater discharge to Rainbow Creek (Section 2.5.2.2)
8) Calculated based on depth to groundwater in four wells in the Basin

A second, independent calculation was made to estimate the amount of evapotranspiration. The amount of evapotranspiration was estimated by applying evaporation pan coefficients for near-by lakes to the approximate irrigated area of the Watershed. Based on this data (presented in Appendix A), approximately 8523 acre-feet of water per year left the Watershed via evapotranspiration. This independent calculation varies from that of the water balance by approximately 40 acre-feet.

A theoretical volume of the aquifer in Rainbow Valley was estimated by the bowl-shaped scenario described in Section 2.5.2. A range of an approximate aquifer storage capacity was obtained by assuming a specific yield of 5 – 25 % (an estimate of 25% for highly weathered granite and decomposed granite to 5% for deeper, less weathered granite). Based on the bowl scenario, it has been estimated that the volume of the residuum within Rainbow Valley is 1 $x10^{10}$ ft^3 and the storage ranges from approximately 11,900 to 59,500 acre-feet of available storage, depending on the specific yield.

2.5.2.4 Existing Groundwater Wells

Four groundwater wells located within Rainbow Valley Basin were monitored by the County of San Diego in the late 1980s and early 1990s (Figure 9). The majority of the wells were previously-existing, hand-dug wells and were less than 10 feet deep. The current status of the four wells is not known.

Nineteen groundwater wells have been located within the Rainbow Valley Watershed. One of the wells is located within the Valley floor. The locations of the wells were obtained from the boring logs obtained from the DWR (Figure 7). Several other well logs from DWR were also obtained; however, the location of the wells could not be determined based on the information on the well logs. Therefore, there are probably several more wells located within the Rainbow Valley Watershed. Additionally, private wells, for which boring logs were not sent to DWR, may have been drilled within the Watershed. However, no information has been obtained for any additional wells.

Hines Nursery operates one irrigation well (Westrup, pers. com. 2005). The depth of the well is reportedly 905 feet bgs and the pump is reportedly set at 750 feet bgs.

2.5.2.4.1 Well Depths

The depths of the wells monitored by the County in the late 1980s and early 1990s were mostly less than 10 feet bgs.

Well depths from the logs reviewed from the DWR varied between 300 feet and 1,104 feet below ground surface for the 19 wells located within the Watershed. The one well located within the Valley floor has a total depth of 927 feet below ground surface. The depth of the Hines irrigation well is reported to be 905 feet bgs.

2.5.2.4.2 Well Yields/Existing Groundwater Production

Well yields reported in the well completion reports obtained from DWR indicate varying yields between 1 and 100 gpm. The majority of these wells had total depths between 400 and 1000 feet below ground surface. It should be noted that these yields were obtained during initial pump tests, usually air lifting over short periods of time, and may not be representative of long-term yields. Based on the driller logs, most of the water is produced from fractures in the granitic bedrock. The one well located within the Valley floor (P-19) reportedly produces approximately 40 gallons per minute. During an initial eight hour pump test, the well above reportedly produced 40 gpm with 400 feet of drawdown from the initial static water level of 10 feet below ground surface with the most water being produced from the fractures in the bedrock.

A pump test was conducted for the Hines Irrigation well in 2000 or 2001 (Westrup, pers. com. 2005). During the pump test, Hines reportedly extracted groundwater at approximately 400 gpm with a pumping groundwater level of approximately 600 feet bgs. Currently, Hines reportedly extracts groundwater at approximately 300 gpm for approximately 2 hours in order to fill an approximately 50,000 gallon tank. Information on the frequency of pumping was not supplied to Dudek.

2.6 Water Demand and Supply

2.6.1 Water Demand

Rainbow residents typically receive imported water only. An unknown number of active private wells in the Watershed area provide minor amounts of water for irrigation or domestic purposes. Based on the number of well logs supplied by DWR and mapped in the Watershed, Dudek estimates that approximately 20 wells are used for domestic or irrigation purposes. Based on an assumed water use of ½ acre-foot per year per well, approximately 10 acre-feet of water per year are produced for domestic use. The majority of these wells have total depths greater than 400 feet and it is assumed that the groundwater is produced from the fractured granite.

According to the Santa Margarita River Watershed Annual Watermaster Report for 2002-2003, water imported by the District in 2003 for use in the Rainbow Creek Subwatershed was very similar to the amount of imported water in the 1960s. Although water use increased in the mid-1980s, the water use has decreased to amounts used in the 1960s and early 1970s. In contrast, water imported by the Rancho California Water District, which serves Temecula, has increased substantially since the late 1970s. The difference is due to population growth.

According to the Santa Margarita River Watershed Annual Watermaster Report for 2002-2003, water imported by the District for use in Rainbow Creek Sub-Watershed is as follows:

Table 6 – Imported Water in Rainbow Creek Sub-Watershed

Year	Acre-Feet of Imported Water	Year	Acre-Feet of Imported Water	Year	Acre-Feet of Imported Water
1966	1308	1979	2348	1992	2277
1967	1095	1980	1489	1993	1965
1968	1377	1981	3153	1994	1651
1969	1253	1982	2460	1995	1661
1970	1689	1983	2190	1996	1815
1971	1650	1984	3068	1997	1429
1972	2037	1985	3410	1998	1601
1973	1616	1986	2945	1999	1727
1974	2049	1987	3390	2000	2217
1975	1247	1988	2985	2001	1804
1976	2239	1989	3003	2002	1676
1977	2343	1990	3818	2003	1510
1978	2188	1991	2904		

Source: Santa Margarita River Watershed Annual Watermaster Report for 2002-2003

A ban on construction of new septic tanks in Rainbow Valley Basin has been enforced since 1970 due to high groundwater levels and a lack of a sewer system. The ban has limited growth in the Watershed area. Due to the building ban, the water demand in Rainbow Valley has held steady over the past 40 years.

According to the Santa Margarita River Watershed Annual Watermaster Report for 2002-2003, 82 percent of the water delivered to the area is used for agriculture. Approximately 9 percent is used for commercial and domestic purposes, and losses account for approximately 9 percent. Based on information obtained from the San Diego Association of Governments, agricultural uses occupy approximately 20 percent of the Watershed area and residential uses occupy approximately 8 percent of the Watershed area. Approximately 65 percent of the Watershed area is undeveloped.

The District has 120 connections within the Rainbow Valley Basin and a total of 288 in the Watershed. Major users in the Watershed area include Hines Nursery, Rainbow Heights Nursery, San Diego County, Roseland Nursery, Rainbow Valley Nursery Co., Eco Farms, A & A Grove Service & Produce Inc., Hanes Ranch, California Highway Patrol, Vallecitos School District, Rainforest Flora Inc., the California Department of Forestry, Oak Crest Estates, and Rainbow Highlands. Within Rainbow Valley Basin, approximately 60 percent of the water supplied by Rainbow Municipal Water District to this area is used by Hines Nursery. Additionally, approximately 90 percent of the water delivered to the watershed was delivered to the area east of I-15.

2.6.2 Groundwater Supply

Minor amounts of groundwater are used for domestic and irrigation purposes. Based on the well logs for private wells obtained from DWR, the depths of the majority of the wells are greater than 400 feet. Dudek was unable to get any information on current groundwater extraction from private wells other than the Hines well, as discussed below. Dudek has assumed that approximately 20 wells in the Watershed produce approximately 10 acre-feet of water per year (assuming domestic uses of ½ acre-foot per year).

Hines Nursery has one operating irrigation well (Westrup, pers. com. 2005). The depth of the well is 905 feet bgs and the pump is set at 750 feet bgs. Mr. Westrup stated that a pump test was conducted approximately four years ago. During the pump test, Hines reportedly extracted groundwater at approximately 400 gpm with a pumping groundwater level of approximately 600 feet bgs. Currently, Hines reportedly extracts groundwater at approximately 300 gpm for approximately 2 hours in order to fill an approximately 50,000 gallon tank. Information on the frequency of pumping was not supplied to Dudek.

Groundwater is not currently used for the public drinking water supply. Similarly, there are no developed surface water supply sources in the Valley.

2.6.3 Water Demand Forecast

The potential for additional development in Rainbow Valley is currently limited by the development moratorium imposed by the County and the existing General Plan. While development pressures will increase significantly over the next 15 years, the current level of development is expected to remain relatively constant.

Additionally, if the Valley follows similar development patterns as the remainder of the District's service area, water use per acre will remain fairly consistent even though significant land use changes may occur. That is, residential water usage per acre approximates agricultural water usage per acre.

Maps of the existing water customers are shown in Figure 11. Also shown in this figure are the water users with the most demand for water.

The potential areas for development in the valley are expected to be within the Valley floor. The slopes of the valley are not well suited to dense development and will continue to be developed at densities between 1-5 acres per dwelling unit. If future housing densities in the valley were allowed at 1 to 4 units per acre, the overall water demand could grow by approximately 50%; however, this is not expected to happen due to the existing General Plan and the development moratorium.

The 2001 RMWD Master Plan predicts the water demand in the year 2020. Based on the predicted demand for the entire District service area and the historical ratio of water used in the Watershed versus water used in the entire service area, the estimated demand for the Watershed in 2020 is 1640 acre-feet per year.

2.6.4 Water Rights

The water rights for the Rainbow Creek Sub-Watershed were defined by the United States District Court in the October 1962 Interlocutory Judgment No. 42. The judgment stated that, as of the 1962 judgment, the United States of America and Fallbrook Public Utility District have vested appropriative rights to surface water in Rainbow Creek. There were no other vested or inchoate appropriative rights to any of the waters of the Rainbow Creek Sub-Watershed at that time (United States District Court 1962).

The judgment stated that the water rights of the Santa Margarita River system are subject to the continuing jurisdiction of the Court. The judgment defines waters of the Santa Margarita River system as surface waters and water within the younger alluvium. Groundwater within the residuum and fractured granite is not a part of the Santa Margarita River system and is not subject to Court definition.

According to the Santa Margarita River Watershed Annual Report for 2002-2003, Chris R. and Jeanette L. Duarte have an appropriative right to store 0.5 acre-feet of water from Rainbow Creek (Watermaster 2004). Dudek does not know if the Duartes currently exercise this right.

In 1975, the final judgment by the California Supreme Court in *City of Los Angeles v. City of San Fernando, et al.* made two major findings regarding imported water. Agencies, such as Rainbow Municipal Water District, have the right to recharge and store imported water in a groundwater basin and to extract the water for use. Additionally, agencies that import and deliver water to lands overlying a groundwater basin, as Rainbow Municipal Water District does, have a continuing right to extract the return flow from the groundwater. The return flow is the portion of the imported water that, following use, percolates into the groundwater basin. In the 1975 San Fernando case, the return flow was 20 to 35.7 percent of the imported water. The return flow in Rainbow Valley Basin may be more than that of the San Fernando case due to the large amount of imported water applied to the ground surface as irrigation.

Rainbow Municipal Water District was formed on December 30, 1953. Based on the data presented in Table 6 (Section 2.6.1), the District has delivered 80,587 acre-feet of imported water to the Rainbow Valley Watershed between 1966 and 2003. No data for 1954 to 1965 have been reviewed. As approximately 90 percent of water delivered to the Watershed was delivered to the area east of I-15, an approximation of the amount of water imported to the Basin is 90 percent of 80,587 acre-feet, or 72,528 acre-feet. Using the return flow percentages from the 1975 San Fernando case (20 to 35.7 percent), the District has a right to extract 14,500 to 25,900 acre-feet of groundwater based on historical deliveries and an ongoing percentage of future deliveries. In addition, as a public agency, the District has an appropriative right to extract groundwater for public or municipal use as recognized by the courts in *Pasadena v. Alhambra* (1949) 33 Cal.2d 908, *Los Angeles v. San Fernando* (1975), and *Wright v. Goleta Water District* (1985). No permit is required for the initial use or perfection of a groundwater appropriation.

2.7 Water Quality

2.7.1 Surface Water Quality

According to data presented in the Basewide Water Requirement Availability Study for Camp Pendleton (Leedshill Herkenhoff 1988), concentrations of nitrate were analyzed between 1970 and 1988 in Rainbow Creek at Willow Glen Road. The concentrations between 1970 and 1982 were generally less than or equal to 10 mg/l or 2.3 mg/l as nitrogen. Nitrate concentrations spiked to approximately 20 mg/l (4.5 mg/l as nitrogen) during this period in the spring of 1973, 1975, 1976, and 1977. In 1982, nitrate concentrations began to rise until 1986, when the peak nitrate concentration was approximately 340 mg/l (77 mg/l as nitrogen). The last samples collected during this time period were collected in the end of 1987 and contained approximately 200 to 250 mg/l nitrate (45-56 mg/l as nitrogen). The method of analysis is not known.

The spike in nitrate concentrations occurred in the 1980s, after the ban on construction of additional septic tanks. Additionally, the spike in nitrate concentrations roughly corresponds with the increase in use of imported water shown in Table 6. The increase in use of imported water in the 1980s likely relates to an increase in agriculture in the area. Based on this information, it appears that the increase in nitrate concentrations was related mostly to agriculture rather than septic tanks.

Surface water quality was monitored by MRCD in 1995/1996 and 1998/1999. Surface water quality was monitored using field measurement methods. The RWQCB monitored surface water quality, including nitrate, in the fall of 2000. Analyses were conducted using Environmental Protection Agency (EPA) Method 300. Average nitrate as nitrogen concentrations during the wet-weather season (October through April) of 1995/1996, 1998/1999, and 2000 are listed in Table 7, below. Peak nitrate concentrations during this time were as high as 34.8 mg/l in April 1996 at Station 2 (Hines). The decline in concentrations between the 1995/1996 and 1998/1999 seasons may be related to stream flow (there was 20 percent more stream flow in 1995/1996 than in 1998/1999) and the implementation of agricultural best management practices by MRCD in 1996. Figure 12

shows the change in nitrate as nitrogen concentrations along Rainbow Creek and over time.

Table 7 - Average Nitrate as Nitrogen Concentrations (mg/l) For October Through April

Year	Station 1 Jubilee	Station 2 Hines	Station 3 Oak Crest	Station 4 Willow Glen
1995/1996	7.1	15.5	10.2	6
1998/1999	0.8	3.2	2.7	2
Jan 2000 – April 2000				12
October 2000	5.2	17*	11.1	1.9

Notes: * - One sample only
1995 – 1999 Field Analysis by MRCD
2000 – Laboratory Analysis by RWQCB

The San Diego RWQCB has adopted the Rainbow Creek Nutrient TMDL. The TMDL lists a maximum nitrate as nitrogen concentration of 10 mg/l. This concentration was exceeded at Stations 2 and 3. The TMDL also lists a biostimulatory limit for nitrogen of 1 mg/l.

Average phosphate as phosphorus concentrations during this time are listed in Table 8, below. Figure 13 shows the change in phosphate as phosphorus concentrations along Rainbow Creek and over time. The TMDL lists a biostimulatory limit for phosphorus of 0.1 mg/l.

Table 8 - Average Phosphate as Phosphorus Concentrations (mg/l) For October Through April

Year	Station 1 Jubilee	Station 2 Hines	Station 3 Oak Crest	Station 4 Willow Glen
1995/1996	0.04	1.3	1.6	0.8
1998/1999	0.1	1.9	1.29	0.6
Jan 2000 – April 2000				0.37
October 2000	0.2	0.96*	1.0	0.4

Notes: * - One sample only
1995 – 1999 Field Analysis by MRCD
2000 – Laboratory Analysis by RWQCB

Average dry weather (June through September) concentrations of nitrate as nitrogen at Stations 3 and 4 were 0.3 mg/l at each station in 1996, 3.3 and 8 mg/l, respectively in 1998, and 8.2 and 1.3 mg/l, respectively in 2000. These dry weather concentrations measured at Stations 3 and 4 represent the quality of the groundwater component of flow Rainbow Creek at these stations. These concentrations are discussed further in Section 2.7.2. The dry weather concentrations are discussed in the groundwater quality section because stream flow during periods of no rain is assumed to be baseflow, although an

unquantified amount of irrigation runoff also contributes to dry and wet weather stream flow.

2.7.2 Groundwater Quality

The County of San Diego collected groundwater samples from the four hand-dug wells in April 1989. The wells are all located in the Valley floor (Figure 9). The majority of the wells were open holes, approximately 10 feet deep. The samples collected from these wells were analyzed for chloride, conductivity, sodium, sulfate, TDS, nitrate, and coliform. Concentrations of nitrate as nitrate, conductivity, TDS, sulfate, and coliform exceeded the maximum contaminant level (MCL). Groundwater sample concentrations are shown on Table 9 and Figure 14.

Table 9 – Groundwater Concentrations

Analyte	Well C-1	Well C-2	Well C-3	Well C-6	MCL
Chloride (mg/l)	206	91.5	162	228	250
Conductivity (umhos/cm)	2800	590	1940	2260	500
Sodium 5 (mg/l)	148	54.4	149	175	NA
Sodium (%)	31.4	55.4	42.6	43.3	60
Sulfate (mg/l)	520	48.9	314	499	250
TDS (mg/l)	2330	370	1400	1620	500
Nitrate (mg/l) NO_3	676	3.6	202	28.6	45
Coliform (MPN/100ml)	16	16	16	16	more than 1 present per month

Source: Peterson 1989
MCL – maximum contaminant level
NA – not applicable

A few groundwater samples were collected from some of the "holes" discussed in Section 2.5.2.1. The data were collected in the 1950s, 1960s, and 1970s. Groundwater samples collected from unknown depths from sample locations within Rainbow Valley contained concentrations of nitrate ranging from 11 to 95 mg/l. Samples were also collected near Oak Crest Estates, with nitrate concentrations ranging from 8.1 to 87 mg/l. Three samples collected from the same well near Oak Crest Estates in March, August, and September 1970 had nitrate concentrations of 8.1 mg/l, 87 mg/l, and 43 mg/l, respectively.

Groundwater quality can also be determined by sampling the baseflow in Rainbow Creek during times of no precipitation, assuming no irrigation return. A table of baseflow water quality is presented as Table 10, below. Water quality data for Stations 3, 4, and 5 are presented. Station 5 (River House) is located more than 2000 feet downstream from Station 4 (Willow Glen) and additional tributaries contribute to Rainbow Creek between Willow Glen and River House. Based on the concentrations shown, it is likely that a surface water source contributes to the water quality between Stations 4 and 5.

Table 10 – Baseflow Water Quality and Flow

Date Range	Station	TDS ppm (from EC)	NO3-N (mg/l)	PO4-P (mg/l)	Flow (cfs)
June-Sept 1996	3	1209-1286	0	1.17-1.3	no station-specific flow measurements
	4	793-915	0-.2	0.49-0.72	no station-specific flow measurements
	5	960-1037	7.5-10.4	0-0.57	no station-specific flow measurements
July-Sept 1998	3	1088-1325	1.7-6.1	0.57-2.82	no station-specific flow measurements
	4	832-992	1-1.6	0.61-0.81	no station-specific flow measurements
	5	896-1011	2.1-5.3	0.41-0.84	no station-specific flow measurements
June-July 1999	3	1200-1300	2.3-2.9	0.95-1.6	no station-specific flow measurements
	4	800-850	0.7-1.2	0.38-0.64	no station-specific flow measurements
	5	900-925	2.3-2.5	0.33-0.38	no station-specific flow measurements
Aug-Sept 2000	3	NM	1.2-11 (ave 7.3)	0.52-1.4 (ave 0.86)	0.03
	4	NM	2.8-8.9 (ave 4.7)	0.29-0.47 (ave (0.36)	0.06
	5	NM	12-14 (ave 13)	0.13-0.22 (ave 0.17)	0.27

Notes: 1996 – 1999 data from MRCD (field analysis), 2000 data from RWQCB (lab analysis)
EC – electrical conductivity
NM – not measured
ppm – parts per million

The contribution of groundwater (baseflow) to the stream water quality was calculated by applying the average baseflow concentration and flow for the 2000 dry season to calculate the yearly projected baseflow contribution, and dividing that by the total annual stream flow and the average surface water concentration for 2000. The calculation is presented in Appendix A and the results are shown below.

Table 11 – Percentage of Surface Water Concentrations Contributed from Baseflow

Parameter	Percent of Surface Water Concentration Contributed from Groundwater (Baseflow) at Station 4
Nitrate as N	4.0
Phosphate as P	7.5

This analysis of the limited available data indicates that groundwater contributes a small amount of contamination to the surface water. Therefore, a project that intercepts the

groundwater discharging to Rainbow Creek will not substantially improve the stream water quality on an annual mass loading basis.

2.8 Data Gaps

Due to sparse, limited data available for the Rainbow Valley area, Dudek has made many assumptions about the physical characteristics of the Watershed. The assumptions include the following; a fully-saturated aquifer system, a gaining stream downstream of I-15 only, an approximately 550 foot deep, bowl shaped contact between the residuum and the fractured granite, and a groundwater divide in the southern portion of the Valley. Data gaps are listed below. Collection of additional data and information through field studies is recommended to fill the data gaps. Recommendations are discussed in Section 9.

Data Gaps

- Size of the groundwater basin
    - Thickness and storage of alluvium and residuum throughout the Basin
    - Shape of the contact
- Fully-saturated aquifer system vs. perched aquifer
- Rainfall data in the Valley
- Valley-specific evapotranspiration data
- Where groundwater contributes to Rainbow Creek
- Existence of a groundwater divide in the southern portion of the Valley
- Groundwater production by private wells
- Inventory of active (existing) wells
- Limited groundwater elevation and quality data
- Quantification and locations of irrigation runoff
- Consistently measured stream flow data
- Surface water quality data

3. PLAN IMPLEMENTATION

3.1 Management Objectives

The GMP is intended to provide the basis for long-term management of the Rainbow Valley Basin to benefit current and future agricultural, environmental, rural and urban needs and seeks to establish a local, safe and reliable water resource alternative. The objectives of the Rainbow Valley Groundwater Management Plan are to:

- Provide a safe, reliable local water supply
- Reduce dependence on imported water
- Lower the groundwater table within Rainbow Valley
- Improve water quality
- Educate the agricultural and residential communities

These objectives and the potential management actions to achieve the objectives are listed in Section 1.2.

3.2 Groundwater Management Plan Components

As discussed in Section 1.4, CWC required components, along with some CWC recommended and voluntary components and DWR Bulletin 118-223 recommended components, are included in this GMP. These components are discussed in the following sections on groundwater monitoring, surface water monitoring, groundwater resource protection, groundwater sustainability, stakeholder involvement, and GMP implementation, reporting, and updating.

The District may implement projects to meet GMP objectives. Potential projects could include groundwater extraction and treatment for domestic or irrigation purposes or groundwater extraction and blending with the raw water supply. Depending on the subsurface conditions, which have not yet been defined, potential projects could also include storage of imported water in the aquifer for use during summer months when costs to import are higher. Additional data and information are needed prior to evaluation of potential projects; however, Dudek has conducted an initial review of potential projects (Dudek 2005a).

3.3 Groundwater Monitoring

Groundwater monitoring may be conducted in order to determine the state of the basin for the purpose of managing the groundwater basin. Prior to and upon implementation of a potential project and management measures such as best management practices, groundwater monitoring may be conducted to evaluate the effectiveness of the project and selected BMPs in meeting GMP objectives.

Groundwater level and quality data obtained to date has been limited. Dudek has not conducted an inventory of current wells (wells that have not been abandoned or destroyed) in the Watershed area. The most current information has been verbal information from Hines Nurseries regarding their 905-foot irrigation well. The potential for future access to any existing wells is not known.

Based on this information, most future groundwater monitoring would likely be accomplished using wells that have yet to be installed. New wells shall be installed in accordance with the guidance in the San Diego County Site Assessment and Mitigation Manual and the California Well Standards. Additionally, current wells that have not been used or monitored within a year should be abandoned according to the San Diego County Site Assessment and Mitigation Manual and the California Well Standards unless they are to be included in a monitoring network. Future monitoring of deeper wells (located in the fractured granite), if conducted, would likely be conducted using existing private wells like the Hines well or, if necessary, new deeper wells could be installed. Nested wells, wells located within close proximity but screened at different depth intervals, would be useful in determining the presence or absence of a perched aquifer. Additionally, boring logs should be recorded during boring advancement for well installation. Several borings should be advanced to the contact of the residuum and fractured granite in order to address data gaps concerning the subsurface lithology within the Basin.

Groundwater monitoring should be coordinated with the County of San Diego. The County of San Diego plans to collect groundwater elevation measurements from a shallow well to be installed at the County Park (McPherson pers. com. 2005). The RWQCB TMDL Report, which has been approved by the San Diego RWQCB and has begun the approximately six month-long process of obtaining State Water Resources Control Board and EPA approval, has tasked the County with groundwater and surface water monitoring. The monitoring plan is discussed in general terms in the RWQCB TMDL Report, Section 10 (RWQCB 2005). The County does not yet have plans for monitoring beyond groundwater elevation measurements in one shallow well in the Basin (McPherson pers. com. 2005).

Groundwater level monitoring may be conducted quarterly and groundwater quality monitoring may be conducted semiannually to document current groundwater conditions and assess long-term trends in order to meet some of the objectives listed in Section 3.1. Inelastic subsidence (permanent subsidence of the ground) has not been identified as a potential problem in Rainbow Valley; however, it may become an issue related to groundwater pumping in the area. Therefore, subsidence may be monitored as a part of this GMP.

In addition to monitoring groundwater elevation and quality, the District may also monitor groundwater production from private wells in the Valley. This would be an important data collection measure, especially if the District implements a project that involves storage of imported water within the aquifer. Groundwater production monitoring would be accomplished by adding flow meters to wells in the Valley.

3.3.1 Groundwater Elevation Monitoring

Groundwater elevations may be measured quarterly (February, May, August, and November) in shallow wells in Rainbow Valley Basin. Water levels would be measured in approximately 6 to 8 monitoring wells, in addition to the wells that may be used for potential projects. Water levels in all wells shall be measured within an 8-hour period. Water levels shall be measured from a surveyed reference elevation.

Possible groundwater monitoring well locations are shown on Figure 15. The groundwater elevation measurements would be used to monitor changes in groundwater elevations and obtain specific information on groundwater movement within and out of the groundwater basin.

Groundwater elevation data may be evaluated by the District on an annual basis to determine the state of the Basin and assess the effectiveness of the potential project and selected best management plans in meeting GMP objectives. The data would be compiled in an electronic database for use in the future GMP updates.

3.3.2 Groundwater Quality Monitoring

Groundwater quality may be monitored semiannually (February and August) in monitoring wells and potential project production wells in Rainbow Valley Basin. Groundwater monitoring shall be conducted in accordance with the guidance in the San Diego County Site Assessment and Mitigation Manual. Groundwater samples should be analyzed for TDS, nitrate, phosphate, and coliform by a California Environmental Laboratory Accreditation Program (ELAP) Certified laboratory. Field measurements of pH, electrical conductivity, and temperature should be recorded. Groundwater samples from wells that may be used for potential GMP projects may be analyzed for additional parameters, depending on proposed use of the water.

Groundwater quality data may be evaluated by the District on an annual basis to determine the state of the Basin and assess the effectiveness of the potential project and selected best management plans in meeting GMP objectives. The data would be compiled in an electronic database for use in the future GMP updates.

3.3.3 Subsidence Monitoring

Land surveys within the Valley should be conducted annually to monitor potential land subsidence in the residuum due to pumping of groundwater. If no subsidence is measured within the first two years of pumping, land surveys could be conducted every five years.

3.4 Surface Water Monitoring

Surface water flow has been monitored daily in Rainbow Creek by the USGS at Willow Glen since November 1989. Surface water flow at various locations within the Rainbow Valley Watershed was monitored for a portion of 2000.

Surface water quality was monitored in support of a Camp Pendleton study between 1970 and 1988 in Rainbow Creek at Willow Glen Road. Surface water quality at various locations within the Rainbow Valley Watershed was monitored by MRCD in 1995/1996 and 1998/1999. Surface water quality was also monitored by the RWQCB in 2000.

Surface water monitoring may be conducted during implementation of this GMP in order to determine the state of the Basin and evaluate the effectiveness of the project and selected best management plans in meeting GMP objectives. Additionally, surface water monitoring may be conducted to evaluate the affect of the project on the stream flow and water quality. If, through modeling or actual flow measurements during project feasibility studies, it is determined that the project may have an affect on stream flow that may impact habitat and species as discussed in the Biological Constraints Report (Dudek 2005b), then necessary permitting and mitigation would need to be conducted if the project were to be implemented.

As stated in Section 3.3, the County of San Diego may implement a groundwater and surface water monitoring program. Monitoring should be coordinated with the County.

3.4.1 Surface Water Flow Monitoring

Surface flow in Rainbow Creek may be measured weekly at Stations 1, 2, and 3 (Jubilee, Hines, and Oak Crest; Figure 5). Surface flow may be measured using a Parshall flume. The District will coordinate with MRCD, which has conducted monitoring at these locations using a Parshall flume in the 1990s.

In order to better evaluate the stream flow data, the District may install and monitor a rain gauge in the Valley.

Surface water flow data may be evaluated by the District on an annual basis to determine the state of the Basin and assess the effectiveness of the project and selected best management plans in meeting GMP objectives. Stream flow data would be used to better determine where Rainbow Creek is a gaining stream. The data would be compiled in an electronic database for use in the future GMP updates. As stated in the previous section, during feasibility studies for potential projects, stream flow data would be used to determine potential permitting and habitat mitigation that may be necessary if the project is implemented.

3.4.2 Surface Water Quality Monitoring

Surface water quality may be monitored monthly at Stations 1, 2, 3, and 4 (Jubilee, Hines, Oak Crest, and Willow Glen). Surface water quality monitoring shall be conducted in accordance with the EPA Environmental Response Team Surface Water Sampling Standard Operating Procedure # 2013, dated November 17, 1994. Surface water samples would be analyzed for TDS, nitrate, and phosphate. Samples would be analyzed by a California ELAP Certified laboratory.

Surface water quality data may be evaluated by the District on an annual basis to determine the state of the Basin and assess the effectiveness of the project and selected best management plans in meeting GMP objectives. The data would be compiled in an electronic database for use in the future GMP updates.

3.5 Groundwater Resource Protection

Several regulations and guidance documents should be followed and best management practices should be implemented to promote the protection of groundwater resources. Examples of regulations and guidance documents are the California Well Standards, the Clean Water Act, and the RWQCB TMDLs for Rainbow Creek. The California Well Standards provide guidance for proper well construction. Proper seals are required on wells to prevent the wells from acting as a conduit for surface contamination to reach the groundwater. The Clean Water Act set water quality standards and provided requirements for the discharge of pollutants. The RWQCB TMDLs for Rainbow Creek were adopted in February 2005 and present goals and guidance for improving the water quality in Rainbow Creek. The TMDLs also presented potential best management practices. In addition to protecting surface water, BMPs would also involve measures that could lead to improved groundwater quality.

Groundwater resource protection also includes best management practices for water conservation.

3.5.1 Best Management Practices

3.5.1.1 Agricultural BMPs

As stated in Section 2.6.1, approximately 82 percent of the water delivered to Rainbow Valley by the District is used for agriculture. The water is often mixed with fertilizers prior to being applied to the fields, nurseries, or groves. Agricultural runoff has been identified in the RWQCB TMDL as a contributor to elevated nutrient concentrations in Rainbow Creek. Best management practices can be implemented to reduce agricultural runoff.

The RWQCB TMDL Report presented potential best management practices for land use categories including agricultural fields, commercial nurseries, and parks. The BMPs

included managing nutrient application, irrigation, drainage water from the irrigation system, and erosion. The potential BMPs and associated costs are presented in Appendix C.

Mission Resource Conservation District has implemented management programs in the past 15 to 20 years. The programs include the Agricultural Water Management Program, which includes an Irrigation Water Management Program, fertilizer and pesticide use guidance, erosion control guidance, and composting and mulching guides. The Irrigation Water Management Program includes evaluation of agricultural fields and nurseries two acres or larger. The management program also includes soil and water testing. The United States Department of Agriculture has also worked with nursery and agricultural field owners to develop BMPs. Details of some of the programs are included in Appendix C.

Appendix C also presents fact sheets and reports from the US EPA and the University of California that detail potential management activities to control non-point source pollution from agricultural sources.

3.5.1.2 Septic BMPs

Based on the number of water meters labeled as municipal or industrial that do not have a sewer fee, there are approximately 200 septic tanks within the Watershed. Approximately 170 of these tanks are located east of I-15. The RWQCB TMDL Report concluded that residential land use (including loads from septic tanks) in the Rainbow Creek Watershed, defined by the RWQCB, contributed approximately 17 percent of the total nitrogen load to Rainbow Creek.

BMPs are management practices that can help to reduce the contribution of nitrogen and other groundwater contaminants by septic tanks. The MRCD has guidance for managing septic tanks (Appendix C). The RWQCB TMDL Report also discusses management measures for septic tanks in Section 11. Although BMPs are designed to keep septic tanks working properly, many septic tanks in the Rainbow Valley Basin do not work properly due to the high groundwater level. Other objectives of this GMP (lowering the water level) are proposed to address this issue.

According to a 1966 San Diego County Department of Environmental Health letter regarding septic tanks, the groundwater level needs to be lower than 8 feet bgs in order for the septic systems to function properly. In order to maintain a water level of at least 10 feet bgs, the water level in the Valley would need to be lowered approximately 5 to 7 feet.

3.5.1.3 Conservation BMPs

Demand management, or water conservation, is frequently the lowest-cost resource available to any water agency. Water conservation is addressed in the Rainbow Municipal Water District Urban Water Management Plan, as an element of the long-term

strategy for meeting the water needs. The goals of the Rainbow Municipal Water District water conservation program are to 1) reduce the demand for imported water, 2) demonstrate continued commitment to the BMPs, and 3) ensure a reliable water supply.

The Rainbow Municipal Water District is a signatory to the Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California, which created the California Urban Water Conservation Council (CUWCC) in 1991 in an effort to reduce California's long-term water demands. Water conservation programs are developed and implemented on the premise that water conservation increases the water supply by reducing the demand on available supply, which is vital to the optimal utilization of the regions water supply resources. The Rainbow Municipal Water District participates in many water conservation programs designed and typically operated on a shared-cost participation program basis among the SDCWA, MWD, and their member agencies.

As a requirement for development projects within the County of San Diego and the District, water conservation measures will be incorporated into the Project including the State-mandated 14 best management practices for water conservation such as installation of ultra low flow toilets (ULFT), development of a water conversation plan for all landscape improvements, and the use of recycled water, all of which are typical requirements of development projects.

As one of the first signatories to the MOU Regarding Urban Water Conservation in California, the District has made implementation of the BMPs for water conservation the cornerstone of its conservation programs and a key element in its water resource management strategy. As a member of the SDCWA, the District also benefits from regional programs performed on behalf of its member agencies.

Current District conservation programs are saving approximately 950 acre-feet per year of water within its entire service area. The vast majority of water savings, approximately 94%, currently obtained through conservation efforts has been from residential ULFT and large landscape programs. The Rainbow Municipal Water District has planned to gradually shift emphasis towards residential landscaping and clothes washers as these programs continue to evolve. This is because opportunities for ULFT will decline and large landscape water efficiency is increasingly emphasized and practiced. The resulting savings directly relate to additional available water in the San Diego region for beneficial use within the SDCWA service area, including the Rainbow Municipal Water District.

In partnership with the SDCWA, the County of San Diego, and developers, the District water conservation efforts are expected to grow and expand. Based upon an analysis of water savings as a percentage of overall demand during the last six years, the District expects to reduce water demand within a range of 1,400 to 2,200 acre-feet, which represents three to five percent of the District's expected 2020 water demand for the entire service area.

The BMP programs implemented by Rainbow Municipal Water District are presented in Appendix C.

3.5.1.4 Implementation of BMPs

Implementation of BMPs has thus far been voluntary. However, the adoption of the Rainbow Creek TMDLs by the San Diego RWQCB, which still requires formal adoption by the State Water Resources Control Board and EPA, could potentially change that. Mandatory BMPs have not yet been proposed or adopted. Additionally, the District may, at some point, enforce BMPs to improve water quality and promote conservation.

4. GROUNDWATER SUSTAINABILITY

4.1 Groundwater Quantity Sustainability

Groundwater sustainability will be an important factor in evaluating potential GMP projects. The goals of the GMP include lowering the water table to help alleviate septic tank problems; however, sustainability must still be considered. The District must study the aquifer characteristics further in order to obtain the information necessary to be able to promote groundwater quantity sustainability.

Based on the information obtained thus far, it is not known whether or not a perched aquifer exists in the Basin or if the Basin is fully saturated. Based on the data that Dudek has reviewed, it appears that the Basin is fully saturated; however, Dudek has received verbal statements during various community forums held in 2005 that indicated the existence of a perched aquifer and a lower aquifer. These statements included references to a Soil Conservation Service study from the 1960s or 1970s. Dudek has not been able to locate the report.

If the aquifer is fully saturated, groundwater quantity sustainability will not be as significant of an issue for evaluation of potential GMP projects. If perched conditions exist, then there is potentially less water in the subsurface, and groundwater quantity sustainability may be more of an issue. Additional field work is necessary prior to evaluation, including modeling, of groundwater quantity sustainability.

4.2 Groundwater Quality Sustainability

Groundwater quality sustainability is also an important issue to consider. Primary contaminants of concern include pesticides, herbicides, nutrients, and petroleum products.

As discussed in Section 3, BMPs can be used to promote groundwater quality sustainability. Additionally, chemical storage in above- or underground storage tanks should be done in accordance with County and State regulations. Based on aquifer characteristics, including groundwater elevations and soil type, the Rainbow Valley Basin is susceptible to contamination from surface or underground sources. In addition to BMPs and adherence to regulations, some of the potential GMP projects, including the projects that limit pollution from septic tanks, also promote groundwater quality sustainability.

5. STAKEHOLDER INVOLVMENT

Public outreach is an important component of the GMP. The District has conferred with regulatory agencies and the community during the preparation of the GMP. The public has had the opportunity to comment on the GMP at various meetings and during the public review period of the Preliminary Draft GMP. The Preliminary Draft GMP and supporting documents (Biological Constraints Report and Potential Projects Report) were available for review at the District office and the GMP was available for review on the District website from April 25, 2005 until May 9, 2005. A notice regarding the review period was posted in the North County Times on April 25, 2005, in the Village News on April 28, 2005, and on the District website.

5.1 Agency Involvement

The District worked with local, state, and federal agencies to obtain data and information from previous studies, discuss the progress of the GMP, and evaluate implementability of potential GMP projects.

Data and information from previous studies were obtained from the RWQCB, USGS, DWR, MRCD, San Diego County, Fallbrook Public Utilities District, Santa Margarita Watermaster, California Department of Forestry, and the United States Department of Agriculture.

In addition to obtaining data and information from other agencies, the District solicited comments and input for the development of the GMP. The District held a meeting with regulatory agencies to solicit additional information, to inform the agencies of the progress of the GMP, and to solicit comments. A preliminary stakeholder meeting was held at the Rainbow District offices on December 7, 2004 with representatives from San Diego County Water Authority, the County of San Diego, the District and Dudek and Associates. An additional stakeholder meeting was held on February 15, 2005, with representatives from local nurseries and the Mission Resources Conservation District.

5.2 Community Involvement

Community involvement included newsletters to District customers, meetings and workshops with the public, notices posted on the District website, notices mailed to stakeholders, and notices published in the North County Times and the Village News. Notices, meeting sign-in sheets, and District newsletters are presented in Appendix D.

The notices and newsletter inserts were the means used to provide written statements to the public describing the manner in which they may comment on and participate in the development of the GMP. Additionally, the District held public workshops and meetings on 3/17/05 and 5/5/05 in which comments were solicited.

5.3 Advisory Committee

An advisory committee will be formed following adoption of the plan to manage and provide further development of the GMP. The advisory committee members will include members of the residential and business communities, Mission Resource Conservation District, and other stakeholders.

6. GMP REPORTING AND UPDATING

Prior to implementation of a potential GMP project, data such as boring logs from the Basin, pump tests, water elevation data, water quality data, and stream flow data will need to be collected and evaluated. Following implementation of BMPs and a potential GMP project, groundwater and surface water data will be collected as discussed in Section 3. The data collected will be compiled into electronic databases following collection.

The data would be evaluated on an annual basis. Reports may be produced following evaluation. The reports should include a summary of monitoring results, including a discussion of historical trends, a summary of management actions or measures implemented during the review period, an evaluation of the effectiveness of the management measures in achieving the GMP goals, a summary of proposed management measures for the future, a summary of GMP component changes, and a summary of coordination activities with other agencies.

Technical reports may also be produced following implementation of certain elements of this plan. For example, well completion reports will be produced following construction of a new monitoring well.

Changes to the GMP may be recommended in the reports described above. Changes will be incorporated in an update to the GMP, which should occur every five years.

7. RECOMMENDATIONS

In order to better understand the state of the Basin and to evaluate potential GMP projects, additional data need to be collected. Data such as boring logs from the Basin, pump tests, water elevation data, water quality data, and stream flow data will need to be collected and evaluated. Dudek recommends the following initial field investigation activities:

- Well Inventory
  An inventory of existing wells in the Watershed should be conducted. The depth, screened interval, and reference elevation should be recorded. Additionally, it should be noted if the District could monitor water levels and production in the wells.

- Well Completion
  Additional groundwater wells should be installed within the Basin to provide additional aquifer data. Some of the borings should extend to the contact between the residuum and fractured granite in order to better estimate the thickness of the alluvium and residuum. Following well installation and development, pump tests should be conducted to determine aquifer characteristics.

  Some of the wells should be installed as nested wells in order to determine if a perched aquifer exists in the Valley.

  Wells should also be installed and water levels monitored south of the Watershed, within the alluvium and residuum, to determine if a groundwater divide exists at the southern edge of the Basin.

- Well Monitoring
  Groundwater elevations and quality should be monitored on a regular basis (see Section 3).

- Surface Water Monitoring
  Stream flow should be monitored at several locations during the dry season to determine where groundwater is contributing to stream flow. Stream flow and quality should be monitored on a regular basis (see Section 3).

Additional data should be collected during feasibility studies conducted for potential projects. The data could include boring logs from the Basin, pump tests, water elevation data, water quality data, and stream flow data. The data collected should be used to evaluate the feasibility and effectiveness of potential projects and the potential affects of the projects on groundwater and surface water levels and quality.

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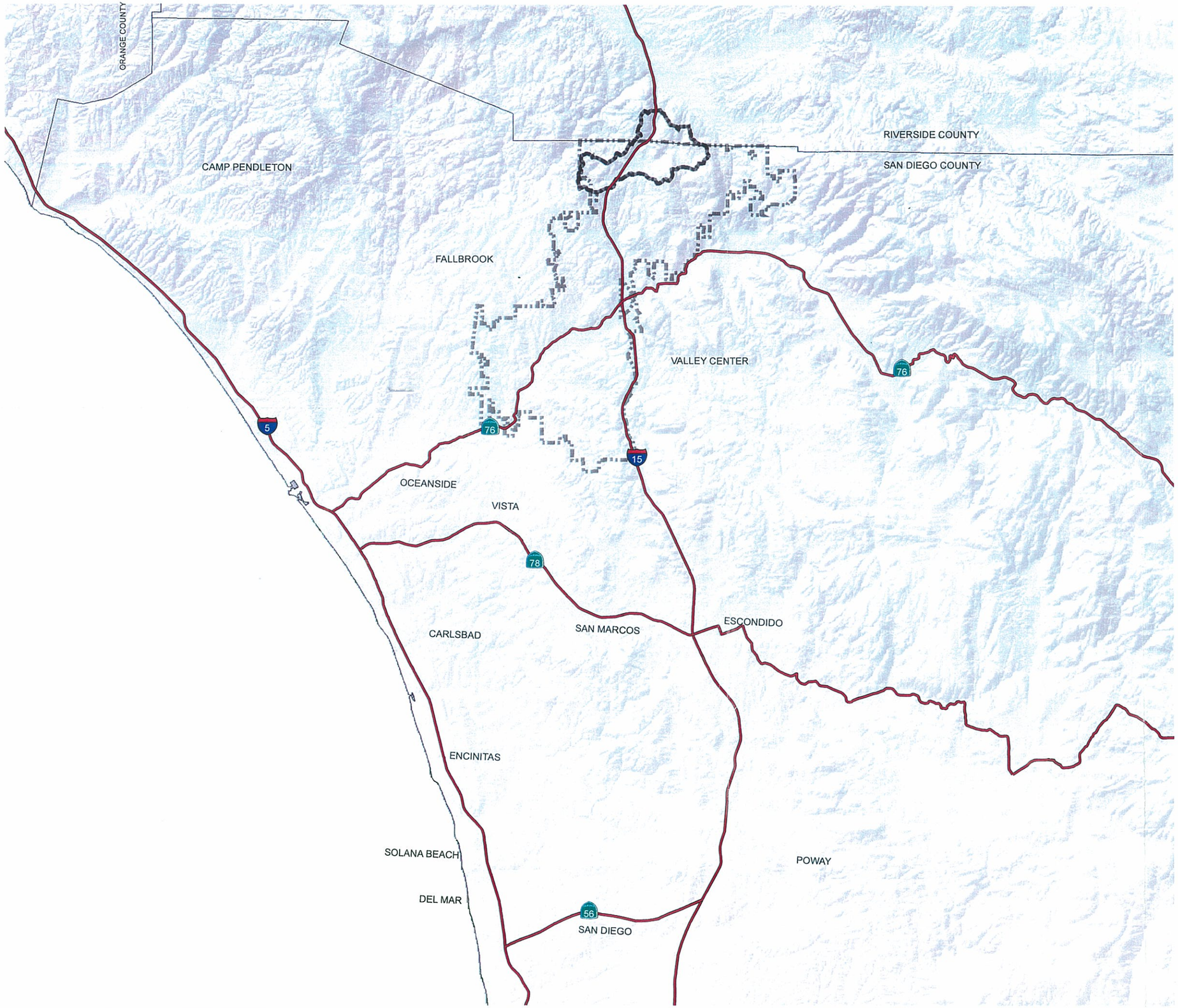


RAINBOW MUNICIPAL WATER DISTRICT

LEGEND

- RMWD BOUNDARY
- RAINBOW VALLEY WATERSHED
- FREEWAYS

N

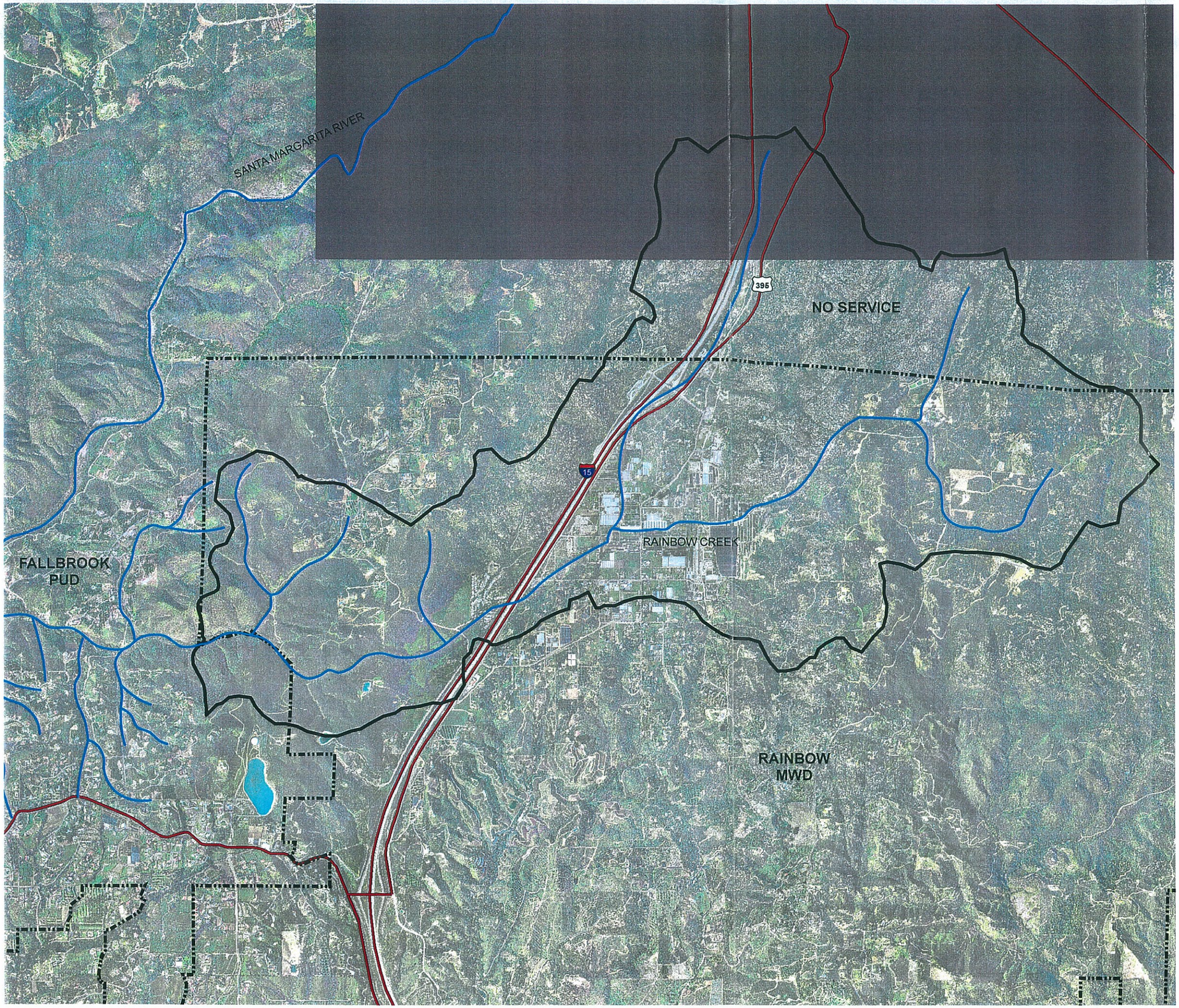
1" = 22,000'

DUDEK & ASSOCIATES, INC.
Professional Teams for Complex Projects

FIGURE 1: VICINITY MAP

RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

04-2005 Figure01_Vicinity.mxd



RAINBOW
MUNICIPAL WATER DISTRICT

LEGEND

- RMWD BOUNDARY
- RAINBOW VALLEY WATERSHED
- STREAMS
- HIGHWAY

N

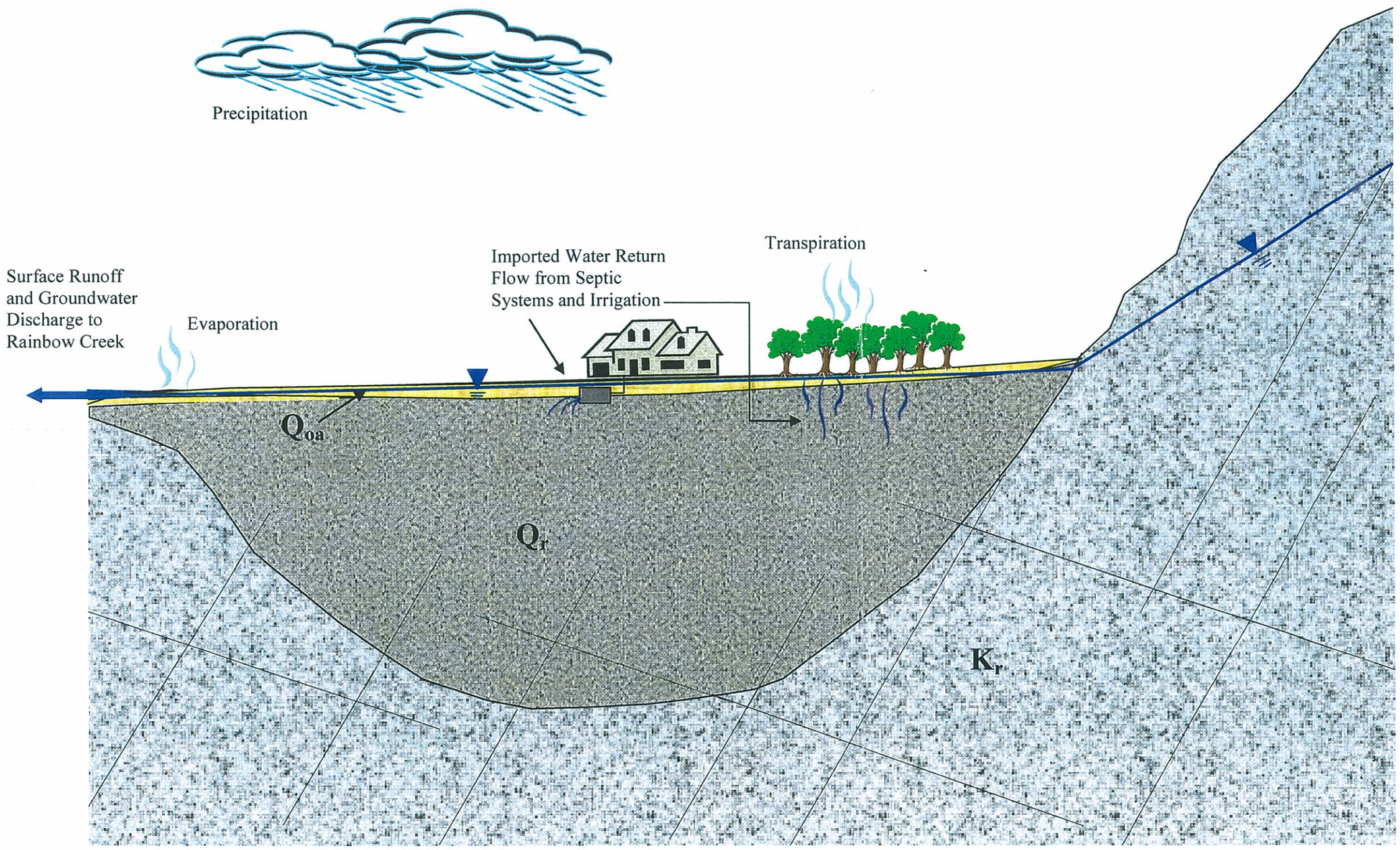
1" = 3000'

DUDEK
& ASSOCIATES, INC.
Professional Teams for Complex Projects

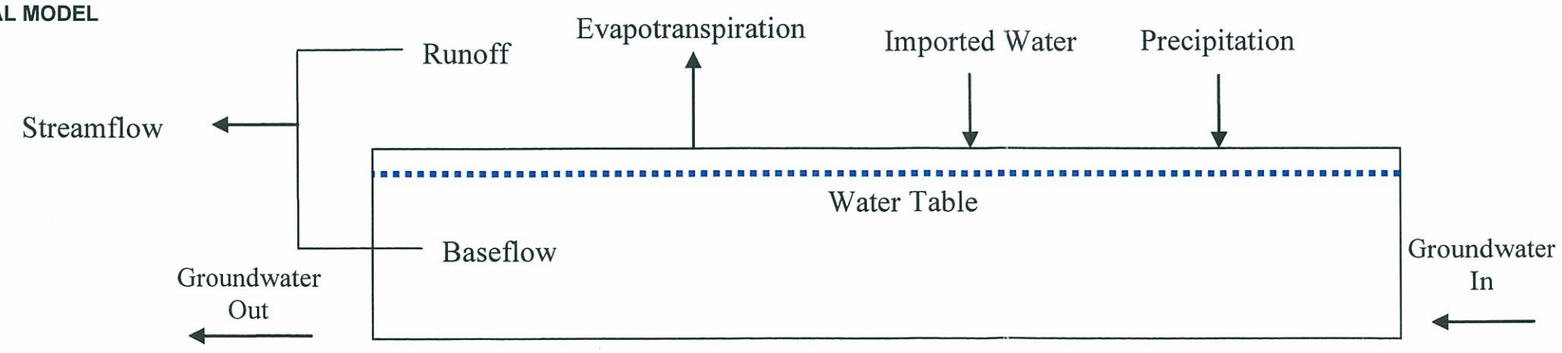
FIGURE 2: RAINBOW VALLEY WATERSHED

RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

04-2005 Figure02_Watershed.mxd



BOX DIAGRAM OF CONCEPTUAL MODEL



RAINBOW MUNICIPAL WATER DISTRICT

LEGEND

- Qoa – Older alluvial flood plain deposits
- Qr – Quaternary Residuum
- Kr – Cretaceous Granodiorite
- Groundwater Table
- Fractures

N

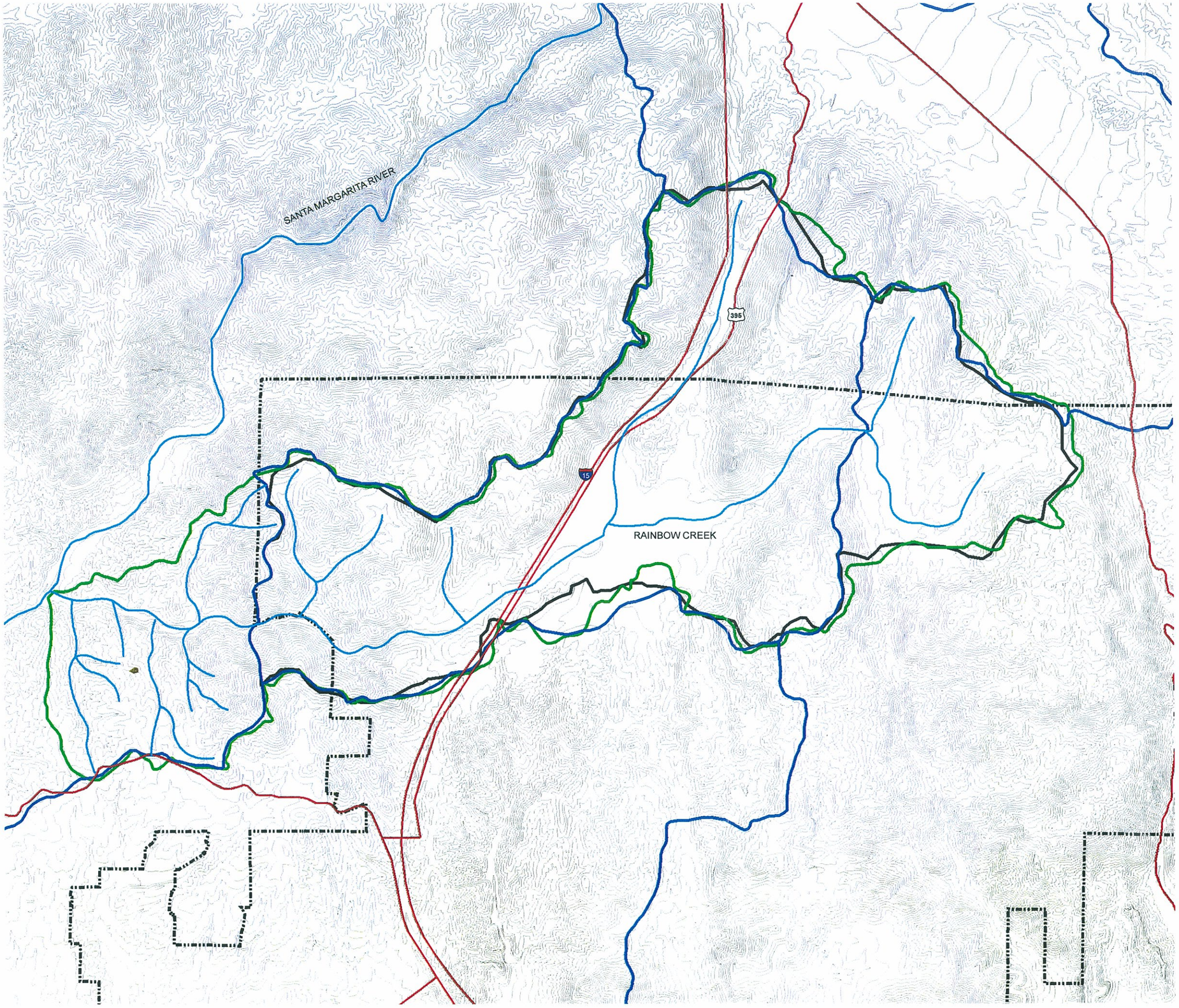
NOT TO SCALE

DUDEK & ASSOCIATES, INC.
Professional Teams for Complex Projects

FIGURE 3: CONCEPTUAL MODEL OF RAINBOW VALLEY

RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

04-2005 Figure03_ConceptualModel.mxd



RAINBOW MUNICIPAL WATER DISTRICT

LEGEND

- RMWD BOUNDARY
- RAINBOW CREEK WATERSHED (SOURCE: RWQCB TMDL)
- RWQCB BASIN PLAN SUB-UNITS
- RAINBOW CREEK SUB-WATERSHED (SOURCE: US DISTRICT COURT, 1962)
- STREAMS (SOURCE: RWQCB TMDL)
- HIGHWAY

N

1" = 3500'

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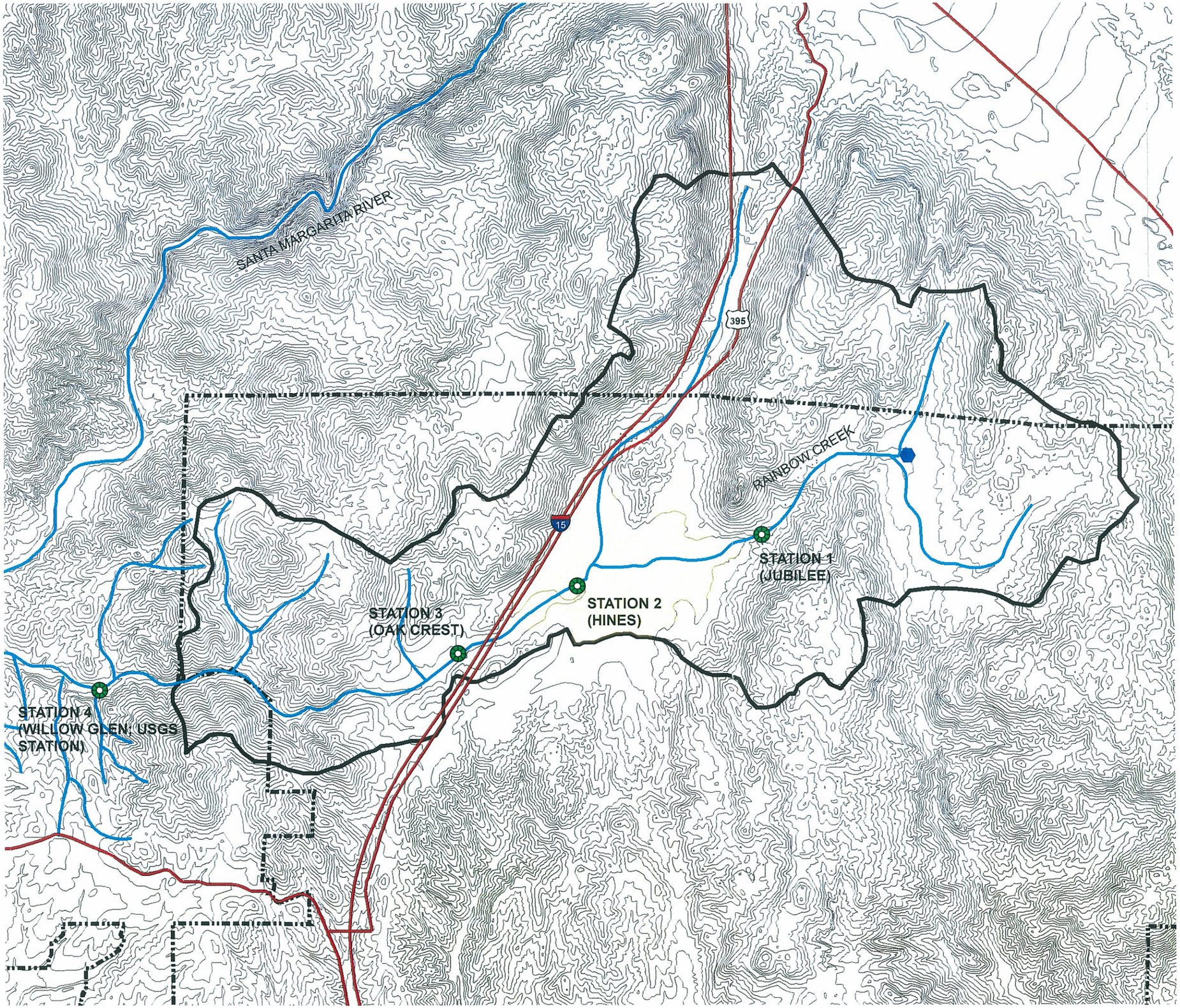
FIGURE 4: WATERSHED BOUNDARIES

RAINBOW VALLEY BASIN
GROUNDWATER MANAGEMENT PLAN

04-2005 Figure04_WatershedBounds.mxd



RAINBOW
MUNICIPAL WATER DISTRICT

LEGEND

- RMWD BOUNDARY
- RAINBOW VALLEY WATERSHED
- VALLEY FLOOR
- RAIN GAUGE LOCATIONS (RAINBOW CONSERVATION CAMP)
- STREAM GAUGE LOCATION
- STREAMS
- HIGHWAY

NOTE: VALLEY FLOOR BASED ON USGS MAPPED Qoa (USGS 2000)

N

1" = 3000'

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& ASSOCIATES, INC.
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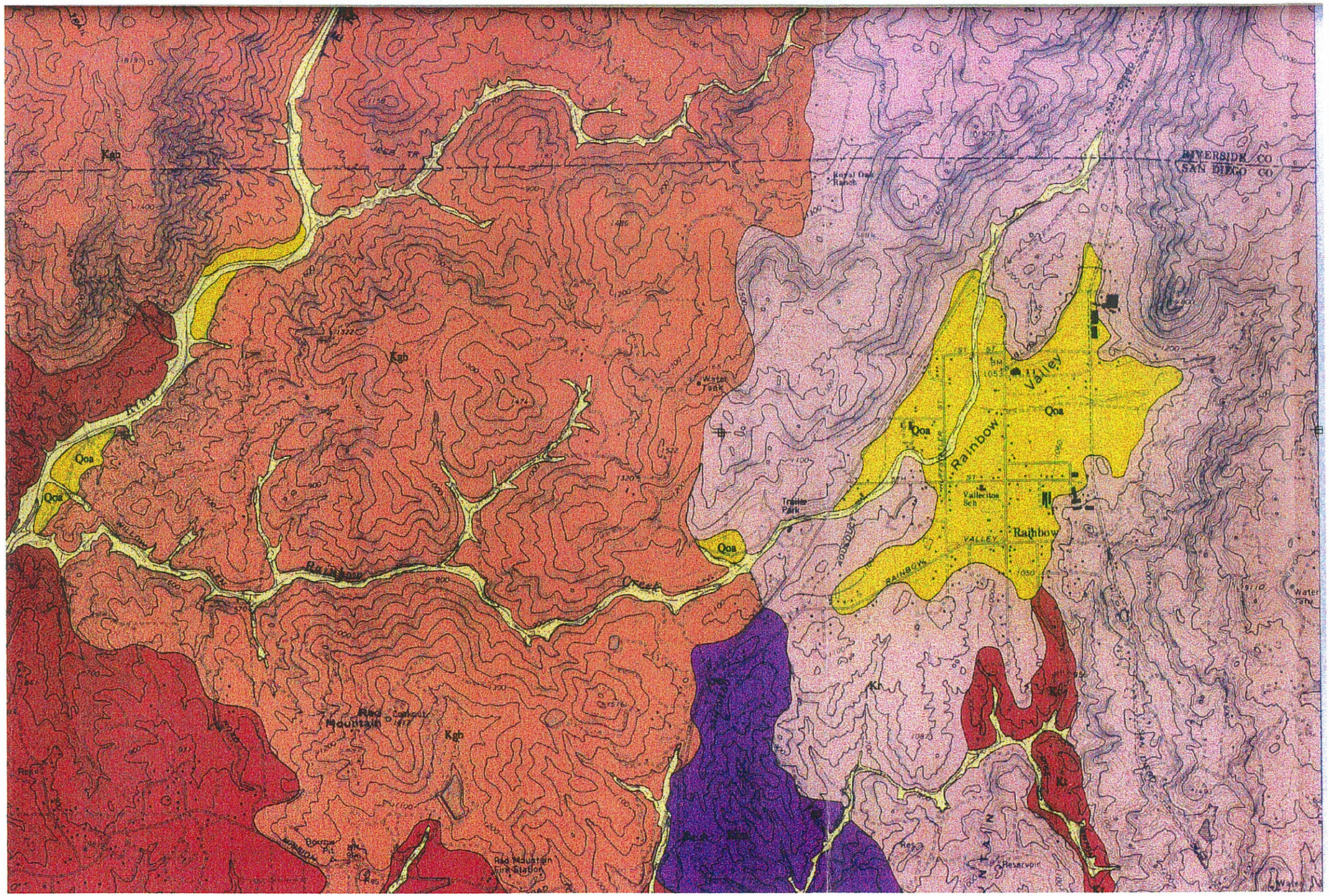
FIGURE 5: RAINBOW BASIN, RAINBOW CREEK, AND MEASUREMENT STATIONS

RAINBOW VALLEY BASIN
GROUNDWATER MANAGEMENT PLAN

04-2005 Figure05_BasCrkMeas.mxd



RAINBOW MUNICIPAL WATER DISTRICT

LEGEND

- Qa - ACTIVE ALLUVIAL FLOOD PLAIN DEPOSITS
- Qoa - OLDER ALLUVIAL FLOOD PLAIN DEPOSITS
- Kr - GRANODIORITE
- Kt - TONALITE
- Kgb - GABBRO
- KJm - METAVOLCANIC AND METASEDIMENTARY ROCKS

SOURCE: USGS TEMECULA QUADRANGLE DIGITAL DATABASE 2000

N

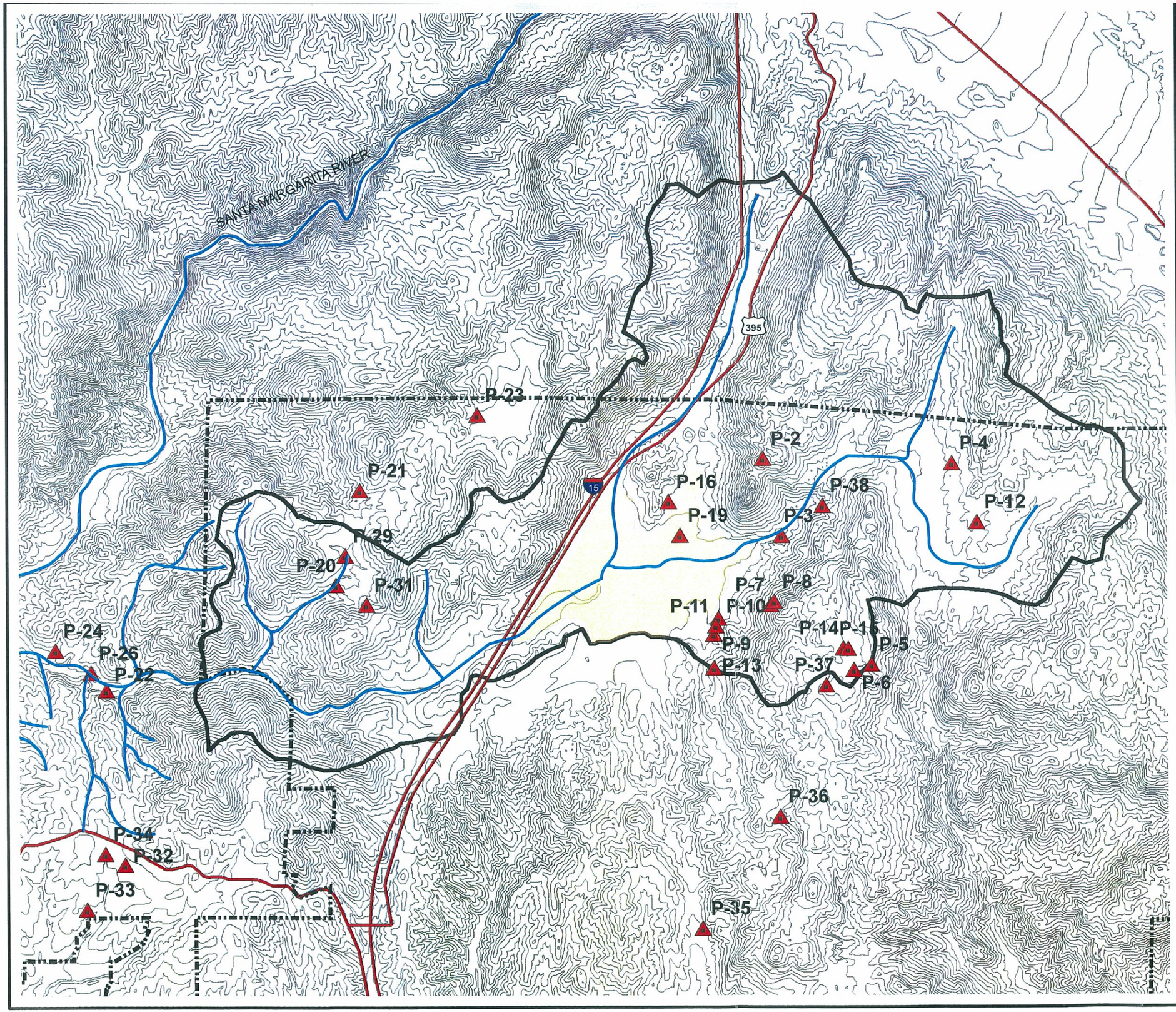
NOT TO SCALE

DUDEK & ASSOCIATES, INC.
Professional Teams for Complex Projects

FIGURE 6: GEOLOGIC MAP OF RAINBOW VALLEY

RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

04-2005 Figure06_GeologicMap.mxd



RAINBOW MUNICIPAL WATER DISTRICT

LEGEND

- RMWD BOUNDARY
- RAINBOW VALLEY WATERSHED
- VALLEY FLOOR
- PRIVATE WELLS
- STREAMS
- HIGHWAY

N

1" = 3000'

DUDEK & ASSOCIATES, INC.
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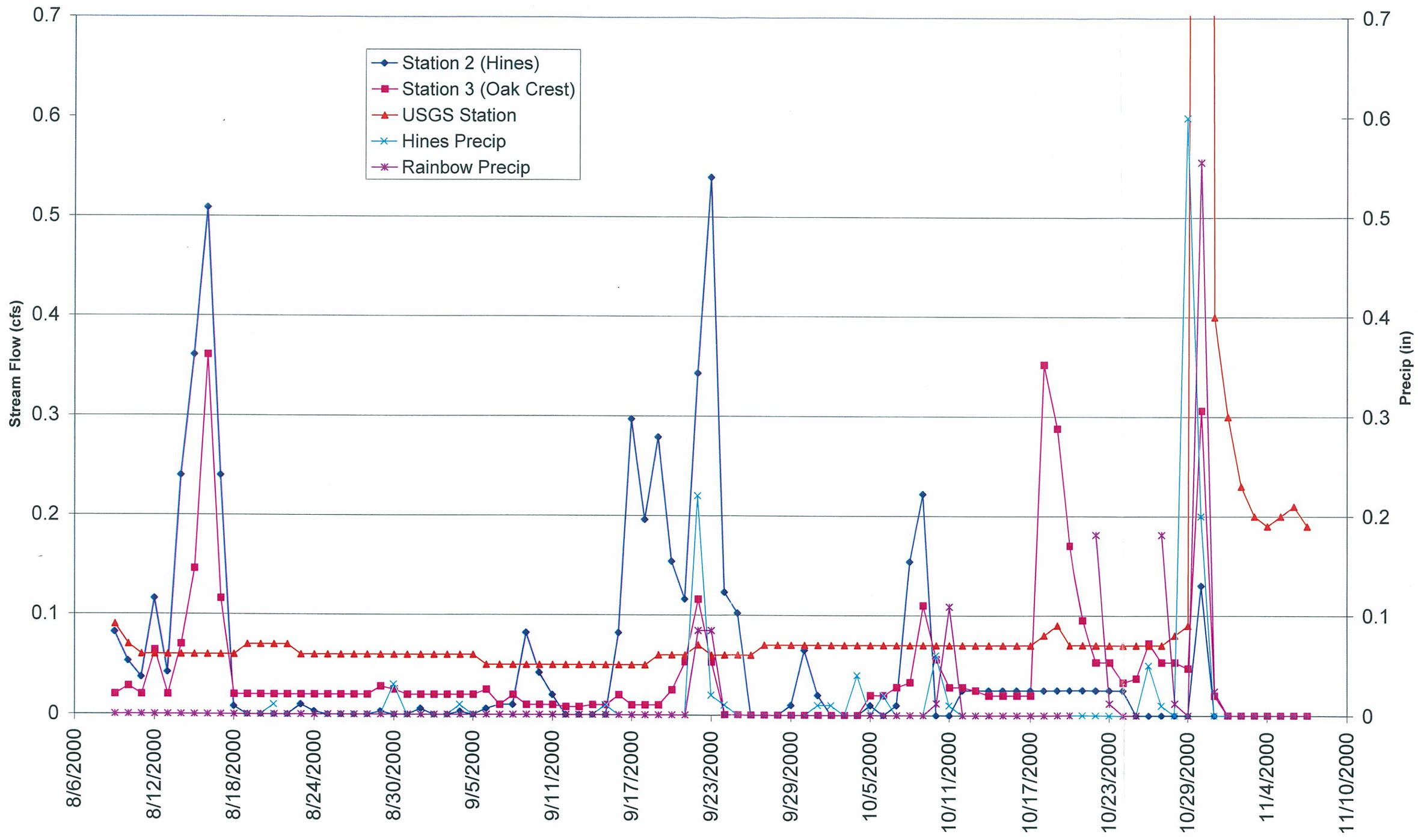
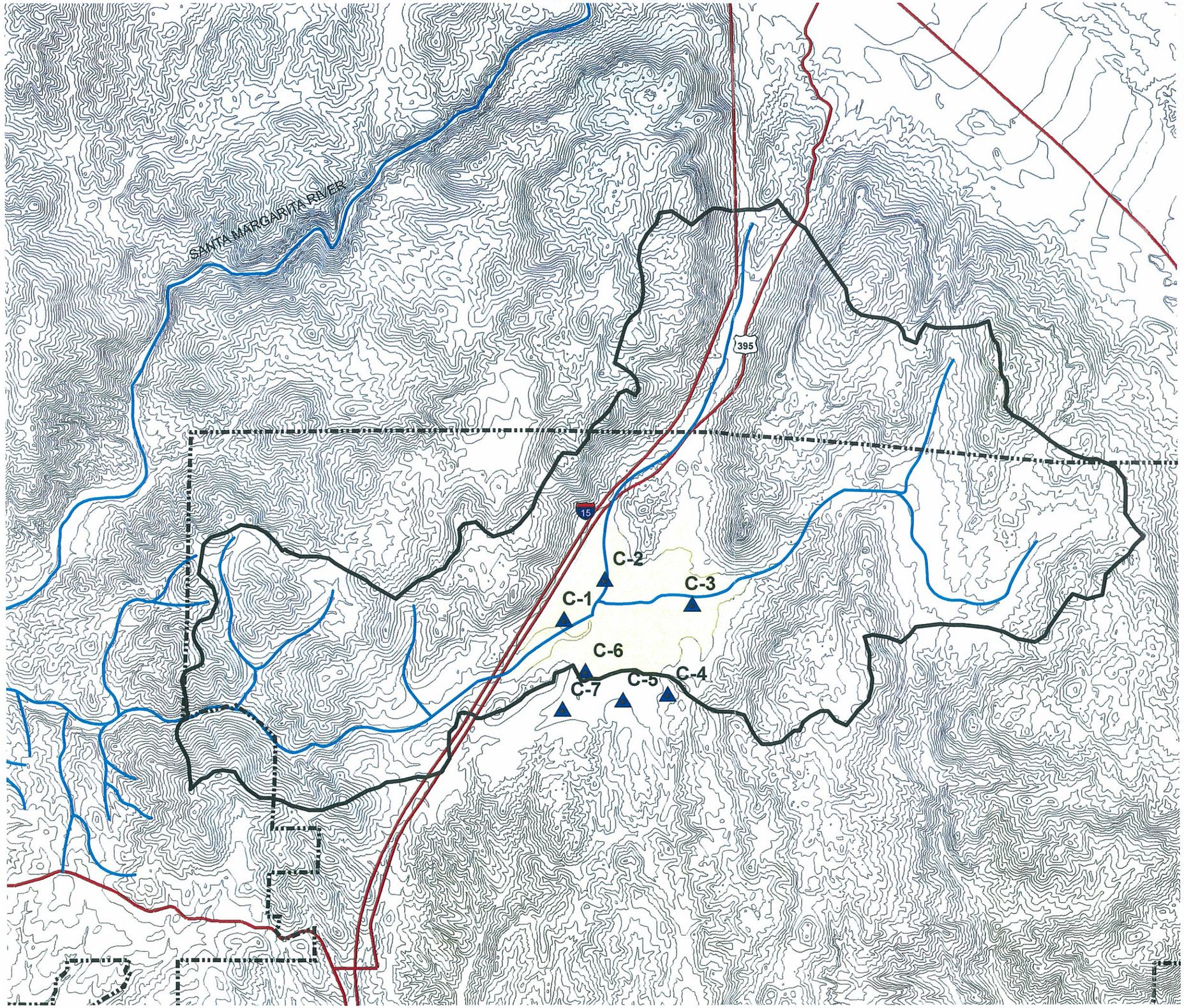
FIGURE 7: PRIVATE WELL LOCATIONS

RAINBOW VALLEY BASIN
GROUNDWATER MANAGEMENT PLAN

04-2005 Figure07_WellLocations.mxd

Figure 8
Stream Flow vs. Precipitation





RAINBOW MUNICIPAL WATER DISTRICT

LEGEND

- RMWD BOUNDARY
- RAINBOW VALLEY WATERSHED
- VALLEY FLOOR
- SHALLOW WELLS
- STREAMS
- HIGHWAY

NOTE: SHALLOW WELLS INTERMITTENTLY MONITORED BY THE COUNTY OF SAN DIEGO FROM 1988 TO 1992.

N

1" = 3000'

DUDEK & ASSOCIATES, INC.
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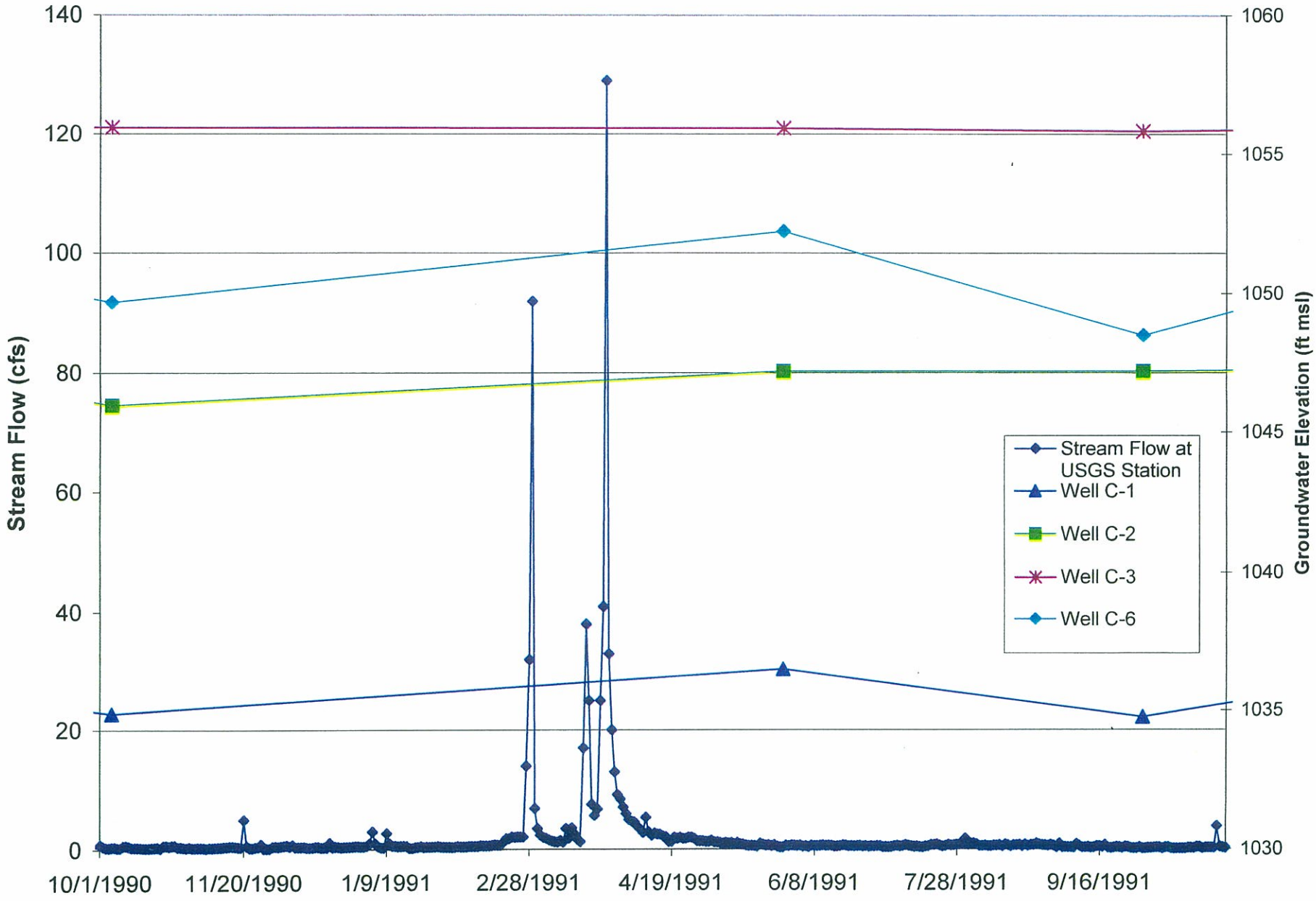
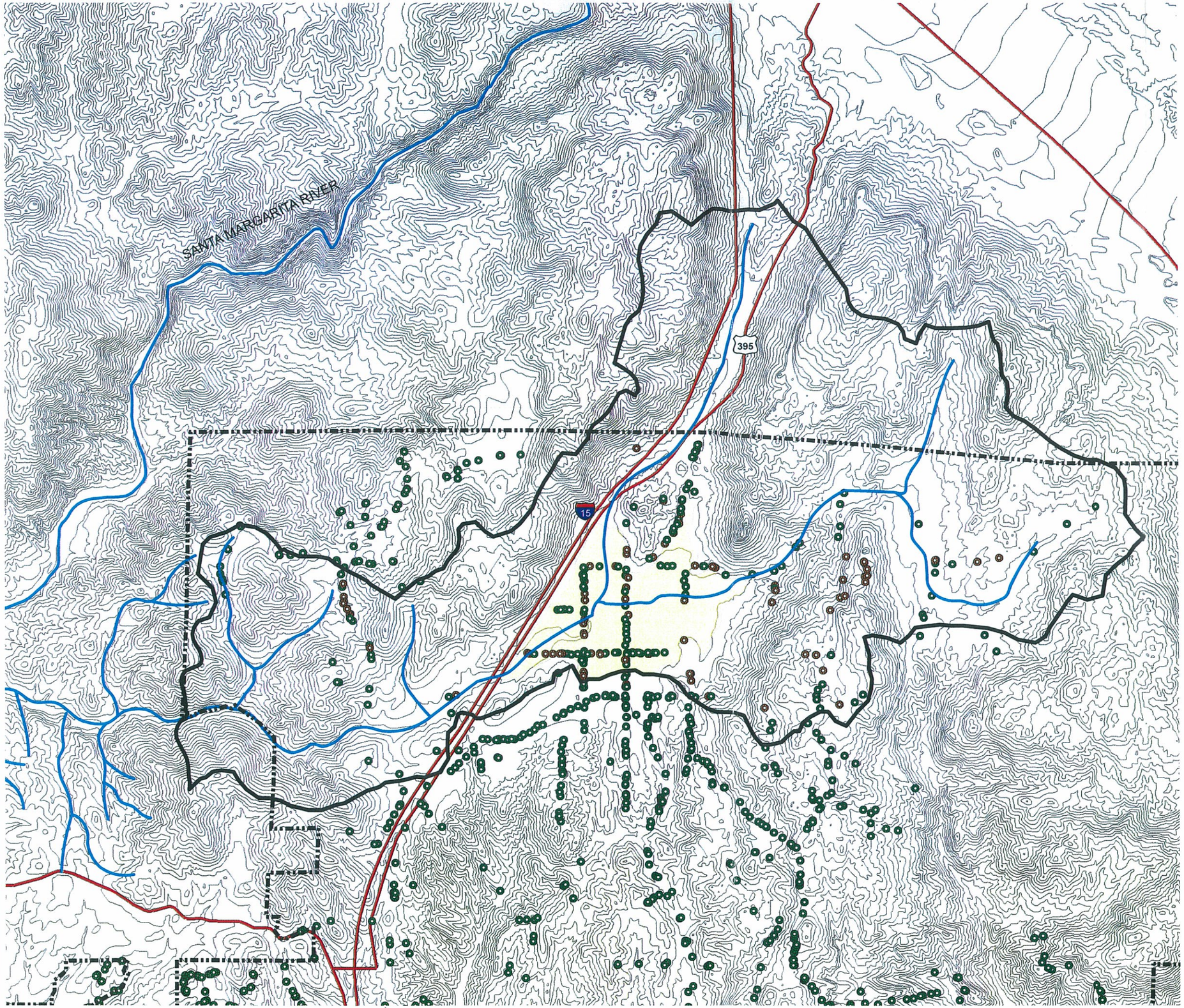
FIGURE 9: SHALLOW WELL LOCATIONS

RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

04-2005 Figure09_ShallowWells.mxd

Figure 10 - Groundwater Elevations





RAINBOW
MUNICIPAL WATER DISTRICT

LEGEND

- RMWD BOUNDARY
- RAINBOW VALLEY WATERSHED
- VALLEY FLOOR

WATER METERS

- HIGH VOLUME USERS (>1,000,000 GALLONS PER YEAR)
- WATER METERS
- STREAMS
- HIGHWAY

N

1" = 3000'

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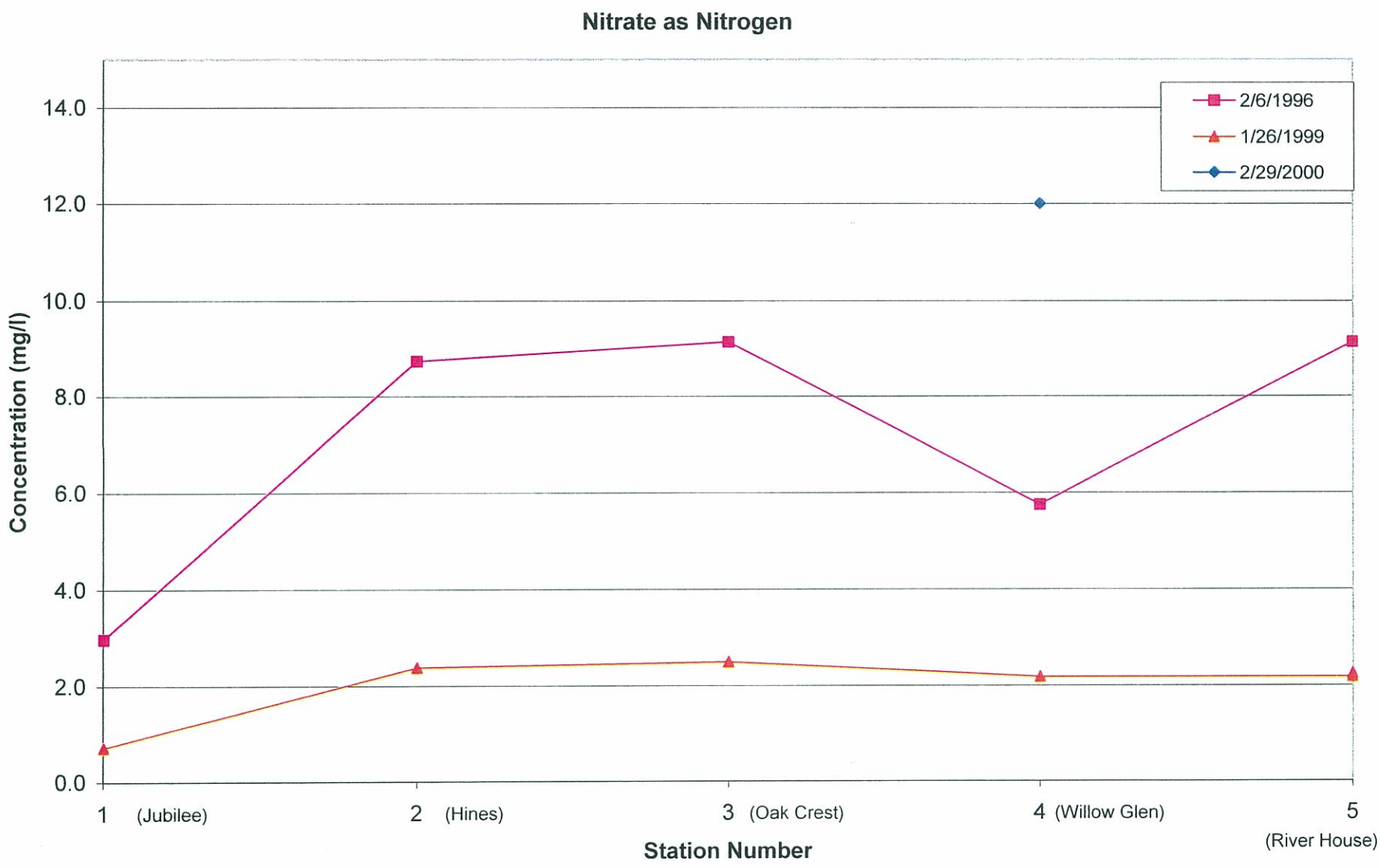
FIGURE 11: EXISTING DISTRICT CUSTOMERS

RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

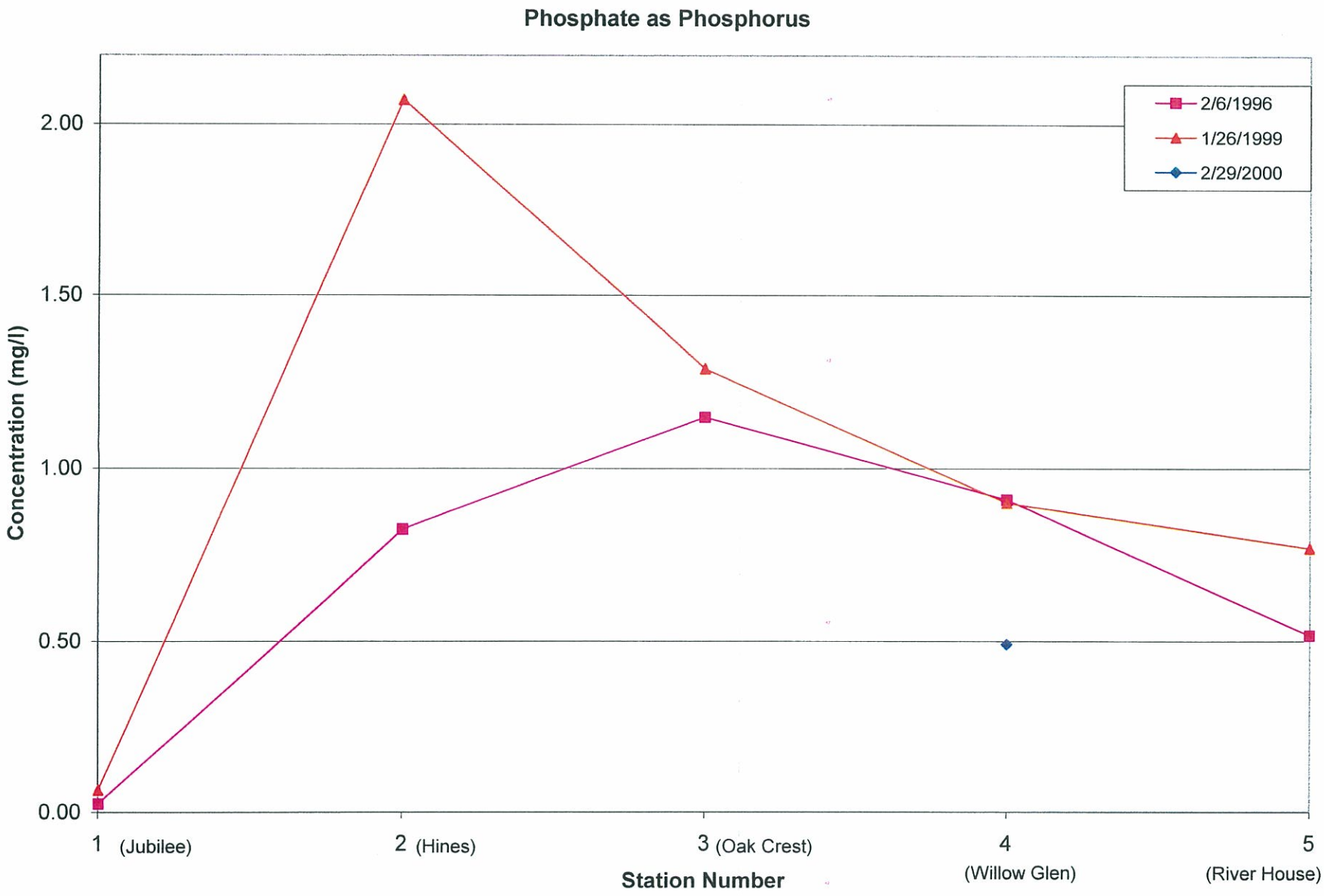
04-2005 Figure11_ExDistCustomers.mxd

Figure 12



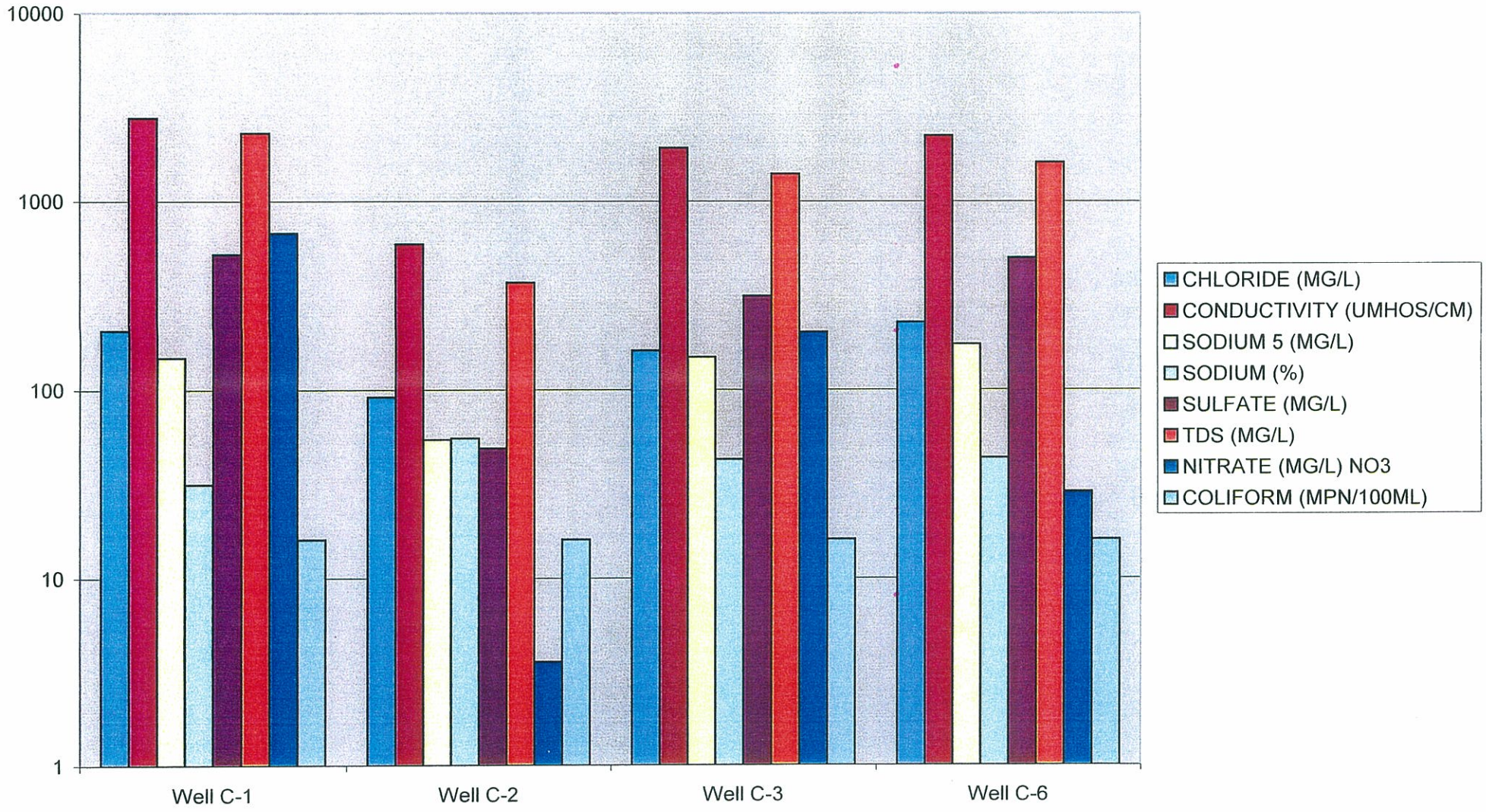
Source: 1996 and 1999 data - MRCD field measurements
2000 data - RWQCB laboratory measurements

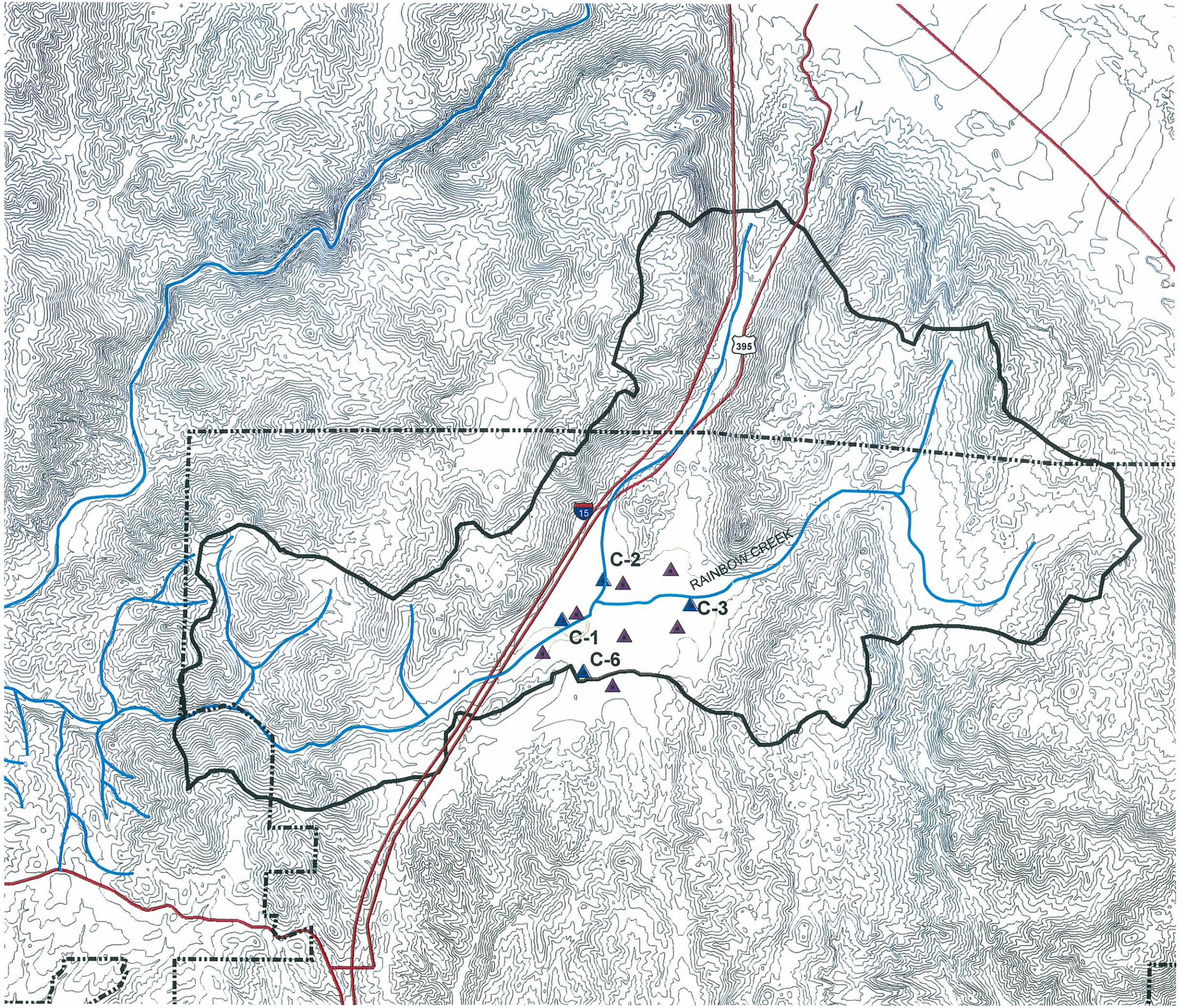
Figure 13



Source: 1996 and 1999 data - MRCD field measurements
2000 data - RWQCB laboratory analysis

FIGURE 14
GROUNDWATER SAMPLES COLLECTED IN THE RAINBOW VALLEY APRIL, 10 1989





RAINBOW MUNICIPAL WATER DISTRICT

LEGEND

- RMWD BOUNDARY
- RAINBOW VALLEY WATERSHED
- VALLEY FLOOR
- POTENTIAL GROUNDWATER MONITORING WELL LOCATIONS
- SHALLOW WELLS
- STREAMS
- HIGHWAY

NOTE: IT IS NOT KNOWN IF THE SHALLOW WELLS STILL EXIST. THE FOUR SHALLOW WELLS WERE LAST MONITORED BY THE COUNTY IN 1992.

N

1" = 3000'

DUDEK & ASSOCIATES, INC.
Professional Teams for Complex Projects

FIGURE 15: POTENTIAL MONITORING WELL LOCATIONS

RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

04-2005 Figure15_MonitoringWells.mxd

APPENDIX A

Calculations

Evapotranspiration Estimate
for Irrigated Areas

DATA

	mean evap (1952-1976) vail lake - elev 1350 off-ground class A mm	in	evap coef orchard	evap	mean evap (1941-1946) lake wohlford - elev 1500 off-ground class A mm	in	evap coef orchard	evap	1997 Red Mtn Reservoir - elev 1100 Pan evap - in	evap coef orchard	evap
Oct	162	6.37794	0.82	5.229911	122	4.80314	0.82	3.938575	2.76	0.82	2.2632
Nov	109	4.29133	0.75	3.218498	92	3.62204	0.75	2.71653	1.5	0.75	1.125
Dec	90	3.5433	0.71	2.515743	60	2.3622	0.71	1.677162	3.81	0.71	2.7051
Jan	88	3.46456	0.72	2.494483	59	2.32283	0.72	1.672438	5.39	0.72	3.8808
Feb	100	3.937	0.75	2.95275	64	2.51968	0.75	1.88976	5.97	0.75	4.4775
Mar	119	4.68503	0.79	3.701174	98	3.85826	0.79	3.048025	0.68	0.79	0.5372
Apr	152	5.98424	0.85	5.086604	106	4.17322	0.85	3.547237	1.89	0.85	1.6065
May	202	7.95274	0.92	7.316521	152	5.98424	0.92	5.505501	1.83	0.92	1.6836
Jun	237	9.33069	0.94	8.770849	171	6.73227	0.94	6.328334	4.21	0.94	3.9574
Jul	291	11.45667	0.95	10.88384	221	8.70077	0.95	8.265732	6.07	0.95	5.7665
Aug	283	11.14171	0.93	10.36179	206	8.11022	0.93	7.542505	6.33	0.93	5.8869
Sep	212	8.34644	0.88	7.344867	171	6.73227	0.88	5.924398	3.11	0.88	2.7368
			total evap	69.87703			total evap	52.0562		total evap	36.6265

average 52.85324 in per year

CALCULATION

total watershed area 5864 approximate irrigated area 33% evapotranspiration ((52.85/12)*5864*.33) 8523.114 acre-ft

Source: Pan evaporation data for Vail Lake and Lake Wohlford - DWR 1979
Pan evaporation data for Red Mountain Reservoir - FPUD 2004
Evap Coef - DWR 1979

Baseflow Calculation - Station 4/USGS Station

Average Baseflow	Ave Baseflow	Total flow in 2000	Baseflow
Aug-Sept 2000	Projected for entire year		
(cfs)	ft^3	ft^3	%
0.066	2081376	21863520	9.519857736
	(=0.066*60*60*24*365)		(Baseflow/Total)

Hydraulic Conductivity Calculation
Based on Water Levels from Caltrans Borings B-1, B-2, and B-3 from 1980

Calculated Gradient	Ave Baseflow	Thickness of Alluvium	Distance Along Rainbow Creek	Area, A	K, ft/s	K, ft/day
i, ft/ft	Station 3 (Q, cfs)	Based on Caltrans Borings Descriptions (ft)	B-2 to B-3 (ft)	thickness x distance (ft2)	Q/(A*i)	
0.17	0.03	11.7	168	1965.6	8.97795E-05	7.75694893

Change in Storage
25% and 5% available storage

delta wl Area	delta wl (ft)	area (ac)	vol (acre-ft)	avail. storage	storage vol (acre-ft)
A	-1.25	40	-50	0.25	-12.5
B	-0.75	95	-71.25	0.25	-17.8125
c	-0.25	102	-25.5	0.25	-6.375
d	0.25	50	12.5	0.25	3.125
E	0.75	52	39	0.25	9.75
F	1.25	111	138.75	0.25	34.6875
				change in storage	10.875

delta wl Area	delta wl (ft)	area (ac)	vol (acre-ft)	avail. storage	storage vol (acre-ft)
A	-1.25	40	-50	0.05	-2.5
B	-0.75	95	-71.25	0.05	-3.5625
c	-0.25	102	-25.5	0.05	-1.275
d	0.25	50	12.5	0.05	0.625
E	0.75	52	39	0.05	1.95
F	1.25	111	138.75	0.05	6.9375
				change in storage	2.175

Water Balance
Oct 1990 - Oct 1991

10/90 - 10/91

in				out					difference	
precip		water delivered		surface water flow out		pumping out		evaporation	delta stored gw	
precip (in/yr)	Area (acre)	water delivered (gal)	time (days)	sw flow out (volume ft3)	t (days)	approx. no. private wells (assumed residential)	approx acre-ft per year per residence		delta wl	available storage
18.52841	5864	380455767.1	365	70732224	362	20	0.5		see attached	0.25
precip (ft)	Vol (acre-ft)	Q (GPD)	acre-ft/yr	Q (GPD)	acre-ft/yr	acre-ft/yr	10		11	acre-ft
1.5440342	9054.216353	1,042,344.57	1167.6	1,461,640.28	1637.037108					

9054 + 1168 - 1,637 - 10 - evap = 11

evap = 8564

Percentage of Surface Water Concentration Contributed from Baseflow for Station 4, Jan - Oct 2000

	Ave Baseflow Concentration (Table 9; mg/l)	Ave Baseflow Flow (Table 9; cfs)	Total Calculated Baseflow Flow Jan-Oct (acre-ft/10 months)	Baseflow Conc x Baseflow Flow for 10 month period (acre-ft x mg/l)	Cumulative Flow Jan - Oct 2000 (acre-ft)	Average Concentration Jan-Oct (mg/l)	Flow x Concentration	Percent contributed by baseflow
Calculation			Column 2 x (26265600s / 10 months) / (43560 ft/acre)	Column 1 x Column 3			Column 5 x column 6	Column 4/Column 7 x 100
Nitrate	4.70	0.06	36.18	170.04	467.13	9.00	4204.14	4.04
Phosphate	0.36	0.06	36.18	13.02	467.13	0.37	172.84	7.54

APPENDIX B

Caltrans Figure

POT "LO" LINE

POT "RC" LINE

39

PLAN

1" = 50'

APPENDIX C

Best Management Practices

General BMPs and Associated Costs
RWQCB TMDL Appendix

Appendix H
Cost Estimates For Implementing Best Management Practices (BMPs)

Table H-1. Commercial Nurseries

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components				Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
COMMERCIAL NURSERIES 339 Acres	LOW	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Soil nutrient analysis 1			each	3	$ 7	$ 25	$ 21	$ 75		
		Irrigation water analysis2			each	1	$ 5	$ 30	$ 5	$ 30		
		Subtotal							$ 26	$ 10,105		
		Irrigation Management										
		None										
		Runoff/Erosion Management										
		None										
								TOTAL	$ 26	$ 10,105	$ 3	$ 1,011

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
COMMERCIAL NURSERIES 339 Acres	MEDIUM	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Soil nutrient analysis [1]			each	3	$ 7	$ 25	$ 21	$ 75		
		Irrigation water analysis[2]			each	1	$ 5	$ 30	$ 5	$ 30		
		Subtotal							$ 26	$ 10,105		
		Irrigation Management										
		Irrigation system upgrades (441, 442)[3 4 5]	5-35	40-85	each	1	$ 350	$ 3,600	$ 350	$ 3,600		
		Irrigation system - tailwater recovery (447)[3 5]	5-15	40-45	each	1	$ 4,500	$ 25,000	$ 4,500	$ 25,000		
		Irrigation water management (449)[3 5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 4,900	$ 29,350		
		Runoff/Erosion Management										
		None										
								TOTAL	$ 4,926	$ 39,455	$ 493	$ 3,946

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
COMMERCIAL NURSERIES 339 Acres	HIGH	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Soil nutrient analysis [1]			each	3	$ 7	$ 25	$ 21	$ 75		
		Irrigation water analysis[2]			each	1	$ 5	$ 30	$ 5	$ 30		
		Subtotal							$ 26	$ 10,105		
		Irrigation Management										
		Irrigation system upgrades (441, 442)[3 4 5]	5-35	40-85	each	1	$ 350	$ 3,600	$ 350	$ 3,600		
		Irrigation system - tailwater recovery (447)[3 5]	5-15	40-45	each	1	$ 4,500	$ 25,000	$ 4,500	$ 25,000		
		Irrigation water management (449)[3 5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 4,550	$ 25,750		
		Runoff/Erosion Management										
		Access road management (560)[3 5]										
		Paved Drives		55-60	square yard	480	$ 2	$ 4	$ 816	$ 1,920		
		Runoff management system (570)[3 5]							$ -	$ -		
		Filter Trap	10-25		acre	0.25	$ 375	$ 12,500	$ 94	$ 3,125		
		Filter Strips (393)[3 5]							$ -	$ -		
		Landscaping		5-15	acre	0.05	$ 450	$ 3,500	$ 23	$ 175		
		Subtotal							$ 932	$ 5,220		
								TOTAL	$ 5,508	$ 41,075	$ 551	$ 4,108

Table H-2. Agriculture

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components				Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
AGRICULTURE												
436 Acres	LOW	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Soil nutrient analysis 1			each	3	$ 7	$ 25	$ 21	$ 75		
		Irrigation water analysis2			each	1	$ 5	$ 30	$ 5	$ 30		
		Subtotal							$ 26	$ 10,105		
		Irrigation Management										
		None										
		Runoff/Erosion Management										
		None										
								TOTAL	$ 26	$ 10,105	$ 3	$ 1,011

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
AGRICULTURE												
436 Acres	MEDIUM	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Soil nutrient analysis [1]			each	3	$ 7	$ 25	$ 21	$ 75		
		Irrigation water analysis[2]			each	1	$ 5	$ 30	$ 5	$ 30		
		Subtotal							$ 26	$ 10,105		
		Irrigation Management										
		Irrigation system upgrades (441, 442)[3,4,5]	5-35	40-85	each	1	$ 350	$ 3,600	$ 350	$ 3,600		
		Irrigation system - tailwater recovery (447)[3,5]	5-15	40-45	each	1	$ 4,500	$ 25,000	$ 4,500	$ 25,000		
		Irrigation water management (449)[3,5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 4,900	$ 29,350		
		Runoff/Erosion Management										
		None										
								TOTAL	$ 4,926	$ 39,455	$ 493	$ 3,946

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
AGRICULTURE												
436 Acres	HIGH	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Soil nutrient analysis [1]			each	3	$ 7	$ 25	$ 21	$ 75		
		Irrigation water analysis[2]			each	1	$ 5	$ 30	$ 5	$ 30		
		Subtotal							$ 26	$ 10,105		
		Irrigation Management										
		Irrigation system upgrades (441, 442)[3,4,5]	5-35	40-85	each	1	$ 350	$ 3,600	$ 350	$ 3,600		
		Irrigation system - tailwater recovery (447)[3,5]	5-15	40-45	each	1	$ 4,500	$ 25,000	$ 4,500	$ 25,000		
		Irrigation water management (449)[3,5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 4,900	$ 29,350		
		Runoff/Erosion Management										
		Access road management (560)[3,5]										
		Pave Roads		85-90	square yard	1000	$ 2	$ 4	$ 2,150	$ 4,300		
		Pave Drives		55-60	square yard	1000	$ 2	$ 4	$ 1,700	$ 4,000		
		Runoff management system (570)[3,5]										
		Filter Trap	10-25		acre	0.2	$ 375	$ 12,500	$ 75	$ 2,500		
		Filter Strips (393)[5]										
		Filter strip (10-20 ft wide)	2-10		acre	0.5	$ 375	$ 12,500	$ 188	$ 6,250		
		Buffer strip (20-30 ft wide)	10-20		acre	0.5	$ 425	$ 1,700	$ 213	$ 850		
		Landscaping	5-15		acre	0.1	$ 450	$ 3,500	$ 45	$ 350		
		Subtotal							$ 4,370	$ 18,250		
								TOTAL	$ 9,296	$ 57,705	$ 930	$ 5,771

Appendix H
Cost Estimates For Implementing Best Management Practices (BMPs)

Table H-3. Orchards

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components				Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
ORCHARDS 781 Acres	LOW	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Soil nutrient analysis 1			each	3	$ 7	$ 25	$ 21	$ 75		
		Irrigation water analysis2			each	1	$ 5	$ 30	$ 5	$ 30		
		Subtotal							$ 26	$ 10,105		
		Irrigation Management										
		None										
		Runoff/Erosion Management										
		None										
								TOTAL	$ 26	$ 10,105	$ 3	$ 1,011

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
ORCHARDS 781 Acres	MEDIUM	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Soil nutrient analysis [1]			each	3	$ 7	$ 25	$ 21	$ 75		
		Irrigation water analysis[2]			each	1	$ 5	$ 30	$ 5	$ 30		
		Subtotal							$ 26	$ 10,105		
		Irrigation Management										
		Irrigation system upgrades (441, 442)[3,4,5]	5-35	40-85	each	1	$ 350	$ 3,600	$ 350	$ 3,600		
		Irrigation system - tailwater recovery (447)[3,5]	5-15	40-45	each	1	$ 4,500	$ 25,000	$ 4,500	$ 25,000		
		Irrigation water management (449)[3,5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 4,900	$ 29,350		
		Runoff/Erosion Management										
		None										
								TOTAL	$ 4,926	$ 39,455	$ 493	$ 3,946

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
ORCHARDS 781 Acres	HIGH	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Soil nutrient analysis [1]			each	3	$ 7	$ 25	$ 21	$ 75		
		Irrigation water analysis[2]			each	1	$ 5	$ 30	$ 5	$ 30		
		Subtotal							$ 26	$ 10,105		
		Irrigation Management										
		Irrigation system upgrades (441, 442)[3,4,5]	5-35	40-85	each	1	$ 350	$ 3,600	$ 350	$ 3,600		
		Irrigation system - tailwater recovery (447)[3,5]	5-15	40-45	each	1	$ 4,500	$ 25,000	$ 4,500	$ 25,000		
		Irrigation water management (449)[3,5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 4,900	$ 29,350		
		Runoff/Erosion Management										
		Access road management (560)[3,5]								$ -		
		Pave roads		85-90	square yard	1000	$ 2	$ 4	$ 2,150	$ 4,300		
		Pave drives		55-60	square yard	1000	$ 2	$ 4	$ 1,700	$ 4,000		
		Runoff management system (570)[3,5]								$ -		
		Filter trap	10-25		acre	0.2	$ 375	$ 12,500	$ 75	$ 2,500		
		Filter Strips (393)[5]							$ -	$ -		
		Filter strip (10-20 ft wide)	2-10		acre	0.5	$ 375	$ 12,500	$ 188	$ 6,250		
		Buffer strip (20-30 ft wide)	10-20		acre	0.5	$ 425	$ 1,700	$ 213	$ 850		
		Landscaping	5-15		acre	0.1	$ 450	$ 3,500	$ 45	$ 350		
		Subtotal							$ 4,370	$ 18,250		
								TOTAL	$ 9,296	$ 57,705	$ 930	$ 5,771

Appendix H
Cost Estimates For Implementing Best Management Practices (BMPs)

Table H-4. Parks

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components				Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
PARKS												
5 Acres	LOW	**Nutrient Management**										
		Facility nutrient reduction management plan			each	0	$ -	$ -	$ -	$ -		
		Subtotal							$ -	$ -	$ -	$ -
		Irrigation Management										
		None										
		Runoff/Erosion Management										
		None										
								TOTAL	$ -	$ -	$ -	$ -

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
PARKS												
5 Acres	MEDIUM	**Nutrient Management**										
		Facility nutrient reduction management plan			each	0	$ -	$ -	$ -	$ -		
		Subtotal							$ -	$ -		
		Irrigation Management										
		Irrigation water management (449)[5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 50	$ 750		
		Runoff/Erosion Management										
		None										
								TOTAL	$ 50	$ 750	$ 5	$ 75

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
PARKS												
5 Acres	HIGH	**Nutrient Management**										
		Facility nutrient reduction management plan			each	0	$ -	$ -	$ -	$ -		
		Subtotal							$ -	$ -		
		Irrigation Management							$ -	$ -		
		Irrigation water management (449)[5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 50	$ 750		
		Runoff/Erosion Management							$ -	$ -		
		Runoff management system (570)[3,5]							$ -	$ -		
		Parking lot water retention		5-10	each	1	$ 150	$ 1,500	$ 150	$ 1,500		
		Filter strips	5-15		acre	1	$ 375	$ 12,500	$ 375	$ 12,500		
		Filter trap	10-25		acre	1	$ 375	$ 12,500	$ 375	$ 12,500		
		Subtotal							$ 900	$ 26,500		
								TOTAL	$ 950	$ 27,250	$ 95	$ 2,725

Appendix H
Cost Estimates For Implementing Best Management Practices (BMPs)

Table H-5. Residential

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components				Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
RESIDENTIAL 618 Acres	LOW	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ -	$ -	$ -		
		Subtotal							$ -	$ -		
		Irrigation Management										
		None										
		Runoff/Erosion Management										
		None										
								TOTAL	$ -	$ -	$ -	$ -

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
RESIDENTIAL 618 Acres	MEDIUM	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ -	$ -	$ -		
		Subtotal							$ -	$ -		
		Irrigation Management										
		Irrigation water management (449)[5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 50	$ 750		
		Runoff/Erosion Management										
		None										
								TOTAL	$ 50	$ 750	$ 5	$ 75

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
RESIDENTIAL 618 Acres	HIGH	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ -	$ -	$ -		
		Subtotal							$ -	$ -		
		Irrigation Management										
		Irrigation water management (449)[5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 50	$ 750		
		Runoff/Erosion Management										
		Runoff management system (570)[3 5]										
		Paved parking	80-85		square yard	480	$ 1	$ 2	$ 408	$ 936		
		Filter trap	10-25		acre	1	$ 375	$ 12,500	$ 375	$ 12,500		
		Subtotal							$ 783	$ 13,436		
								TOTAL	$ 833	$ 14,186	$ 83	$ 1,419

Appendix H
Cost Estimates For Implementing Best Management Practices (BMPs)

Table H-6. Urban

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components				Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
URBAN												
34 Acres	LOW	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ -	$ -	$ -		
		Subtotal							$ -	$ -		
		Irrigation Management										
		None										
		Runoff/Erosion Management										
		None										
								TOTAL	$ -	$ -	$ -	$ -

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
URBAN												
34 Acres	MEDIUM	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ -	$ -	$ -		
		Subtotal							$ -	$ -		
		Irrigation Management										
		Irrigation water management (449)[5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
		Subtotal							$ 50	$ 750		
		Runoff/Erosion Management										
		None										
								TOTAL	$ 50	$ 750	$ 5	$ 75

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
URBAN												
34 Acres	HIGH	**Nutrient Management**										
		Facility nutrient reduction management plan			each	1	$ -	$ -	$ -	$ -		
		Subtotal							$ -	$ -		
		Irrigation Management										
		Irrigation water management (449)[5]	20-35	45-60	each	1	$ 50	$ 750	$ 50	$ 750		
									$ -	$ -		
		Subtotal							$ 50	$ 750		
		Runoff/Erosion Management										
		Access road management (560)[3,5]										
		Pave roads		85-90	square yard	1000	$ 2	$ 4	$ 2,150	$ 4,300		
									$ -	$ -		
		Runoff management system (570)[3,5]										
		Filter strips	5-15		acre	1	$ 375	$ 12,500	$ 375	$ 12,500		
		Filter trap	10-25		acre	0.25	$ 375	$ 12,500	$ 94	$ 3,125		
		Stream corridor improvement (204)[1]		60-75	acre	1	$ 700	$ 5,500	$ 700	$ 5,500		
		Subtotal							$ 3,319	$ 25,425		
								TOTAL	$ 3,369	$ 26,175	$ 337	$ 2,618

Table H-7. Septic Tank Disposal Systems

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components				Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
SEPTIC TANK DISPOSAL SYSTEMS												
407 Units	LOW	Facility nutrient reduction management plan			each	1	$ -	$ -	$ -	$ -		
		Septic tank inspection[6]			each	160	$ 75	$ 200	$ 12,000	$ 32,000		
		Septic system pumping[6]			each	40	$ 150	$ 350	$ 6,000	$ 14,000		
		Subtotal							$ 18,000	$ 46,000		
								TOTAL	$ 18,000	$ 46,000	$ 1,800	$ 4,600

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
SEPTIC TANK DISPOSAL SYSTEMS												
407 Units	MEDIUM	Facility nutrient reduction management plan			each	1	$ -	$ -	$ -	$ -		
		Septic tank inspection[6]			each	200	$ 75	$ 200	$ 15,000	$ 40,000		
		Septic system pumping[6]			each	50	$ 150	$ 350	$ 7,500	$ 17,500		
		Subtotal							$ 22,500	$ 57,500		
								TOTAL	$ 22,500	$ 57,500	$ 2,250	$ 5,750

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs							Capital Costs		Annual Operation and Maintenance	
					Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Low	High	Low	High
SEPTIC TANK DISPOSAL SYSTEMS												
407 Units	HIGH	Facility nutrient reduction management plan			each	1	$ -	$ -	$ -	$ -		
		Septic tank inspection[6]			each	400	$ 75	$ 200	$ 30,000	$ 80,000		
		Septic system pumping[6]			each	100	$ 150	$ 350	$ 15,000	$ 35,000		
		Replace Conventional Systems with Enhanced System[7]			each	170	$ 10,000	$ 20,000	$ 1,700,000	$ 3,400,000		
									$ -	$ -		
									$ -	$ -		
									$ -	$ -		
		Subtotal							$ 1,745,000	$ 3,515,000		
								TOTAL	$ 3,490,000	$ 7,030,000	$ 349,000	$ 703,000

Appendix H
Cost Estimates For Implementing Best Management Practices (BMPs)

Table H-8. Caltrans

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components: Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Capital Costs: Low	Capital Costs: High	Annual Operation and Maintenance: Low	Annual Operation and Maintenance: High
CALTRANS												
214 Acres	LOW	**Nutrient Management**										
		Stormwater Chemical Analysis (nitrogen and phosphorous only)			each	3	$ 35	$ 50	$ 105	$ 150		
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Subtotal							$ 105	$ 10,150		
		Irrigation Management										
		None7										
		Runoff/Erosion Management										
		None										
								TOTAL	$ 105	$ 10,150	$ 11	$ 1,015

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components: Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Capital Costs: Low	Capital Costs: High	Annual Operation and Maintenance: Low	Annual Operation and Maintenance: High
CALTRANS												
214 Acres	MEDIUM	**Nutrient Management**										
		Stormwater Chemical Analysis (nitrogen and phosphorous only)			each	3	$ 35	$ 50	$ 105	$ 150		
		Stormwater Chemical Analysis (Metals, Organics, Pesticides, and PCBs)			each	3	$ 800	$ 1,400	$ 2,400	$ 4,200		
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Subtotal							$ 2,505	$ 14,350	$ 251	$ 1,435
		Irrigation Management										
		None7							$ -	$ -		
		Runoff/Erosion Management										
		Runoff management system (570)[3 5]										
		Filter strips	5-15		acre	1	$ 375	$ 12,500	$ 375	$ 12,500		
		Infiltration Trench	5-10		per foot	5000	$ 15	$ 75	$ 75,000	$ 375,000		
		Subtotal							$ 75,375	$ 387,500	$ 7,538	$ 38,750
								TOTAL	$ 77,880	$ 401,850	$ 7,788	$ 40,185

LAND USE CATEGORY	BMP LEVEL OF EFFORT	POTENTIAL MPs / BMPs	Nutrient Management Effectiveness (percent)	Water Management Effectiveness (percent)	Components: Unit	Number of Units	Cost per unit (low)	Cost per unit (high)	Capital Costs: Low	Capital Costs: High	Annual Operation and Maintenance: Low	Annual Operation and Maintenance: High
CALTRANS												
214 Acres	HIGH	**Nutrient Management**										
		Stormwater Chemical Analysis (nitrogen and phosphorous only)			each	3	$ 35	$ 50	$ 105	$ 150		
		Stormwater Chemical Analysis (Metals, Organics, Pesticides, and PCBs)			each	3	$ 800	$ 1,400	$ 2,400	$ 4,200		
		Facility nutrient reduction management plan			each	1	$ -	$ 10,000	$ -	$ 10,000		
		Subtotal							$ 2,505	$ 14,350		
		Irrigation Management										
		None[8]							$ -	$ -		
		Runoff/Erosion Management										
		Runoff management system (570)[3 5]							$ -	$ -		
		Filter strips	5-15		acre	1	$ 375	$ 12,500	$ 375	$ 12,500		
		Filter trap	10-25		acre	0.5	$ 375	$ 12,500	$ 188	$ 6,250		
		Infiltration Trench	5-10		per foot	5000	$ 15	$ 75	$ 75,000	$ 375,000		
		Sediment Basin (350)[3]			each	1	$ 700	$ 1,000,000	$ 700	$ 1,000,000		
		Subtotal							$ 76,263	$ 1,393,750		
								TOTAL	$ 78,768	$ 1,408,100	$ 7,877	$ 140,810

Appendix H
Cost Estimates For Implementing Best Management Practices (BMPs)

Footnotes for Table:

1. Mission Resource Conservation District (MRCD) 1997. Brochure: Mission Resource Conservation District - Soil Nutrient Analysis. Fallbrook, CA. Printed May 1997.
2. MRCD 1997. Brochure: Irrigation Water Management - Water Quality Analysis. Fallbrook, CA. Printed May 1997.
3. Soil Conservation Practice Numbers from U.S. Department of Agriculture (USDA), May 1995. Calleguas Creek Watershed Erosion and Sediment Control Plan for Mugu Lagoon. USDA Natural Resources Conservation Service, in cooperation with Ventura County Resource Conservation District and the California State Coastal Conservancy. Davis, CA, May 1995.
4. Upgrades include sprinkler, drip irrigation, and microspray systems
5. BMP practices, cost estimates, and percent effectiveness from U.S. Department of Agriculture (USDA), May 1995. Calleguas Creek Watershed Erosion and Sediment Control Plan for Mugu Lagoon. USDA Natural Resources Conservation Service, in cooperation with Ventura County Resource Conservation District and the California State Coastal Conservancy. Davis, CA, May 1995. Table 4-b.
6. MRCD 1999. Focus on Resource Conservation: Septic System Operation, Inspection, and Maintenance - The Homeowner's Guide. Fallbrook, CA. Summer 1999.
7. Enhanced septic tank disposal systems can provide additional treatment to household wastewater, such as reduction of waste strength, removal of pathogens, and/or removal of nitrate-nitrogen, by adding components that utilize a combination of aerobic and anaerobic treatment before effluent is released to the environment. University of Rhode Island (URI) Cooperative Extension, 2001. Septic System Information for Rhode Islanders, Frequently Asked Questions Fact Sheet. Rhode Island Regional Water Quality Program, University of Rhode Island College of Env. & Life Sciences, Dept.of Natural Resources Science, Cooperative Extension On-Site Wastewater Training Center. May 2001.
8. Assumed no significant irrigation by Caltrans occurs along the Interstate 15 corridor

Assumptions:

For Commercial Nurseries, Agriculture, Orchards, and Caltrans land use categories, the Facility NRMP is estimated to range from $0 to $10,000.

For Parks, Residential, Septic Tank Disposal Systems, and Urban land use categories, the County of San Diego NRMP is assumed to cover this issue.

Average commercial nursery size in Fallbrook is approximately 12 acres. Based on personal communication with Paul Davy, Supervising Agricultural Inspector, Stormwater Management, County of San Diego, Department of Agricultural, Weights & Measures on May 21, 2003.

Average agricultural operation size in San Diego County is approximately 13 acres. Based on USDA, 1997. 1997 Census of Agriculture Highlights for San Diego County, California. USDA, National Agricultural Statistic Service, 1997 Census of Agriculture, Volume 1 Geographic Area Series, "Table 1. County Summary Highlights: 1997." http://www.nass.usda.gov/census/census97/highlights/ca/cac037.txt, printed on December 17, 2003.

Agricultural and Irrigation Water Management Program
MRCD Fact Sheet

Mission Resource Conservation District

Agricultural Water Management Program

What Is The Agricultural Water Management Program?
Irrigation System Evaluation, FREE!
Weekly CIMIS Data
Avocado CIMIS Calculator!
Soil and Water Testing Services
Salinity Management

The Agricultural Water Management Program has been in existence for over 20 years, and the sole purpose of the program is to help North San Diego County growers and gardeners streamline their farming and growing operations by providing information FREE OF COST:

- conserving precious water resources through Irrigation Water Management
- fertilizer and pesticide tips and guides
- erosion prevention and control suggestions
- composting and mulching guidelines

Mission Resource Conservation District

Home | Grower | Education | Support | Contact Us

Irrigation Water Management Program

What's This?
Where Can I Learn More?
What Does an Evaluation Entail?
How Long Does It Take?
What Will I Get?
How Much Does It COST?
What's The Catch?
Who Qualifies?
How Do I Sign Up?
Environmental Quality Incentive Program: The Government Can Help You Pay For A System Retrofit!

What is Irrigation Water Management?

IWM is an integrated strategy for managing crop water use for maximum effeciency. To implement IWM, you need to know some essential information about your farming operation. Ask yourself these questions:

- **What are the performance characteristics of my irrigation system?**
- **How much water do my crops need and when do they need it?**

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Where Can I Learn More?

Mission Resource Conservation District (MRCD), has provided irrigation water management assistance to north county growers for over 15 years. The process starts when you have an irrigation system evaluation, the foundation of irrigation water management.

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What Does an Evaluation Entail?

The primary purpose of an irrigation evaluation is to assess the performance of your irrigation system while it is in operation. To do this, we'll have you turn on various portions of the system for a short time so we can measure its output and uniformity.

Back to Top

How Long Does An Evaluation Take?

While this can vary depending on the size of the property and the complexity of the irrigation system, a typical evaluation lasts between 3 and 4 hours. You will get the most out of the evaluation if you can take the time to follow us through the entire process.

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What Will I Get?

We will provide you with a detailed report that includes:

- **Data on the system's flow rate and performance;**
- **Observations and recommendations to improve system performance (if needed);**
- **Information about the soils on your property and their water holding capacity;**
- **Information on crop water use patterns.**

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HOW MUCH DOES IT COST?

NOTHING! NADA! ZIP! ZILCH! IT'S ABSOLUTELY FREE!

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What's the Catch?

No catch. The San Diego County Water Authority funds most of these evaluations, and the Bureau of Reclamation funds the rest. If you are located within the Rainbow Creek Watershed, your evaluation is funded by the EPA. These public funding sources allow us to provide you with unbiased information since we're not trying to sell you anything.

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Who Qualifies?

Everyone who owns or manages 2 or more irrigated acres of crop land in San Diego County.

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SOUNDS GREAT! HOW DO I SIGN UP?

Call us at (760) 728-1332

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Extra Funding exists for You, the Landowner, to help pay for improvements on your system following our Recommendations

The Natural Resource Conservation Service administers an Environmental Quality Incentive Program, which provides cost-sharing incentives for eligible landowners. Find out more at the EQIP Page. More information will soon be available on line; we will make sure you have access to them as soon as we can. In the mean time, why not call us for a brochure?

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All programs of the Mission Resource Conservation District and the USDA Natural Resources Conservation Service are offered on a nondiscriminatory basis without regard to race, national origin, sex, age, religion, marital status or disability.

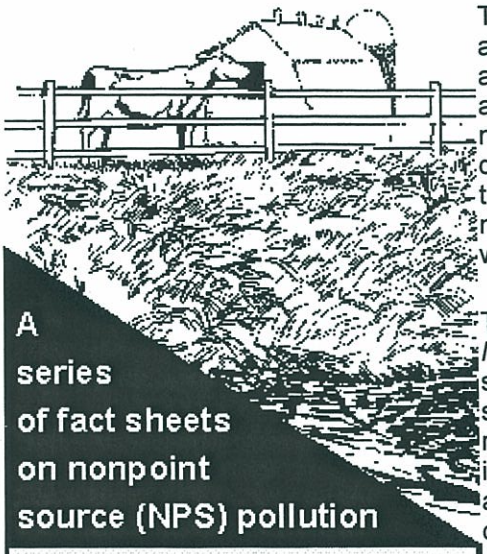
Managing Nonpoint Source Pollution from Agriculture
US EPA Fact Sheet

What is NPS Pollution
NPS Categories
Publications & Info Resources
Education Resources
Funding
Outreach
CWA Section 319
CZARA Section 6217
State-EPA NPS Partnership
Training/Meetings
Polluted Runoff For Kids!

Managing Nonpoint Source Pollution from Agriculture

Pointer No. 6
EPA841-F-96-004F

Note: This information is provided for reference purposes only. Although the information provided here was accurate and current when first created, it is now outdated.



Did you know that NPS pollution from agriculture is the leading source of impairments to surveyed rivers and lakes?

The United States has over 330 million acres of agricultural land that produce an abundant supply of low-cost, nutritious food and other products. American agriculture is noted worldwide for its high productivity, quality, and efficiency in delivering goods to the consumer. However, when improperly managed, agricultural activities can affect water quality.

The most recent *National Water Quality Inventory* reports that agricultural nonpoint source (NPS) pollution is the leading source of water quality impacts to surveyed rivers and lakes, the third largest source of impairments to surveyed estuaries, and also a major contributor to ground water contamination and wetlands degradation.

Agricultural activities that cause NPS pollution include confined animal facilities, grazing, plowing, pesticide spraying, irrigation, fertilizing, planting, and harvesting. The major agricultural NPS pollutants that result from these activities are sediment, nutrients, pathogens, pesticides, and salts. Agricultural activities also can damage habitat and stream channels. Agricultural impacts on surface water and ground water can be minimized by properly managing activities that can cause NPS pollution.

Numerous government programs are available to help people design and pay for management approaches to prevent and

control NPS pollution. For example, over 40 percent of section 319 Clean Water Act grants were used to control agricultural NPS pollution. Also, several U.S. Department of Agriculture and state-funded programs provide cost-share, technical assistance, and economic incentives to implement NPS pollution management practices. Many people use their own resources to adopt technologies and practices to limit water quality impacts caused by agricultural activities.

Managing Sedimentation.Sedimentation occurs when wind or water runoff carries soil particles from an area, such as a farm field, and transports them to a water body, such as a stream or lake. Excessive sedimentation clouds the water, which reduces the amount of sunlight reaching aquatic plants; covers fish spawning areas and food supplies; and clogs the gills of fish. In addition, other pollutants like phosphorus, pathogens, and heavy metals are often attached to the soil particles and wind up in the water bodies with the sediment. Farmers and ranchers can reduce erosion and sedimentation by 20 to 90 percent by applying management measures to control the volume and flow rate of runoff water, keep the soil in place, and reduce soil transport.

Managing Nutrients. Nutrients such as phosphorus, nitrogen, and potassium in the form of fertilizers, manure, sludge, irrigation water, legumes, and crop residues are applied to enhance production. When they are applied in excess of plant needs, nutrients can wash into aquatic ecosystems where they can cause excessive plant growth, which reduces swimming and boating opportunities, creates a foul taste and odor in drinking water, and kills fish. In drinking water, high concentrations of nitrate can cause methemoglobinemia, a potentially fatal disease in infants also known as blue baby syndrome. Farmers can implement nutrient management plans which help maintain high yields and save money on the use of fertilizers while reducing NPS pollution.

Managing Confined Animal Facilities.By confining animals to areas or lots, farmers and ranchers can efficiently feed and maintain livestock. But these confined areas become major sources of animal waste. Runoff from poorly managed facilities can carry pathogens (bacteria and viruses), nutrients, and oxygen-demanding substances that contaminate shellfishing areas and other major water quality problems. Ground water can also be contaminated by seepage. Discharges can be limited by storing and managing facility wastewater and runoff with an appropriate waste management system.

Managing Irrigation.Irrigation water is applied to supplement natural precipitation or to protect crops against freezing or wilting. Inefficient irrigation can cause water quality problems. In arid areas, for example, where rainwater does not carry residues deep into the soil, excessive irrigation can concentrate pesticides, nutrients, disease-carrying microorganisms, and salts-all of which impact water quality-in the top layer of soil. Farmers can reduce NPS pollution from irrigation by improving water use efficiency. Actual crop needs can be measured with a variety of equipment.

Managing Pesticides.Pesticides, herbicides, and fungicides are used to kill pests and control the growth of weeds and fungus. These chemicals can enter and contaminate water through direct application, runoff, wind transport, and atmospheric deposition. They can kill fish and wildlife, poison food sources, and destroy the habitat that animals use for protective cover. To reduce NPS contamination from pesticides, people can apply Integrated Pest Management (IPM) techniques based on the specific soils, climate, pest history, and crop for a particular field. IPM helps limit pesticide use and manages necessary applications to minimize pesticide movement from the field.

Managing Livestock Grazing.Overgrazing exposes soils, increases erosion,

encourages invasion by undesirable plants, destroys fish habitat, and reduces the filtration of sediment necessary for building streambanks, wet meadows, and floodplains. To reduce the impacts of grazing on water quality, farmers and ranchers can adjust grazing intensity, keep livestock out of sensitive areas, provide alternative sources of water and shade, and revegetate rangeland and pastureland.

RELATED PUBLICATIONS

Additional fact sheets in the Nonpoint Pointers series (EPA-841-F-96-004)

Agriculture and Wetlands: A Compilation of Factsheets (EPA-503/9-92-003)

Alternative Agriculture, National Research Council, National Academy Press, Washington, DC 1989

Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Chapter 2 (EPA-840-B-92-002)

Journal of Soil and Water Conservation, Vol. 45, No. 1, Jan/Feb 1990 (EPA-841-N-90-100)

Livestock Grazing on Western Riparian Areas, EPA Region 8, Denver, CO

The Quality of Our Nation's Water: 1994 (EPA-841-S-95-004)

Soil And Water Quality: An Agenda for Agriculture, National Research Council, National Academy Press, Washington, DC, 1993

USDA National Resources Inventory, Natural Resources Conservation Service

To order any of the above EPA documents call or fax the National Center for Environmental Publications and Information.

Tel (513) 489-8190

Fax (513) 489-8695

FOR MORE INFORMATION

U.S. Environmental Protection Agency

Nonpoint Source Control Branch

Washington DC 20460

Last updated on Thursday, May 20th, 2004
URL: http://www.epa.gov/OWOW/NPS/facts/point6.htm

Management Options for Nonpoint Source Pollution
Greenhouse and Container Crop Industries
University of California

Management Options for Nonpoint Source Pollution Greenhouse and Container Crop Industries

University Of California Cooperative Extension

San Diego County - 1998

Disclaimer

It is not recommended that the suggested management practices in this manual ever be taken and used as a basis for law. We understand that every operation is unique and requires a site-specific assessment of : **a.** Whether there is a need to implement further management, and **b.** Practices appropriate to a site. All information needed to implement these measures is not contained in this document.

Acknowledgments

Much of the information in this manual has been taken from the Clean and Green Water Quality Manual for Greenhouse and Nursery Growers, by the Horticultural Water Quality Alliance (1992). We have included information particularly relevant to the San Diego County area. The Alliance is a coalition of industry trade associations that is dedicated to the prevention of surface and groundwater contamination, to the promotion of safe pesticide and fertilizer use, and to the advancement of effective irrigation management and proper disposal of agricultural chemicals. For more information on the Alliance, contact: The Alliance, c/o The Society of American Florists, 1601 Duke Street, Alexandria, Virginia 22314-3406 Ph: (703) 836-8700 Fx: (703) 836-8705.
A complete version of the Clean and Green Water Quality Manual for Greenhouse and Nursery Growers may be purchased from the Alliance.

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Management Options for Nonpoint Source Pollution: Greenhouse & Container Crop Industries

Introduction

Water quality management involves a combination of interrelated practices needed to protect, improve, restore, or maintain water quality. Until recently, most of the effort directed toward control of water pollution involved easily identified sources of pollutants, such as sewage treatment plants or industrial facilities. This type of pollution is referred to as point source pollution. However, with the passage of the federal Coastal Zone Act Reauthorization Amendments or CZARA, another more elusive type of pollution that has no easily identified source has been targeted. This is referred to a nonpoint source pollution (NPS).

Agriculture is one of several industries that have been identified as contributing to nonpoint source pollution. While it is impossible to locate the source of the pollutants, it is known that certain growing practices will contribute more to nonpoint source pollution, while other practices can minimize water quality problems.

Current federal regulations have provided a very workable three-tiered approach for minimization of nonpoint source pollution. This begins with voluntary measures and moves toward stringent and strictly regulated criteria. Strict and inflexible mandatory regulations may be avoided by early voluntary compliance with initiatives to reduce nonpoint source pollution. This document was designed to provide the best available management options for the greenhouse and container crop industries. The intent is to allow the grower to comply with regulatory requirements at the voluntary level, and to avoid future, more stringent regulatory actions. Not all the management options described here are appropriate for every operation, and costs and complexity vary. In addition, as technology advances, new management options will be appropriate for these industries.

Irrigation Management and Water Quality

Water quality management involves a combination of interrelated practices that protect, improve, restore or maintain water quality. Managing runoff helps to protect water quality by reducing soil erosion from irrigation and rainfall, and minimizes contaminant carry over into surface and groundwaters. In addition to protecting water quality, the management strategies and techniques described in this chapter may streamline the efficiency and economy of your operation. Preventative measures to manage irrigation runoff can also be less costly than possible liability and fines. Please keep in mind that other practices may be appropriate for your growing operations, and that our set of practices is not all inclusive.

Monitor Water Quality

The first step in developing an irrigation management plan is to determine what is currently present in the runoff water, and in what concentrations. Excessive amounts of nitrate, phosphorus, other salts, pesticides and pathogenic organisms are the most common problems. For sources of analytical labs in the San Diego area, see the Appendix. The cost of a water analysis will be between $10 and $80, depending on the laboratory, and tests run. A simple test for nitrates and other nutrients is relatively inexpensive. However, a thorough chemical analysis will be more costly. If you elect this option, first inventory the chemicals used in your operation, particularly those most likely to end up in the water supply.

Trace elements usually occur at very low levels in irrigation water runoff and only an initial and occasional analysis is necessary to see what these trends are. Boron is generally the most critical element, which has a narrow window of tolerance. Zinc is likely to be a problem only for those operations using biosolids in their media.

It is important to note that how samples are taken, handled and analyzed can greatly affect the test results. Be sure the laboratory you select is equipped to give you the data you need, and then follow the instructions for sampling and handling that they provide. The lab should use EPA Standards and be certified for GLP (Good Lab Practices).

Water quality monitoring should be done on a regular basis, and, as there may be seasonal variations, seasonal analysis is the best plan. All water quality records should be kept for at least 5 years.

Maximize Irrigation Efficiency

Due to the high cost of water in San Diego County, most growers already practice some form of water conservation. Using less water initially is the best method of reducing runoff and associated problems. Runoff reduction techniques are much less costly to implement than large scale treatment and disposal procedures. Runoff can be prevented by several methods, resulting in less water and fertilizer use. Small savings in water and fertilizer costs can add up when you consider the profit per unit.

A well-designed, efficient irrigation system is the foundation of a good water management plan. Adapting efficient irrigation technologies to your production systems will help reduce the amount of runoff, while keeping costs down. Low-volume application techniques such as drip irrigation and sub-irrigation do an excellent job of delivering water to containers and both can be very efficient. Overhead systems without trays to collect water and leachate, on the other hand, tend to create large volumes of runoff. Standing water can provide an environment conducive to certain insect populations as well as water-borne pathogens. Lots of standing water can lead to a problem with fungus gnats and shore flies.

Irrigation Scheduling

Common watering practices are imprecise at best. Some growers tend to rely on the "eyeball" method to determine when plants need water. As a result, many crops get more water than they need, creating excess runoff. Irrigation scheduling, based on environmental conditions, and regulating the length of irrigation time, will control water and fertilizer runoff as well as minimize weed growth.

A variety of computers and irrigation scheduling software is available. The cost of such a system, balanced against the availability and expense of qualified labor, can be a very worthwhile investment. Resulting water savings can be tremendous in San Diego County.

Pulse Irrigation. Pulse irrigation refers to the practice of splitting irrigations into smaller increments, thereby greatly reducing the amount of runoff as water becomes more available to the plant. Pulsing can work with sprinkler, drip, or sub-irrigation to minimize fertilizer and water waste. Pulse irrigation creates a very efficient system, applying only what is needed when it is needed.

To ensure uniform delivery of water and fertilizer when using pulse irrigation, climatic conditions must be taken into consideration. Also remember that leaching is a necessity regardless of the type of irrigation system used. Irrigation water in San Diego County generally has an EC_w (electrical conductivity) of 0.9 to 1.2 dS/m^{-1} (decisiemens per meter). Frequently what growers perceive as salts from the irrigation water that need to be leached is actually excessive fertilizer.

When and How Much to Water. If you do not have a system to control irrigation, simpler methods can be used. With container crops, a target weight for watering must be set. The target weight can be determined in a couple of ways: The first method requires that you weigh several plants that are to the point of requiring water, average the weights and use that as the target weight to institute watering (This weight will vary depending on the type of plants being grown, plus other factors). The important point is to water the plants at the same level of dryness every time. The second method involves checking the weight of the container at full waterholding capacity, and then at the plants' point of wilting. The goal is to water most plants when 60 - 70 percent of the available water (or the difference between full capacity and wilting) has been used. This target, (for an average plant) allows plants on the edge of the bench that dry out more quickly to be near but not at the wilting point at the time of irrigation. The target weight may have to be increased as the crop grows.

Controlling how long each application of water lasts can be accomplished with minimal investment under many circumstances. Seconds of irrigation time, not minutes, are important when it comes to reducing water consumption. Although they are still in the process of being tested, remote sensor tensiometers can be an effective aid but are expensive.

Select Appropriate Growing Medium

Root medium can be selected for higher water holding capacity to improve the efficiency of irrigation. For example, rockwool, vermiculite, peat, or organic compost* will enhance water holding capacity and provide aeration, while polystyrene only adds air space to the mix. The greater the water holding capacity of the root medium, the less frequently watering will be necessary. At the same time, the need for leaching must also be minimized if there is to be any real advantage to higher water holding capacity.

**** Be sure to know the source of organic compost. Salts are always a concern. Be sure that EC_e levels are acceptable, or plan to leach.***

Sometimes, simply filling the pots with more medium, or filling them more thoroughly and uniformly will increase water holding capacity per pot and decrease irrigation frequency. Careful watering will prevent media from splashing out of the pot.

For information on good potting mix characteristics, desirable particle size guidelines, and physical properties of some media, see the Appendix.

Nutrient-Holding Capacity. The nutrient-holding capacity of the root medium is an important consideration as well. Higher nutrient-holding capacity may not be necessary if fertilizer is applied regularly according to plant demand and with reduced leaching, or if resin coated slow-release fertilizers are used. Humic acid materials such as peat, will increase the nutrient-holding capacity substantially.

Drainage and Aeration. Media designed for use in outdoor container plant production must be able to provide adequate drainage and aeration under conditions of heavy rainfall, and may need to be more porous or well-drained than greenhouse container media.

Consider the Use of Wetting Agents

Increased water absorption translates into more efficient utilization of the nutrients you apply. Research at Michigan State University found that wetting agents increase the water absorption of many peat-based media, when using either drip irrigation or sub-irrigation. Peat is notoriously difficult to wet. Wetting agents not only allow quicker wetting and uniform water distribution, but also allow more water to be held by the peat. In addition to assuring rapid wetting of dry root media and reducing channeling of water down the sides of pots, the use of wetting agents can also result in reduced leaching.

The commercial mix you currently use may already contain a wetting agent. If so, you may not gain anything by adding more. If you decide to add a wetting agent, check in advance to see if there are any effects on your growing medium. Be sure to select a quality product designed for horticultural use. Don't over use wetting agents, as they can be toxic to plants and can be a leachate contaminant themselves.

Reduce Leaching

How much should you leach? Accepted growing practices dictate that in order to grow plants in containers, you have to leach frequently. The move from poorly drained, soil-based mixes to well drained, peat-based mixes has led to increased leaching. Since soilless media drain so well, it's easier to apply excess solution to make sure the medium is well saturated and leached, whether or not it's needed. The optimum amount of leaching is 10-15%. This means 10-15% of the water applied runs through the container. If you measure how much leaching occurs when you irrigate, you will realize how little water it takes to achieve 10 to 15% leaching.

Drip Irrigation and Higher Leaching Rates. Drip irrigation may also lead to higher leaching rates. This may be due to the fact that water from drip tubes does not saturate some peat-based media rapidly or uniformly. Changing media components or adding wetting agents can solve this problem. Adding water slowly, in short bursts rather than one long irrigation, will also allow uniform wetting with less runoff. Try substituting two short applications of one minute each for one longer application of three minutes. Your interval time will depend upon your situation. Though time intervals will differ, this technique also has been used successfully in outdoor container production.

Low-Volume Drippers. Low-volume drippers will help reduce leaching if water quality is good and the drippers don't plug. Leaching is reduced because less water is applied at once, giving the soil more time to absorb it; also, more water goes where it's intended.

Fertilizer Concentrations. When fertilizer concentrations are reduced, less leaching will be needed, and conversely, if leaching is reduced, you will need to use less fertilizer to avoid buildup in your containers.

Application of Clear Water/Blending. Often times, applying clear water (where available) with no leaching, is sufficient, and no leaching will be required. Water and media analysis will provide you with information to help in your decision of whether or not to leach. Water treatments such as reverse osmosis are very expensive, and generally are used only on a limited basis, such as in propagation areas.

Sub-Irrigation/Tray Benches to Collect Water. Trays to collect water and leachate can be used with overhead irrigation systems or hand watering. They provide a type of sub-irrigation and greatly increase the efficiency of overhead irrigation. This is a low-investment approach which can have a major impact on water and fertilizer use.

Consulting an Irrigation Specialist. You may want to consult an irrigation specialist and/or consultant. These specialists can provide information which may improve on-farm water management. Irrigation system evaluations such as those provided by Mission Resource Conservation District and private consulting services can identify correctable problems such as worn nozzles, uneven spacing, uneven nozzle sizes, excessive run length, etc. Evaluations may also identify when and where over- or under-irrigation occurs. The Mobile Lab service is free. Contact the Mission Resource Conservation District for more information: (760) 728-1332.

**** Total salt content is usually reported as the electrical conductivity (EC_w). Chemically pure water does not conduct electricity, but water with dissolved salts in it does. Electrical conductivity usually reported as decisiemens per meter (dS/m^{-1}).***

Further Information

NRCS Field Office Technical Guide (FOTG). FOTG contains information on the following irrigation water management practices: Sprinkler (Code 442), Trickle/Drip (Code 441), Surface and Subsurface (Code 443), Tailwater Recovery (Code 447), Nutrient Management (Code 590), Pest Management (Code 595), Toxic Salt Reduction (Code 610). Codes refer to conservations practices contained in the Field Office Technical Guide. You may also want to contact an NRCS technician for assistance.

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Collect, Treat and Recycle Open Runoff/Tailwater Recovery

Minimizing irrigation generally is the most economical means of controlling runoff. However, collecting, treating and reusing runoff water can also accomplish the task. In San Diego County, this can save the grower money too. In greenhouses, the type of watering system and greenhouse floor used will determine how you collect excess water. For some operations, water collection from floors or field drains will be necessary in the short term. The preferred method, however, is closed systems where the water does not come into contact with the floor or the soil.

The following practices are found in the NRCS Field Office Technical Guide. You may wish to talk to an NRCS technician or UC Farm Advisor to help you decide which practices most appropriately suit your situation.

Agricultural Waste Management (Code 312). A planned system for managing runoff from concentrated waste areas. Such systems are planned to preclude discharge of pollutants to surface or groundwater and to recycle waste through soil and plants to the fullest extent practicable. Components include, but are not limited to the following:

Tailwater Recovery (Code 447). A facility to collect, store, and transport irrigation tailwater for reuse thereby conserving water supplies.

The quality of tailwater is dependent on the initial source, and handling by the grower. If there is a question regarding tailwater quality, have it tested. Runoff water usually is filtered and treated to control pathogens prior to its reuse in irrigation. Furthermore, special care must be taken in selecting and using pesticides, particularly herbicides, when reusing runoff. Plant damage may result. Nursery experts advise selecting herbicides with low water solubility; preferably below one part per million. Soil components play an important role in pesticide availability as well. Certain pesticides will adsorb to clay particles; this becomes a concern when erosion occurs and the particles wash downstream.

Subsurface Drain (Code 606): A conduit installed beneath the ground surface to collect and/or convey drainage water. Its objectives are to: **1.** Improve the soil environment for vegetative growth, reduce erosion, and improve water quality; **2.** Collect groundwater for beneficial uses; **3.** Remove water from heavy use areas, such as around buildings and roads, and accomplish other physical improvements related to water removal; and **4.** Regulate water to control health hazards caused by pests such as liver fluke, flies, or mosquitoes.

Collect Runoff From Outdoor Production Areas

Reservoirs (Code 436). Collecting runoff in outdoor production generally involves channeling or piping runoff water into a collection reservoir located at a lower elevation than the production areas. Depending on site conditions, reservoirs may be earthen or lined with such materials as vinyl or concrete. Reservoirs normally are sized to hold runoff from irrigation as well as a moderate rainfall.

Reservoir capacity should be designed on the basis of probable storm events. Contact the NRCS for a calculation of adequate reservoir size, and utilize qualified engineers for design and implementation. A permit may be required by the regional Water Quality Control Board (Waste Discharge Requirements).

Reservoirs also should be designed to prevent seepage, another potential source of groundwater contamination

Grassed Waterway (Code 412). A channel that is established using suitable vegetation for the stable conveyance of runoff. Suitable plant species may be selected with the assistance of an NRCS technician or other professional.

Lined Waterway (Code 468). A waterway or outlet having an erosion-resistant lining of concrete, stone, or other permanent material. It provides for safe disposal of runoff where unlined or grassed waterways would be inadequate. Properly designed linings may also control seepage, piping, and sloughing or slides.

Structure for Water Control (Code 587). Can be used for water quality control, such as sediment reduction or temperature regulation. It works to control the direction or rate of flow, or maintain a desired water level in water conveyance systems. It controls the stage, discharge, distribution, delivery, or direction of flow of water in open channels or water use areas.
Diversion (Code 362). A channel constructed across the slope with a supporting ridge on the lower side to divert water.

Filter Strip or Vegetative Filter (Code 393). Sediments and other pollutants from runoff or waste water may be removed by the use of filter strips (an area of vegetation) which act to reduce pollution by filtration, deposition, infiltration, absorption, adsorption, decomposition, and/or volatilization.

Strips vary in width depending upon site. They need to be managed carefully, including mowing, irrigation, fertilization and replacement every few years. (Based on experience in northern California, NRCS estimates 10'- 20' wide filter strips to cost approximately $75.00/acre).

For references on filter strips, contact the Natural Resources Conservation Service (NRCS).

Waste Utilization (Code 633). Waste can be used to fertilize, to provide forage and fiber, and to maintain soil structure and prevent erosion while also protecting water resources. Composting is an example of waste utilization .

Storm Runoff. Many growers are required to capture storm runoff from production areas. This can be a significant volume of water to divert and hold. Therefore, it may be wise for growers to use space efficiently, eliminating hard surface areas and providing vegetative cover. Another tactic is to divert clean water from the production area so that it can leave the property.

However, if the intent is to increase runoff for recycling purposes, harder, more impervious surfaces are preferred over more permeable surfaces. This method will reduce groundwater contamination, reduce fertilizer usage and return the maximum amount of water.

Collect Runoff From Field Drains and Non-Concrete Floors

Water Holding Areas. If you have a heavy, clay soil under your greenhouse, you can use field drains to collect runoff into a central location. The water storage area can be an earthen pond, a vinyl-lined pond, or an in-ground cement reservoir. Above-ground water silos can be less convenient because of the need to pump and lift water.

Concrete Floors. At present, not all greenhouse operations in San Diego County irrigate in an open system such as those described above. With very porous soils that allow water to percolate quickly, concrete floors may be the best option to protect groundwater resources. For many greenhouse operators, concrete floors may not currently be economically feasible.

Further Aspects of Reusing Water

Nutrient Recycling. When reusing water, it is important to remember that nutrients are being recycled and therefore less nitrogen and other minerals will have to be applied. Testing for nutrient levels in the water source should be done to calculate how much more nutrient must be added. If this is not taken into consideration, salts can build up and damage crops. With analysis of the water, adjustments for pH and EC levels can also be made. The following chapter on nutrients addresses this in much greater depth.

Erosion/Drainage Control & Water Conservation

The following practices relate to site specific issues. You may want to talk to an NRCS technician regarding what is appropriate for your operation.

For more information on any of the following management practices, refer to the NRCS Field Office Technical Guide, or contact your local Natural Resources Conservation Service (NRCS) office.

Management Practices

Critical Area Planting (Code 342). Involves planting vegetation on highly erodible or critically eroding areas. It helps to stabilize the soil and reduces damage from sediment and runoff to downstream areas.

Managing Roads (Code 560). Roads can be designed such that runoff is controlled, erosion prevented, and water quality maintained or improved. The type of construction, maintenance, and the road's location determine the road's effect on water quality. Placement of culverts and proper banking are factors in road design. Keeping culverts clean and maintaining waterbars or dips helps to avoid rutting and sedimentation. Over the long term it is more cost effective to properly design a road and perform upkeep than to have to deal with damage that results from not doing so. The Natural Resources Conservation Service (NRCS) can assist you in designing your roads.

Underground Outlet (Code 620). A conduit installed beneath the surface of the ground to collect surface water and convey it to a suitable outlet. Its purpose is to dispose of excess water from diversions, subsurface drains, surface drains, principal spillways from dams (outside the dam area only), without causing damage by erosion or flooding.

Constructed Wetlands (Code 359). Are presently being evaluated for their ability to clean up runoff. They can serve as a biological filter for removing chemical pesticides and fertilizers. In addition, the extra water surface of the wetland area increases the oxygen available to decompose organic compounds and to oxidize dissolved metals in the water. Constructed wetlands have proven effective in filtering out sediment and nitrate in other parts of the country.

One drawback, however, is that a certain amount of acreage is necessary for the practice to be effective. This will rule out many growers with limited acreage. In addition, many landowners are hesitant to install a wetland area on their property because of possible limitations on land use in the future. Work remains to be done on this technique in California, but the outlook is promising for many areas. As of yet, no one in San Diego County is using this technology.

Further Information on Management Practices for Sediment Control (Videos)

Best Management Practices for Sediment Reduction video (not specific to greenhouse and container crops) available in English and Spanish. By the University of California Cooperative Extension.

Farmer to Farmer video (not specific to greenhouse and container crops). By the West Stanislaus Resource Conservation District.

Excess Water Removal

While water is expensive or in short supply in San Diego County, there is a silver lining to this situation. With respect to nonpoint source pollution, San Diego County is fortunate because it simply does not have the quantity of water to allow for activities conducive to causing the pollution problems found in other parts of the nation. Only occasionally is excess water removal a problem. Excess water removal includes a combination of interrelated conservation practices needed to prevent flooding, manage runoff, and provide drainage within the plant root zone. Previously mentioned practices include diversions, reservoirs, structures for water quality control, lined waterways, and subsurface drainage systems. Also consider the following:

Management Practices

Berms or Dikes (Code 356). An embankment constructed of earth or other suitable materials to protect land against overflow or to regulate water. Dikes are often used to prevent overflow, provide better use of drainage facilities, prevent damage to land and property, and facilitate water storage and control.

Roof Runoff Management (Code 558). Roof management facilities include but are not limited to erosion resistant channels or subsurface drains with rock-filled trenches along building foundations below eaves, roof gutters, downspouts, and appurtenances. The purpose of such a system is to prevent roof runoff water from flowing across concentrated waste areas, barnyards, roads and alleys, and to reduce pollution and erosion, improve water quality, prevent flooding and improve drainage.

Pathogen Detection and Control

Types of Pathogens Encountered. In container crops, the most common root pathogens are the fungi Phytophthora_*Phytophthora*, Pythium_*Pythium* and *Rhizoctonia*. Bacteria can also be spread by water, but usually do not enter the roots unless there is existing root damage. The species of pathogens found in your area, as well as local environmental conditions such as temperature and humidity will influence the types of pathogens you encounter and the rate of infection.

Pathogen Problems. Where water goes and how it is collected will determine the potential for pathogen problems. Topwatering systems, where water passes through the organic media in containers and then is collected off the ground, have the greatest potential to spread pathogens. However, greenhouse and container crop operations in San Diego County using open recirculation have not found this to be a problem. The type of crop generally dictates whether you need to treat recirculated water for pathogen control before using it again. Consult your local Farm Advisor for this information.

Treating Recycled Runoff Water. Chlorine and bromine can be used to treat recycled runoff water. Chlorination involves the use of granular calcium chloride or gaseous chlorine, although the latter should be used only for larger operations. The key is having enough free chlorine (about 0.5 ppm) in the water long enough (roughly one minute) to kill pathogens. Various techniques, such as double loop intake lines or the injection of chlorine in the surface water where it enters the suction line, have been used to increase exposure time. The pump's impeller further aids mixing. If you choose to work with chlorine, remember that chlorine gas is very hazardous and must be handled with adequate safeguards. There are standards for the chlorine concentration in runoff water, which are lower than the standard acceptable level in drinking water. Remember that any chemical water treatment will need to be included in your overall hazardous materials management plant and conform to current pesticide regulations.

The newest agent available to control water borne pathogens is a bromine biocide, commonly known as *Agribrom.* The concentration required is higher (5 to 10 ppm of free residual bromine), than chlorine. The manufacturer claims that it is safer to handle than chlorine and is equally effective, if not more so. Exposure time is about the same as for chlorine. Heat treatment of water to 95° C, ozonation, or the use of ultraviolet irradiation and ultrafiltration also can work and may be viable for you. Anything less allows some pathogens to enter a survival mode and produce heat-resistant spores.

Cost-Sharing

Environmental Quality Incentives Program (EQIP). A federally funded program designed to solve soil, water and related resource problems through cost sharing. EQIP assistance is available to install a variety of measures to control erosion. These practices also help farmers reduce sediment and chemical waste.

A project must be able to demonstrate significant conservation benefits like water savings or erosion reduction to be eligible for cost-sharing. Further information may be obtained from Agricultural Stabilization and Conservation Service (ASCS) or Natural Resources Conservation Service (NRCS) staff. The San Diego/Riverside County ASCS office is in Indio. Their address is: 45691 Monroe St., (760) 347-3675.

CAIF. Grants from $2,500 to $80,000 are available for project having a direct effect on Carlsbad agriculture through the Resource Conservation District (RCD) of Central San Diego County (760-745-2061) as well. Projects are not limited to water or soil conservation.

Municipal Treatment Plants

Depending on the local sanitary district, dry season runoff may or may not be permitted to be discharged into local municipal waste water treatment systems. However, if it is permitted, the discharge is usually restricted to off-peak hours, and user fees are typically high. Since most treatment facilities are quickly becoming overloaded, this approach is a short-term solution for the disposal of dry season runoff.

The Status of Storm Water Permits. The greenhouse and container crop industries are not currently included in the storm water permitting process. The possibility exists that both of these industries (which are somewhat independent of the soil compared to field grown crops), may some day be included under the requirements of the Industrial Stormwater Permit process. For more information, contact Regional Water Quality Control at (619) 467-2952.

Nutrients

The balance of crop nutrients is important in producing vigorous, efficient plants. This chapter will discuss many of the considerations a grower has when developing a fertilization plan. These include the timing of fertilization, the use of alternative fertilizer types, composting, lab analysis, fertilizer injectors, backflow preventers, and salts. In most cases today, fertilizers are applied as a continuous liquid feed—soluble fertilizers are injected directly into the irrigation water, either at each irrigation or at regular intervals. However, several local nurseries have been reported to have switched to all slow-release granular fertilizers and seem to have eliminated both the nitrate and phosphorus problem. The concentrations of NO_3^- and PO_4 in the runoff is often less than the concentration in the original groundwater that is used for irrigation.

For more information on developing a fertilization plan, see the Natural Resources Conservation Service (NRCS) Conservation Practice Standard "Nutrient Management" (Code 590). It addresses management of the amount, form, placement, and timing of applications of plant nutrients to supply nutrients for optimum yields, while minimizing contamination of water sources.

Nitrate. The groundwater contaminant most often detected is nitrate. The primary causes of nitrate contamination in groundwater are the improper disposal of human and animal wastes and the overuse of chemical fertilizers. Most of the nitrogen in water comes from nitrates produced by or added to the soil. Nitrogen may be added to the soil in the form of chemical fertilizers containing nitrates, ammonium, or compounds that are converted easily to ammonium (NH_4^+), which later is converted to nitrate (NO_3^-). (Even "organic" fertilizers contain nitrogen that is converted to NO_3^-.)

Nitrates are extremely soluble in water and can move easily through soil into drinking water supplies. High levels can build up over time as nitrate accumulates in the water. The maximum contaminant level or MCL for drinking water is 45 mg/l of NO_3^- or 10 mg/l of NO_3^-N. Ingesting excessive amounts of nitrate poses a health hazard to infants under six months of age and some susceptible adults, causing condition called methemoglobinemia (or blue baby syndrome), which reduces the ability of the blood to absorb oxygen. 0.5-1.5% methemoglobin in the blood is normal; more can start to cause problems. Nitrate in groundwater is a danger sign not only because of the potential adverse health effects associated with nitrate, but also because it is often an indication that groundwater is vulnerable to degradation by other contaminants such as pesticides, bacteria and viruses.

Phosphorus. Phosphorus is primarily a problem in surface waters. In greenhouse and container crop production, a more water-soluble phosphorus is used as a vital nutrient. This element can get into streams, creeks and other surface water repositories, causing a condition of excessive algal growth known as *eutrophication.*

Removing nitrate and phosphorus from drinking water sources is much more difficult and expensive than preventing the contamination in the first place.

Fertilize Only When Needed

New water management schemes have required that optimum levels of fertilization be revised. In many cases, present recommendations have been found to be in excess of what the plant actually needs. Therefore you may want to develop your own plan. San Diego County produces a huge variety of flower and nursery crops, and specific fertilization requirements may not be available for the crops you produce.

Fertilizer Residue From Previous Applications. Since fertilizer is not particularly expensive, many growers use excessive amounts to ensure optimum plant growth. This practice is a major contributor to the high levels of nitrates present in irrigation runoff. When fertilizing pots, consider the amount of fertilizer still in the container from former fertilizations. Also, remember that the greater the volume of solution applied, a greater proportion of fertilizer salts are leached from the pot; the lower the volume of solution applied, the more fertilizer remains in the pot.

Nutrient Concentrations. The choice of nutrient concentrations is an important topic that often is inadequately addressed. This is particularly true for the application of nitrogen (N). Plants frequently take up considerably less nitrogen and water than the amounts applied. You need to evaluate crop needs and fertilize appropriately.

Nutrients In Recycled Water. If you are reusing your water, there is a good chance that there will be unused fertilizer dissolved in it. This should be taken into account when determining the level of fertilization for your crops. One local grower was able to reduce his fertilizer application by 30% by taking into account the nitrogen level of the recycled water.

The Key to Proper Fertilizer Use. *The key to proper fertilizer use is regular applications, controlled leaching and weekly analysis of the electrical conductivity (EC) of the root media*. Many plants can be grown with low nutrient concentrations if the supply is constant.

Weekly evaluation of pH, EC and fertility applications will prevent most nutritional problems you may encounter. A conductivity or soluble salt meter is a tool you can use to determine how much fertilizer is present and whether more is required. Make a chart to keep track of EC values on a weekly basis. If the EC value is dropping below the optimal level, you can increase the concentration of the fertilizer solution, while maintaining the volume of the solution being applied.

If the fertilizer program is resulting in too high an EC, switching to a lower fertilizer concentration or to clear water will bring the EC back into range. Fertilizing only when needed based on media analysis and charting of EC levels can greatly reduce the amount of fertilizer applied, and often yields better crops.

Application Timing. Timing is very important. Fertilization rates in the early stages of growth depend on the plant's growth rate. Using less fertilizer early in the plant's development encourages root establishment. Rooted cuttings or newly potted liners should receive reduced levels of fertilizer (a third of normal production levels) until plant roots become established. When leaf growth starts, increase fertilization. Once roots are established, fertilizer levels must be maintained during the stage of active *vegetative* growth, but should be reduced during the stages of growth or seasons when the plant cannot use the fertilizer.

Factors Influencing Fertilizer Choices

Most commercially available fertilizers are "general purpose," containing different nutrients in combinations predetermined to promote optimum plant growth. However, custom blending of fertilizers often best meets the needs of specific crops.

A complete 20-20-20 fertilizer contains 20 percent nitrogen, 20 percent P_2O_5 and 20 percent K_2O by weight. If a grower is directed to apply 200 parts per million (ppm) of nitrogen to a crop, what will result? If you apply 200 ppm nitrogen, there will also be high levels of phosphorus (P). *Any excess fertilizer, unused by the plants, represents chemicals—and money—down the drain, as well as a potential environmental contaminant.*

Many of the practical aspects of nursery and container crop nutrition and fertilization are covered well in widely available texts. The best approach is to consider several recommendations and then use *common sense* and experience to develop a fertilization plan for your own operation.

In addition to irrigation water and root media chemistry, other factors, such as root medium components, temperature and slow-release versus constant liquid fertilization (CLF) application methods, micronutrient deficiencies, and application timing influence fertilizer choices. These are addressed briefly below.

Soilless Media and Trace Elements. Some water-soluble fertilizers are formulated specifically for soilless media. These formulations contain higher micronutrient concentrations and less ammoniacal nitrogen.

Soilless Media and Ammonium Nitrogen. Ammonia toxicity problems can occur in soilless media because of high levels of ammonium or urea fertilizer. As mentioned earlier, the 20-20-20 mixes typically contain about 70 percent ammoniacal nitrogen, a rate too high for many plant species growing in soilless media. Formulations such as 20-10-20 Peat Lite Special contain just 40 percent ammoniacal nitrogen, a safe level for year round use. *Ideally, no more than 50 percent of nitrogen fertilizer should come from the ammonium form.* Ammonium can cause toxicity on some plants when the soil is cool and waterlogged, when the ammonium is converted to ammonia.

How to Read a Fertilizer Bag

The judicious use of fertilizers can boost crop production tremendously. However, the misapplication of fertilizers can reduce your profit margin and cause harm to the environment. The following is a guide to the information found on a hypothetical bag of fertilizer. All of the ingredients listed here may not be found in all fertilizer formulations.

Primary plant nutrients are used in considerable quantities by crops and include **Nitrogen, Phosphorus and Potassium. Secondary** plant nutrients include **Calcium, Magnesium and Sulfur.** These elements are used in moderate quantities by crops and can effect soil pH. **Micronutrients** or **Minor Elements** include **Zinc, Iron, Manganese, Copper, Boron and Molybdenum.** While these elements are used in very small quantities, they are essential for plant growth.

Nitrate, NO_3^-, is the most readily available form of nitrogen to plants. However, it moves through the soil very easily with irrigation water and can be lost to leaching through over-irrigation. Excessive soil moisture conditions can lead to *denitrification.* This is a process where soil bacteria turn nitrate into nitrogen gas, N_2 ,or nitrous oxide gas, N_2O. These gasses are lost to the atmosphere. Both of these gasses are considered *greenhouse* gasses.

All **ammoniacal** based fertilizers start out life as **ammonia, NH_3**. Ammonia is a gas at normal temperatures and is difficult to handle. Adding one more hydrogen atom creates **ammonium, NH_4^+**. Ammonium is dry and stable at normal temperatures. While plants can absorb and utilize ammonium, it is easily tied up by soil particles and becomes immobile. Eventually, soil bacteria will convert ammonium into nitrate. This is known as *nitrification.* The rate at which nitrification occurs depends on soil temperature, soil moisture levels, etc. For the most part, the warmer a soil is (assuming adequate moisture), the quicker nitrification will occur.

Urea, $CO(NH_2)_2$, is generally the cheapest form of solid nitrogen. Urea is very soluble in water and is a good choice for use in injection systems. This solubility makes urea very leachable when first applied. Once in the soil, urea is changed through enzymatic action to ammonium. At this point it becomes available to plants.

Minor Elements are essential for good crop production. However, the line between deficiency and excess or toxic levels can be very fine. Often, *chelating* agents are included with minor elements. Chelates are organic compounds that bind to a minor element and delay it from forming insoluble compounds. This makes the chelated element available to plants for a longer time.

The **grade** of a fertilizer indicates the percentage by weight (in order), of total nitrogen, available phosphoric acid and water soluble potash. Example - The grade of a particular fertilizer is 15-15-15. This indicates that the bag contains 15% nitrogen, 15% phosphorus pentoxide (P_2O_5), and 15% potassium oxide (K_2O). The label does *not* say 15% phosphorus or 15% potassium. Both of these constituents are reported in their oxide forms rather than their elemental forms. **To covert P_2O_5 into elemental phosphorus, multiply by 0.44. To convert K_2O into elemental**

K, multiply by 0.83. Thus, a 100 pound bag of 15-15-15 fertilizer contains 15 pounds of total nitrogen, 6.6 pounds of phosphorus (15 X 0.44), and 12.5 pounds of potassium (15 X 0.83).

The **phosphorus** content of fertilizers is stated as **Available Phosphoric Acid.** Phosphorus can be expressed in its elemental form P, or in an oxide form, usually P_2O_5 or phosphorus pentoxide. Plant requirements for phosphorus are commonly expressed in the elemental form, whereas the analysis of fertilizer is usually stated in the oxide from. To convert, multiply the elemental form by 2.3 to find out how much oxide form you need. Phosphorus is easily bound to soil particles and resists leaching. Because of this, the vast majority of phosphorus contained in the soil is unavailable to plants at any given time.

The **potassium** content of fertilizer is expressed as **Water Soluble Potash.** Potassium is taken up by plants in the form of K^+. Like phosphorus, plant requirements for potassium are expressed as the elemental form while fertilizer is sold in the oxide form of K_2O or potassium oxide. To convert from the elemental form to the oxide form, multiply by the elemental form by 1.2. Sandy and coarse textured soils do not hold potassium well, making it susceptible to leaching.

How much and what type of fertilizer do you need? You'll never accurately know unless you perform regular media and leaf tissue testing. **DON'T ASSUME!** What you did last year may not be adequate this year. Purchase and apply only the nutrients you need. This not only benefits the environment, but your profit margin as well.

Slow-Release Versus Constant Liquid Fertilization (CLF). Preplant incorporation of slow-release fertilizers reduces nutrient runoff and nitrate contamination as compared to the use of highly soluble fertilizers in a CLF program. Temperature is a factor however, when some slow-release fertilizers are used with fertilizer sensitive crops like bedding plants. High temperatures can lead to accelerated rates of fertilizer release. Pay attention to soluble salt levels and leach only when necessary to reduce salts. Keep in mind when choosing your application methods that nitrogen fertilization follows the front of water. Ask vendors of slow-release fertilizer to help you develop and implement the correct program for your site.

Split applications of slow-release fertilizers (applying some preplant and the remainder part way through the crop cycle), are more efficient than a single application. Combining liquid and slow-release fertilizers can also work well to attain maximum productivity with the least amount of waste.

The best possible fertilizer blend for your situation can be obtained from one of the many companies in the United States that markets custom fertilizers, or you may mix it yourself. *The end results will be better quality plants, less chemical contamination of surface and groundwater and, in all probability, savings in overhead expenditures.*

Further Information

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Fertilizer Injectors

Much has been written about liquid fertilizer programs since methods of dispensing chemical salts through accurate fertilizer injectors (also called fertilizer proportioning equipment) have been devised. New fertilizer injectors seldom produce the erratic results of earlier models.

The option of controlling nutrient applications with pinpoint accuracy can prevent groundwater contamination and facilitate the recycling of leachate water for fertilization. Newer, programmable fertilizer injectors can allow for changes in the concentrations of individual nutrients according to growing conditions within and outside the plant.

With some new injectors, the concentration of individual nutrients can be adjusted independently, according to the needs of the plants. This requires the use of several fertilizer stock tanks or a change in the injector ratios. However, many growers prefer to use the same mix for all crop types.

Precise nutritional prescriptions can be formulated when nutrient uptake estimates are correlated with the environmental and physiological conditions of the plants at the time of sampling. The result is delivery of nutrients to the plant's roots when plants need it.

Ease of application, flexible adjustment of nutrient supply, and control of soil pH are advantages of a liquid feed program. Major drawbacks are the high cost of equipment, and the necessity for employees with the technical knowledge required to operate and maintain the equipment. Liquid and controlled-release methods require a sizable initial investment in equipment or materials, but later require limited labor. Although equipment investment for granular application is low, high labor requirements may result in higher costs than any other system in the long run.

Some larger nurseries are moving away from using liquid fertilizer injection (due to increased loss of nitrates, etc.) to using slow-release fertilizer in preplant or topdress. In some situations it is more cost-effective, reliable, and environmentally sound. The success of slow-release fertilizers is dependent on many factors (e.g. the number of crop types, how long they will be in containers, etc.)

Use of Alternative Fertilizer Types

Manures and composts can be good potential sources of plant nutrients, as well as good soil conditioners, depending on the type of manure and the quality of handling and storage. Poultry manure (aged) has been recommended by some growers. The exact residual nitrogen release must be determined by careful monitoring of crop performance and use of soil and plant tissue analysis. If residual release is not taken into account, over-fertilization can result. In addition, manures are high in salts, therefor management for salts must be taken into account.

Phosphorus (P) and Potassium (K). Animal manures and composts are excellent sources of plant-usable phosphorus and potassium. In neutral or acidic soil, phosphorus in manure is worth 70 to 90 percent of phosphorus in superphosphate fertilizers. In calcareous (high-pH) soils, manure phosphorus is worth 100 percent or more of phosphorus in superphosphate fertilizers. This is because inorganic phosphate tends to undergo precipitation reactions and become unavailable to plants in high-pH soil. Some native soils in San Diego County tend to be high in pH. However, growing media are often neutral or low pH. Also, availability of phosphorus in manure is relatively insensitive to cool soil temperatures near 60° to 65° F.

Salts and Weed Seeds in Livestock Manures. Salts in animal manures can accumulate to undesirable levels in the soil when excessive amounts are applied or irrigation and precipitation are inadequate to leach the accumulated salts from the root zone. Composting does not reduce the salt level unless the compost is leached, which isn't recommended. Manure that has not been properly composted can also contain viable weed seeds.

Composting

The nitrogen (N) content of composts is often of great interest to growers who want to know what nitrogen contribution they can expect from a given application of compost. Others consider compost to be a soil conditioner, and not a fertilizer material. For both economic and environmental reasons, minimizing nitrogen losses from composting and cropping systems is important. When excess water is added to a compost pile, either through irrigation or precipitation, the surplus water leaches through the system. This water can carry significant amounts of organic nitrogen, ammonia and nitrate, especially early in the composting process. Nitrogen losses from this process can be avoided by preventing the addition of excess water to the compost pile or by recycling leachate back into the pile.

Composts also contain many other macro- and micronutrients. In the absence of losses due to leaching, most mineral nutrients are conserved during composting. In addition to serving as a source of nutrients, composts may affect the availability of nutrients in the soil. Composts can increase the cation exchange capacity of soils, thus allowing

increased availability of calcium, magnesium and potassium. Composts can help neutralize and buffer soil pH as well; this may increase the availability of many plant nutrients which become less available when soils become too acid or alkaline.

The addition of compost to the soil and its further decomposition can also stimulate soil microbial diversity and activity. The diverse microbial communities which can exist in composts and compost-amended soils may include organisms which reduce pathogenic microbe populations and/or activity through a variety of mechanisms, including competition, parasitism and antibiosis. The level of pathogen suppression of some composts is sufficiently high that they are used specifically for this purpose in container soils in the horticultural industry.

Given the number and diversity of factors that contribute to compost quality (See table below), evaluating the quality of a given compost takes some thought. The quality of compost that is intended for use in a container mix has to be high. The quality of a compost is determined primarily by two factors: the composition of the base materials and the composting process; this information should be available to the customer at no cost. Many compost producers may also provide laboratory analysis data for plant nutrients, salts, and/or contaminants such as heavy metals and pathogens. There is a trend to standardize compost to give growers an idea of what they're getting when making a purchase. Compost quality is regulated by the EPA 503 regulations when the material contains biosolids. California State green waste regulations have also been developed. Compost quality characteristics include:

Chemical	***Biological***	***Physical***
pH	Maturity/activity	Particle size
Nutrients	Weed seeds	Contaminants
Salts	Animal pathogens	Degradation
Metals	Plant pathogens	
Organic compounds (pesticides, etc.)	Pathogen suppression	
	Plant response	

Modern Potting Composts. Penn. State Univ. Press, University Park, Penn.

Lab Analysis - Determining Nutrients Available in Soil or Irrigation Water

Soil and water quality tests are essential components of sound greenhouse and container crop management practices.

Soil Testing. Soil testing should be conducted on a regular basis. Along with plant tissue analysis, soil tests are the grower's best guide to effective use of fertilizers. There are several common methods used for soil analyses, particularly in terms of the chemicals used for extraction. San Diego County labs are listed in the Appendix. Tests cost between $15-$80, depending on the lab and the type of test. Interpretation of soil tests should be done with the help of an experienced agricultural consultant, preferably one who is familiar with greenhouse and container crops. Important indicators to look at include: pH, EC and sodium adsorption ratio (SAR).

Keep in mind that the recommended levels for nutrients can be reported in a number of ways and are based on the type of soil test that was performed and the crop being grown. Additionally, soil and growing media components can vary considerably and other factors (particularly soil pH) must be considered when calculating micronutrient availability.

Taking Soil Samples. Soil testing should be done regularly as a preventive measure to avoid deficiency or toxicity problems. If a good fertilization program is followed, initial and semiannual tests are usually sufficient for outdoor container crops. Monthly soil testing for nutrient levels is necessary only for the faster growing greenhouse crops (or, "fast turn crops"), and pH and EC tests should be done frequently. It is important to obtain representative soil samples in order to make valid decisions after testing. Most laboratories can provide instructions and containers in which to place samples. Also factor in the turn around time for labs versus the usefulness of the information.

Interpreting Soil Test Results. The interpretation of soil test results should be coupled with information from the fertilization program, trends in relation to previous analyses, foliar analyses, and the appearance of visual symptoms of nutrient disorders.

Further Information

Conducting and Interpreting Soil Tests. L. Dodge and R. Evans.

Monitor and Keep Track of Root Media pH and EC

Container mixes are generally porous, well aerated and have a high proportion of organic material. Such mixes characteristically have a low pH and require amendments, such as dolomite or limestone, to raise the pH to the desirable range of 6.0 to 7.0. *Reduction* of high pH in a container mix can be accomplished by addition of fine sulfur, but results are not long lasting and are quite variable.

Foliar Testing

Foliar testing is an important procedure that can help guide your fertilization program. Foliar levels of nutrition are available for some potted crops. Thus, plant tissue testing is a recommended practice, both prior to establishing a fertilizer program and on a regular basis to prevent the onset of nutrient deficiencies. San Diego County labs are listed in the Appendix. Tests cost approximately $20-$70, depending on the lab and the tests run.

Further Information

Soil and Plant Tissue Testing in California. 1983. University of California (#1879). 56 pp.
Plant Analysis Handbook. J. Benton Jones, Jr., B. Wold and H.A. Mills. Micro-Macro Publishing, Athens, GA.

Water Testing

Most water from municipal systems needs to be tested once a year, but surface water from ponds or creeks may need to be tested as often as every four to six months. These water supplies often have seasonal variations.

Irrigation Water Tests provide information about potential toxicity problems, as well as information that is useful for formulating fertilizer programs. Some elemental constituents (organic and inorganic materials) are important because they indicate how much of a particular nutrient may be added in the irrigation water. Others are important because they affect soil pH or are toxic to plants. The results of a water analysis can be judged against the following standard criteria: EC_w, HCO_3^-, B, Cl^-, SAR, Na%, Na^+ & Mg^{++}, residual sodium carbonate and NO_3^-N.

Tips When Using a Lab. Duplicate samples should be sent and, since numbers can vary from one lab to another, send blanks (with known values). Some nurseries have found different results from different labs analyzing the same sample. It is very important to have accurate data for pesticide analysis, or lab reports to regulating agencies, for example. The EPA supplies a listing of criteria to use in selecting a lab to do your work.

The pH of Irrigation Water should generally be between 5.5 and 7.0. Most nutrients and other chemicals, such as growth regulators and fungicides are available to the plant in this range. Water pH is the most important factor influencing root media pH. The higher the water pH, the more the media pH will increase, ultimately making it more difficult to lower the overall pH.

Compensating for High pH in Water and Growing Media. Many growers add concentrated acid to fertilizer stock tanks to achieve a certain pH in the irrigation water. The practice of injecting acid (phosphoric, sulfuric or nitric), into irrigation water is well established but can be dangerous for those handling the materials, as well as being hard on injectors pipe, and other hardware. To obtain an accurate measure of pH when acids are used, treated irrigation water should sit for 12 to 24 hours before sampling for analysis.

Other options for controlling pH should also be considered. For instance, growers can apply iron sulfate and ammonium sulfate to the media, or add finely ground elemental sulfur.

Backflow Preventers. Backflow preventers are a requirement of code and pesticide labels that allow for chemigation. Whenever there is a cross connection linking your water source to another system operating at a higher pressure, such as a fertilizer injection system, there is a danger of backflow into the water source. Air-gaps and reduced pressure principal (RP) backflow devices are best suited to comply with this requirement.

Salts

Test treated irrigation water periodically for soluble salts. The continuous addition of fertilizers can result in salt buildup in the soil if the amounts added exceed plant demand and the excess fertilizer is not leached below the root zone. The total soluble salt concentration in irrigation water is made up of all dissolved chemical elements in the solution: fertilizers, acid, fungicides and salts already present in the source water.

Many ornamental crops are sensitive to high salinity. Crops grown in plugs are especially susceptible to high salt levels, and require high quality irrigation water. High salinity can restrict water uptake by plants, decrease crop yields, reduce the size of flower stems and leaves, and can burn leaf margins.

Poor water quality in San Diego County makes leaching a necessity. A proper irrigation program helps to slow the accumulation of salts in the soil mix.

Tracking EC Levels. How much leaching should be done? It depends a great deal on what crop is grown, but as a general rule, leaching should be done frequently if the EC_w of the applied irrigation water (before fertilizer is added) is greater than 2.0 decisiemens per meter (dS/m^{-1}), weekly if the EC_w is about 1.5 dS/m^{-1}, and monthly if the EC_w is less than 1.0 dS/m. For salinity tolerances of various crops, see Tables 3 and 4.

If root media EC levels are too high, be sure to find out if it is due to water quality or over-fertilization. Imported irrigation water in San Diego County generally has an EC_w of between 0.9 to 1.2 dS/m^{-1}. Tracking the root media EC_e graphically will help you use water and fertilizer more efficiently.

What to do if Your Water is Saline. If your water is saline or poor in quality, try to lower the EC_w of your irrigation water by changing water sources, blending water sources, or using a water treatment like reverse osmosis when economically feasible. Mixing or alternating irrigations with domestic water and recycled water can also help.

Is There Salty Water in Your Future?

"Salty water may play a significant role in the production of fruit in Southern California in the very near future" writes Gary Bender, San Diego County Farm Advisor. With water projected to cost $900 to $1,000 per acre foot in San Diego County by the year 2000, many growers are currently drilling wells and hitting salty water.

Water from wells in northern San Diego County sampled between 1988 - 1995 ranged from a low of 300 ppm to a high of 4000 ppm with a mean of 1031 ppm total dissolved solids (TDS). Water from sewage reclamation plants is also somewhat salty, ranging from 950 to 1050 ppm TDS. As a benchmark, district water (derived mostly from the Colorado River) ranges from 590 to 640 ppm.

Except for a few lucky growers in the river valleys, well water in San Diego County has never been a major source of water for agriculture. Not only is the supply limited, but as mentioned, the water quality is often poor.

The question remains: If we do incorporate poor quality water into our irrigation scheme, how can it best be used to cause the least deleterious effect on our crops?

Methods for Utilizing Salty Water

1. The most obvious method for handling salty water is to use more water and irrigate more often.

2. The best quality water should be applied during the most sensitive times in the life of the plants. Blending of saltier water into better quality water should begin gradually, later in the season, with the poorest quality water being applied in the fall when evapotranspiration is declining.

3. Another method for handling salty water is to simply apply it to crops that are less sensitive to salts. Tables in the *Western Fertilizer Handbook* and additional tables in this document can be useful in comparing the sensitivities of various crops to salty water.

4. When wells are drilled, the poorest quality water is often found at shallow depths (down to 200' deep). Some well drillers case wells down to 200' and then pump concrete up the outside of the well casing to prevent salty water from entering the well. The well is then drilled down to 600' to 1000' depth. One driller reports that the water quality using this technique improved from 1800 ppm to 300 ppm by excluding shallow salty water.

Salt and Boron Tolerances of Selected Ornamentals

An extensive data base has been analyzed at the U.S. Salinity Laboratory in Riverside, California to determine the relative tolerance of plants to salinity and boron. Salt tolerance data for 49 ornamental species are expressed as the maximum permissible EC plants can tolerate without foliar injury or excessive stunting (Tables 1 and 2). However, keep in mind that growth may be reduced as much as 50%, although the plants should appear healthy and attractive.

Boron tolerances of 40 ornamentals indicate the maximum permissible boron concentration the soil that does not cause a yield reduction (Table 3). However, some crops may exhibit leaf injury without decreasing yield. Boron is an essential plant element, but it can become toxic to some plants when soil-water concentrations only slightly exceed that required for optimum plant growth. Signs of boron toxicity in broadleaf plants include: Yellow to brown or black leaf edges, especially on older leaves. Shoots have short internodes, subject to gumming and dieback.

Table 1. Salt Tolerance of Ornamental Shrubs, Trees and Ground Cover.[a, b]

Common Name	Botanical Name	Max. Permissible EC (dS/m^{-1}) [c]
Very Sensitive		
Star Jasmine	*Trachelospermum jasminoides*	1-2
Pyrenees cotoneaster	*Cotoneaster congestus*	1-2
Oregon grape	*Mahonia aquifolium*	1-2
Photinia	*Photinia X fraseri*	1-2
Sensitive		
Pineapple guava	*Feijoa sellowiana*	2-3
Chinese holly cv. "Burford"	*Ilex cornuta*	2-3
Rose, cv. "Grenoble"	*Rosa* spp.	2-3
Glossy abelia	*Abelia X grandiflora*	2-3
Southern yew	*Podocarpus macrophyllus*	2-3
Tulip tree	*Liriodendron tulipifera*	2-3
Algerian ivy	*Hedera canariensis*	3-4
Japanese pittosporum	*Pittosporum tobira*	3-4
Heavenly bamboo	*Nandina domestica*	3-4
Laurustinus, cv. "Robustum"	*Viburnum tinus*	3-4
Strawberry tree, cv. "Compact"	*Arbutus unedo*	3-4
Crape Myrtle	*Lagerstroemia indica*	3-4
Moderately Sensitive		
Glossy privet	*Ligustrum lucidum*	4-6
Yellow sage	*Lantana camara*	4-6
Orchid tree	*Bauhinia purpurea*	4-6
Southern Magnolia	*Magnolia grandiflora*	4-6
Japanese boxwood	*Buxus microphylla* var. japonica	4-6
Xylosma	*Xylosma congestum*	4-6
Japanese black pine	*Pinus thunbergiana*	4-6
Indian hawthorn	*Raphiolepis indica*	4-6
Dodonaea, cv. "Atropurpurea"	*Dodonaea viscosa*	4-6
Oriental arborvitae	*Platycladus orientalis*	4-6
Thorny Elaeagnus	*Elaeagnus pungens*	4-6
Spreading Juniper	*Juniperus chirensis*	4-6
Pyracantha, cv. "Graberi"	*Pyracantha fortuneana*	4-6

Chinese hibiscus	*Hibiscus Rosa-sinensis*	4-6
Cherry plum	*Prunus cerasifera*	4-6

(a) After Maas, 1986. Salt Tolerance of Plants. Appl. Ag. Res. 1:12-26.
(b) Species are listed in order of increasing tolerance based on appearance as well as growth reduction.
(c) Salinities exceeding the maximum permissible may cause leaf burn, loss of leaves, and/or excessive stunting.
(d) Maximum permissible EC is unknown. No injury symptoms or growth was apparent at 7 dS/m^{-1}. The growth of all iceplant was increased by soil salinity of 7 dS/m^{-1}.

Table 2. Salt Tolerance of Ornamental Shrubs, Trees and Ground Cover.[a, b]

Common Name	Botanical Name	Max. Permissible EC (dS/m^{-1}) [c]
Moderately Tolerant		
Weeping bottlebrush	*Callistemon viminalis*	6-8
Oleander	*Nerium oleander*	6-8
European fan palm	*Chamaerops humilis*	6-8
Blue dracaena	*Cordyline indivisa*	6-8
Spindle tree, cv. 'Grandiflora"	*Euonymus japonica*	6-8
Rosemary	*Rosmarinus officinalis*	6-8
Aleppo pine	*Pinus halepensis*	6-8
Sweet gum	*Liquidamber styraciflua*	6-8
Tolerant		
Brush cherry	*Syzygium paniculatum*	>8 [d]
Ceniza	*Leucophyllum frutescens*	>8 [d]
Natal plum	*Carissa grandiflora*	>8 [d]
Evergreen Pear	*Pyrus kawakamii*	>8 [d]
Bougainvillea	*Bougainvillea spectabilis*	>8 [d]
Italian stone pine	*Pinus pinea*	>8 [d]
Very Tolerant		
White iceplant	*Delosperma alba*	>10 [d]
Rosea iceplant	*Drosanthemum hispidum*	>10 [d]
Purple iceplant	*Lampranthus productus*	>10 [d]
Croceum iceplant	*Hymenocyclus croceus*	>10 [d]

(a) After Maas, 1986. Salt Tolerance of Plants. Appl. Ag. Res. 1:12-26.
(b) Species are listed in order of increasing tolerance based on appearance as well as growth reduction.
(c) Salinities exceeding the maximum permissible may cause leaf burn, loss of leaves, and/or excessive stunting.
(d) Maximum permissible EC is unknown. No injury symptoms or growth was apparent at 7 dS/m^{-1}. The growth of all iceplant was increased by soil salinity of 7 dS/m^{-1}.

Table 3. Boron Tolerance Limits of Ornamentals.[a, b]

Common Name	Botanical Name	Threshold g/m = ppm[c]
Very Sensitive		
Oregon grape	*Mahonia aquifolium*	<0.5
Photinia	*Photinia X fraseri*	<0.5
Xylosma	*Xylosma congestum*	<0.5
Thorny elaeagnus	*Elaeagnus pungens*	<0.5
Laurustinus	*Viburnum tinus*	<0.5
Wax-leaf privet	*Ligustrum japonicum*	<0.5
Pineapple guava	*Feijoa sellowiana*	<0.5

Spindle tree	*Euonymus japonica*	<0.5
Japanese pittosporum	*Pittosporum tobira*	<0.5
Chinese holly	*Ilex cornuta*	<0.5
Juniper	*Juniperus chinensis*	<0.5
Yellow sage	*Lantana camara*	<0.5
American elm	*Ulmus americana*	<0.5
Sensitive		
Zinnia	*Zinnia elegans*	0.5-1.0
Pansy	*Viola tricolor*	0.5-1.0
Violet	*Viola odorata*	0.5-1.0
Larkspur	*Delphinum* spp.	0.5-1.0
Glossy abelia	*Abelia* X *grandiflora*	0.5-1.0
Rosemary	*Rosmarinus officinalis*	0.5-1.0
Oriental arborvita	*Platycladus orientalis*	0.5-1.0
Geranium	*Pelargonium* X *hortorum*	0.5-1.0
Moderately Sensitive		
Gladioli	*Gladiolus* spp.	1.0-2.0
Marigold	*Calendula officinalis*	1.0-2.0
Poinsettia	*Euphorbia pulcherrima*	1.0-2.0
Chinese Aster	*Callistephus chinensis*	1.0-2.0
Gardenia	*Gardenia* spp.	1.0-2.0
Southern yew	*Podocarpus macrophyllus*	1.0-2.0
Brush cherry	*Syzygium paniculatum*	1.0-2.0
Blue dracaena	*Cordyline indivisa*	1.0-2.0
Ceniza	*Leucophyllum frutescens*	1.0-2.0
Moderately Tolerant		
Bottlebrush	*Callistemon citrinus*	2.0-4.0
California Poppy	*Eschscholzia californica*	2.0-4.0
Japanese boxwood	*Buxus microphylla*	2.0-4.0
Oleander	*Nerium oleander*	2.0-4.0
Chinese hibiscus	*Hibiscus Rosa-sinensis*	2.0-4.0
Sweetpea	*Lathyrus odoratus*	2.0-4.0
Carnation	*Dianthus caryophyllus*	2.0-4.0
Tolerant		
Indian hawthorn	*Raphiolepis indica*	6.0-8.0
Natal plum	*Carissa grandiflora*	6.0-8.0
Oxalis	*Oxalis bowiei*	6.0-8.0

(a) After Maas, 1986. Salt tolerance of plants. Appl. Ag. Res. 1:12-26.
(b) Species listed in order of increasing tolerance based on appearance as well as growth reduction.
(c) Boron concentrations exceeding the threshold may cause leaf burn and loss of leaves.

Further Information

Agricultural Salinity and Drainage Handbook for Water Managers. Blaine Hanson, Stephen Grattan, and Allan Fulton. 1993. Water Management Series publication no. 93-01. University of California Irrigation Program, University of California, Davis.

How to Fertilize Plants in Containers. Charles R. Johnson. *American Nurseryman.* August 15, 1979.

Integrated Pest Management (IPM)

IPM practices help to minimize the potential environmental impact of chemicals, while obtaining the most cost-effective results and producing a high quality product. By adopting IPM strategies, growers can reduce chemical applications substantially. *This is not to say that pesticides are not an important component of these pest management methods.* Historically, growers have applied pesticides according to a growing calendar or schedule, rather than on an as-needed basis. This preventative approach can be costly, increase problems with insecticide resistance, and have negative environmental impacts. However, IPM stresses close monitoring of pest populations, cultural controls, and biocontrols, with the judicious use of crop protection chemicals, when needed, to fight a particular pest.

In selecting an Integrated Pest Management (IPM) program that works best for your operation, you should determine your growing objectives. For ornamental agriculture, this objective typically is to produce high quality, pest- and damage-free plants. In some situations however, the objective may be to maintain healthy plants, allowing for some tolerance of minor insect or mite pest damage. Financial considerations will, of course, shape the overall objectives of your IPM program.

Planning Considerations

The NRCS recommends the use of IPM principles. They offer Conservation Practice Standards in Pest Management (Code 595). Pest Management is defined as "managing agricultural pest infestations (including weeds, insects, and diseases) to reduce adverse effects on plant growth, crop production, and environmental resources". Excerpts from NRCS planning considerations include:

The use of crop rotations and adjustment of planting dates to help control weed, insect, and disease problems when economically feasible.
The use of hand weeding for small, isolated areas, or on larger areas where labor costs are not prohibitive.

The effects of erosion control practices, including subsurface water management, used to reduce soil loss and runoff on transport of adsorbed and dissolved pesticides.

The effects of repetitive use of the same or similar pesticides on pest resistance and shifts in the pest types.

The effects of pest control measures on non-target soil organisms, as well as aquatic and terrestrial life. Streamside vegetation is apt to contain threatened and endangered plant and animal species. This vegetation is protected by law in the state of California. In addition, you may be liable for any harm to threatened and endangered species within the habitat. It is wise to leave a small buffer between your operation and streamside vegetation, and to be careful when using such practices as aerial spraying in which drift may enter the ecosystem.

Prior to each application, consider weather conditions like fog and predicted rain, scheduled irrigations, and pesticide characteristics for their potential effect on pesticide leaching and runoff. Use well-designed irrigation systems and good irrigation water management to minimize leaching losses from deep percolation. Consider the effects of seasonal rainfall and water use on potential pesticide loss from the plant environment to surface or groundwater.

Determine which pesticides are being used that may cause water quality problems. Minimize use of pesticides identified locally as being of concern in the region, watershed or sub-watershed.

Consider using lower pesticide application rates than those called for on the label when local experiments have proven them effective. Take into account chemical formulation, weather conditions and if pest resistance management will be compromised.

Consider the use of surface or subsurface band application of pesticides such as treating only the top of the seedbed to reduce total amount applied.

If you have old wells on your property, inspect them and bring them up to the safeguards required for new wells to prevent point contamination from seepage to groundwater.

Controlling the environment to limit pest populations: It's beneficial to screen areas where pests may enter the greenhouse, such as vents and exhaust fans. If a grower can't screen an area completely, a partial screening (on the side where the wind flows in) or screening of propagation areas, for example, can be helpful.

The use of composted organic matter increases microorganisms in the soil. The increase of beneficial microorganisms in the soil works to build up suppressive populations of beneficials which have act to overcome and out compete incoming pathogens. Reduction of fungicide usage has been noted.

Select pesticide application methods that would minimize volatilization losses and potential runoff losses.

Adopt Good Management Practices

Preventive measures taken early and continually will help to prevent outbreaks of pest populations. The following good management practices can dramatically reduce pest populations, helping to maximize the effectiveness of chemical and biological controls:

Clean Up Your Growing Environment: A clean production environment is essential. By fumigating or treating greenhouses before establishing a new crop, you can help eliminate pest problems from previous crops. Eliminating weeds and other hosts for pest populations is also important.

Further tips to maintaining a clean environment include:

Keep hoses off the ground to avoid contaminating plants.

Level the ground to avoid problems associated with standing water.

Select Pest-Free Plants. It's vital to bring uninfested plants, plugs, cuttings or transplants into your growing environment. Quarantining plants prior to introduction to the operation is a good idea. Carefully inspect all new shipments, discarding or treating any with pest problems. Proper disposal of disease or pest-infested plants is important. If possible, purchase pest-resistant or tolerant plant species or cultivars to reduce the need for chemical applications during the growing cycle. By becoming knowledgeable about the susceptibility of your plants to certain pests, you can anticipate potential problems as well.

Reduce Stress to Plants. Plants under stress are more vulnerable to pests and diseases, and can withstand less pest-inflicted injury. *Proper fertilization and irrigation practices are essential in reducing the stress that predisposes plants to pest infestation.* Optimum temperature, humidity, light, favorable pH, and good soil condition also are important factors in minimizing pest outbreaks.

Detect Pest Problems Early - Monitoring Tips

Evaluate pest populations on a regular basis to determine the actual need for chemical control agents, rather than relying on regularly scheduled chemical applications. *It's far more efficient and economical to treat ornamentals only if and when a pest problem actually exists.* Reducing the number of applications not only reduces overall production costs, it also reduces the ever-increasing environmental liabilities for the grower (e.g. possible contaminated runoff, aerial drift, worker exposure, strict re-entry intervals, unexpected phytotoxicity, possible chemical resistance, chemical residues on the plants, and possible illegal use of a chemical).

Establish an ongoing monitoring system to detect pest infestations early. By regularly inspecting plants, growers can detect troublesome pests while they are still manageable and before major damage is done to the plants.

Base decisions to use pesticides on monitoring and establish an economic threshold for each pest problem on the crop.

Common Monitoring Techniques and Devices

Examining plant samples, including the undersides of leaves.

Hanging yellow or blue sticky traps just above the crop.

Using insect "zappers" inside the greenhouse can be very effective against certain pests, such as *Lepodoptera* pests (*Noctuidae*).

Using pheromone or black light traps.

Using a vacuum suction machine or sweep net in the crop.
Placing yellow sticky traps around the growing area, for instance, can detect early movement of adult whiteflies, thrips, adult leafminer flies, fungus gnats and aphids. It's also important to inspect plants regularly, paying particular attention to the undersides of leaves, where pests can hide. In addition, shaking portions of the plant onto off-white paper will dislodge pests and help detect small, hard-to-see pests, such as spider mites and thrips. Recognize the damage produced by major pests as well as the insects themselves.

When monitoring uncovers a significant number of pests or a number above a threshold you can tolerate, then it's time to implement appropriate control methods.

When Applications are Most Effective. In one example, research has shown that in a chrysanthemum crop, peak adult leafminer populations occurred around the first week in July and the first and last weeks in August. The researchers concluded that the optimum time to treat for adult leafminers was during these peak periods. Applying chemical agents at just the three pea periods during one cropping cycle proved more economical and effective than routine spraying on a weekly basis.

If a larvicide is used, the most effective application should be made when adult populations are on the decline, according to researchers. This is the time when eggs and newly hatched larvae are in the leaves.

Another example involves the use of yellow traps and leaf samples to detect the sweet potato whitefly, a serious pest that can attack poinsettias aggressively and with little warning. Growers typically rely on assessing whitefly populations by simply shaking sample plants. This casual inspection of the poinsettia crop is not enough, given the potentially explosive nature of the sweet potato whitefly. Yellow traps hung just above the poinsettias or leaf samples are far more reliable for assessing whitefly pest populations.

Growers should set a threshold for whiteflies per trap or leaf. Thresholds will vary from crop to crop and from grower to grower. Should the populations go beyond this threshold during any of the weekly inspections, remedial action is needed to control the population before it reaches hard-to-control numbers. In addition, estimating the pest population density is important in selecting the proper control method.

Timing of pesticide application should also take into account soil moisture levels, anticipated weather conditions, and irrigation to achieve greatest efficiency and reduce the potential for offsite transport.

Integrate Biological Controls Where Effective

Biological Controls. The use of natural predators or parasites to keep harmful pests in check can be highly effective in combination with good management practices and judicious use of chemical control agents. It's important to note, however, that natural biological controls cannot work alone, nor can they work if pesticides are sprayed indiscriminately with little regard for each chemical's effects on the beneficial insects. It's important to become familiar with beneficial insect species.

Numbers of Beneficial Insects to Introduce. "When a natural enemy is considered for release into an ornamental crop, the number that must be released per plant or per unit area is critical to the success of the biological control program and is very important in terms of the economics of the biological control effort," according to Dr. Michael Parrella, an entomologist at the University of California, Davis. Many natural enemies can be purchased commercially and released into crops. Information on release rates can be obtained from your local insectary. If you're not sure what is causing your pest problem or the impact a certain pesticide may have on the beneficial insects in your nursery or greenhouse, consult a commercial lab or your local farm advisor.

Consider Less Toxic Pesticides

You may prefer to use non-toxic or low-toxicity chemicals. This is particularly important in minimizing potential contamination of nearby surface and groundwater supplies, and in reducing hazards to workers.

Pesticide manufacturers are developing a new breed of crop protection chemicals called biorational materials which pose fewer potential environmental affects. These chemicals are less toxic to mammals and non-target animals, are less likely to migrate into groundwater, have fewer worker exposure hazards, and are most likely to be compatible with natural biological control agents.

Although not every new chemical possesses all of these traits, there are promising new materials that offer one or more of these beneficial characteristics. Insect Growth Regulators (IGR) are one class of these promising new compounds. Although they tend to be expensive, they work well. Talk to your pesticide distributor about which type may work for you.

IGRs can alter the normal growth and development of insects by:

Affecting embryonic, larval and nymphal development.
Altering metamorphosis.
Limiting the reproductive capacity.
Changing behavior.
Disrupting insect hibernation.

These new chemicals will likely be the pesticides of the future and hold great promise for widespread inclusion in IPM programs in the greenhouse and container crop industries.

Pesticide Application Techniques

Adopt improved application technology where available, registered and legal, to reduce the amount of chemicals applied and to maximize effectiveness. This improved technology also helps to reduce grower costs.

Ultra Low Volume Application. Ultra low volume applicators may be used when allowed by the pesticide labels. However, many labels specify dilution rate and thereby preclude the use of low-volume sprayers.

Surfactants, Stickers and Sticker-Spreaders. Surfactants and sticker-spreaders make your pesticide applications more effective. Surfactants, also known as wetting agents or spreaders, can be one of three types: anionic, non-ionic, or cationic.

Anionic Surfactants are used to keep the pesticide on plant surfaces. These materials reduce the likelihood of the material being washed off the plant by precipitation. Anionic surfactants also prevent pesticides from being readily absorbed into plant tissues, increasing the effectiveness of insecticides that are stomach or contact poisons.

Non-ionic Surfactants increase pesticide uptake through the plant cuticle. This is of particular use for pesticides with systemic activity and will improve the uptake of herbicides. Pesticides mixed with nonionic surfactants, however, may be prone to washing off treated surfaces by rainfall, dew, or irrigation.

Cationic Surfactants aid in getting pesticides through the plant cuticle but are not used alone as pesticide adjuvants since they are highly phytotoxic when not blended with other types of adjuvants. Blending of surfactants is common.

Stickers, as the name implies, are adhesives, which improve pesticide adhesion to sprayed surfaces. They help protect pesticides from washing off treated surfaces and can reduce pesticide loss from wind or leaf abrasion. An ultraviolet inhibitor may be added to protect the pesticide from degradation by sunlight. It is important to follow label directions carefully; too much sticker can bind the pesticide so that it is unavailable to the target organism. In addition, because some pesticides already contain a sticker, additional amounts should be avoided. The pesticide label may specify that no sticker should be used.

Sticker-Spreaders are a mixture of surfactant and adhesive sticker. These combinations are commonly used as general purpose adjuvant for many pesticide applications. Check that the surfactant in the mixture is compatible with the type of pesticide being used when you use a sticker-spreader. Also check that the pesticide formulation does not already contain a sticker.

Remember when selecting adjuvants, ascertain the desired effect of the material, then check pesticide and adjuvant labels so make sure these materials are appropriate to the application site, target pest, and equipment.

Weigh All Pest Management Options Carefully

As discussed earlier, IPM emphasizes monitoring plants regularly to identify pest problems. Growers can then make informed choices as to the most appropriate control tactics for each pest situation. When selecting a particular pest management option, consider the economic and environmental implications of each approach, including worker safety, pesticide residues, potential ground or surface water contamination, drift, etc. If chemical controls are necessary, compare the mode of action, cost and application methods for each registered product. When using a registered product for the first time, on a new plant or in a new mixture, apply it to a small number of plants first to observe any toxic reactions in the plant.

Above all, when using any pesticide product, always read and follow all label directions carefully. Failure to do so is a violation of the product's registration and the law.

More information on topics important to the implementation of IPM can be found in the Appendix.

Useful Organizations

The University of California Statewide IPM Project. University of California, Davis, CA 95616. (916) 752-8350.

The American Floral Endowment. 37 Camelot Drive, Edwardsville, IL 62025. (618) 692-0045.

The Horticultural Research Institute. 1250 I Street, N.W., Suite 500, Washington D.C., 20005. (202) 789-2900.

The Joseph H. Hill Memorial Foundation. P.O. Box 99, Haslett, MI 48840. (517) 339-9544.

The BPI Foundation. P.O. Box 27241, Lansing, MI 48909. (517) 694-8537.

The Farm and Home Advisor's Office. 5555 Overland Dr., Bldg. #4, San Diego, CA 92123. (619) 694-2845.

University of California Publications

IPM Manual for Greenhouse Crops is presently being developed.

Pests of Landscape Trees and Shrubs.

Pests of the Garden and Small Farm - A Grower's Guide to Using Less Pesticide. 1990. Includes information on designing a pest management program, diseases, nematodes, weeds, common insects, mites, other arthropods, snails and slugs (#3332). 276 pp.

Container Nursery Weed Control. 1979. Includes: Specific recommendations for weeds that cause problems in the nursery; general control methods (#21059). 12 pp.

Pesticide Study Publications. Includes: Study materials for the California Department of Pesticide Regulation's Pesticide Applicator, Structural Pest Control Operator License, Qualified Pesticide Applicator License, and Qualified Pesticide Applicator Certificate examinations.

Ornamental and Turfgrass Pest Control. 1977 (#2964). 16 pp.

The Safe and Effective Use of Pesticides. 1988 (UC Pub. #3324). Volume 1 of the UC Pesticide Application Compendium, this book tells how to prevent accidents, injuries, and environmental problems when applying

pesticides. Required study material for the California Department of Pesticide Regulation's Qualified Pesticide Application License (QAL) and Qualified Pesticide Applicator Certificate (QAC) exams. 400 pp.

Diagnosing Ornamental Plant Diseases. 1988. A guide to many of the serious diseases of ornamental plants in Southern California, with practical advice on diagnosing ornamental plant diseases in general (#21446). 36 pp.

Insect Pest Management Guidelines for California Landscape Ornamentals. 1987. A comprehensive guide on insect pests of nearly 100 ornamental plants and plant groups: diagnosing problems, monitoring populations, assessing damage. An IPM table offers quick reference to symptoms, descriptions, and management options. 20 color photos (#3317). 88 pp.

Ornamental and Turfgrass Pest Control. 1977 (#2964). 16 pp.

Plants Resistant or Susceptible to Verticillium_**Verticillium Wilt.** Rev. 1981. Backyard and commercially grown trees, shrubs, vines, ground covers, vegetables, field crops, and herbaceous ornamentals are listed (#2703). 12 pp.

Chrysanthemum Cultivars Resistant to Verticillium_**Verticillium Wilt and Rust.** Rev. 1981 (#21057). 4 pp.

Plants in California Susceptible to *Phytophthora cinnamomi.* 1980 (#21178). 12 pp.

Pesticide Applicator Instructor's Handbook. 2nd ed., 1993. UC IPM Publication No. 14. Available by taking instructor's course through UC IPM. The pesticide applicator instructor's course is offered through University of California Integrated Pest Management (UC IPM). Courses are offered throughout the state. As a benefit of taking the course, you will receive the Pesticide Applicator Instructor's Handbook (UC IPM Publication 14). For information on a course offered nearest you, call the UC IPM office at (916) 752-7691.

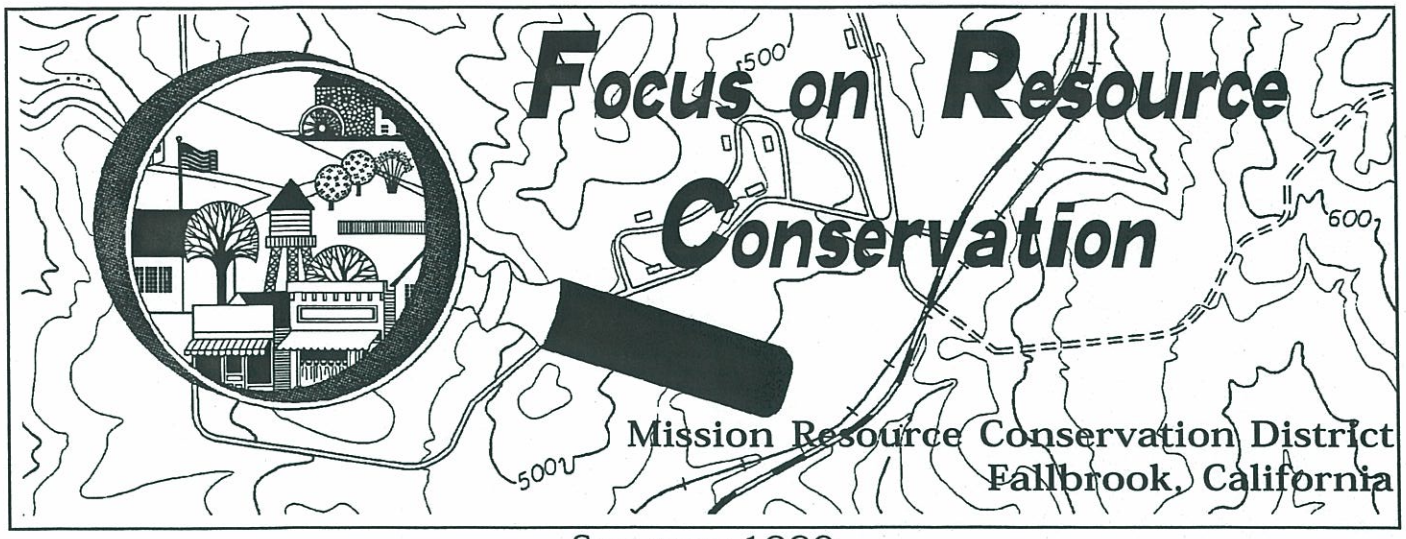
The UC IPM Database. The UC Statewide IPM Project was established in 1980 to develop and promote the use of IPM programs in California. The IPM computer system provides easily used programs through its IMPACT program, which is accessible in Cooperative Extension county offices and by anyone with a dial-up modem who requests a user code and password. The IMPACT program includes current pest management guidelines for many agricultural crops and home pest problems. The guidelines list recommended pesticides and other control methods as well as monitoring methods and other IPM techniques. Printed copies are available at the Cooperative Extension county offices. The drawback to using the database is that it is not accessible to the private sector during weekdays between 10-12 and 1-4. Access hours are unrestricted to UC staff/students, government/public agencies, and schools. The UC IPM Program provides three resources to help you learn how to log into the computer and run the programs: a quick reference card, a user's manual ($15) and training.

Further References

Efficient Weed Management. C.L. Elmore.

Roses: a Manual on the Culture, Management, Diseases and Insects of Greenhouse Roses. Roses, Inc., Haslett, MI.

Septic BMPs
MRCD Brochure



Summer 1999

Septic System Operation, Inspection, and Maintenance The Homeowner's Guide

Out of sight and out of mind. Does this describe your relationship with your septic system? If you are like most homeowners, you probably never give much thought to what happens to what goes down your drain. But if you rely on a septic system to treat and dispose of your household wastewater, what you don't know can hurt you. Proper operation and maintenance can have a significant impact on how well your septic system works and how long it lasts.

Why Maintain Your System?

There are three main reasons why proper maintenance is so important - money, health, and economy.

1. Failing septic systems are expensive to repair or replace, and poor maintenance is a leading cause of early system failures. The least amount of preventive maintenance cost very little in comparison. For example, it typically costs from $3,000 to $10,000 to replace a failing septic system, compared to approximately $75 to $200 to have a system inspected, and $150 to $350 to have it pumped.

2. The health of your family, your community, and the environment can all be impacted by your septic system. When septic systems fail, inadequately treated household wastewater is released into the environment. Any contact with untreated human waste pose significant health risks, and untreated wastewater from defunct septic systems is an ugly contaminant of drinking water sources. Chemicals improperly released through a septic system pollute local water sources and contribute to system failures. Therefore, it is imperative that homeowners educate themselves about what should and should not be flushed into a septic system.

3. The economic health of your community can be negatively affected by a bad septic system. Failed septic systems can cause property values to decline. Sometimes building permits cannot be issued or real estate sales can be delayed for these properties until the systems are repaired or replaced. Also, failed septic systems can contribute to the pollution of local rivers, streams and ponds.

Why Do Systems Fail?

Improper siting, construction errors, and design flaws often contribute to septic system failures. However, if your septic system has been properly designed, constructed , and installed, the **you** are probably the biggest threat to the health and longevity of **your** septic system. Fortunately, it is easy to learn how to properly operate and maintain a septic system.

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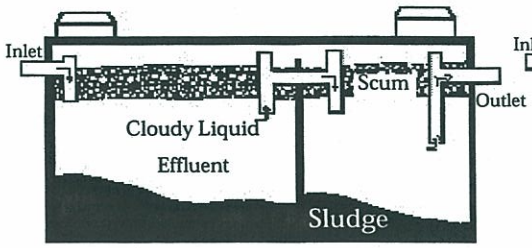
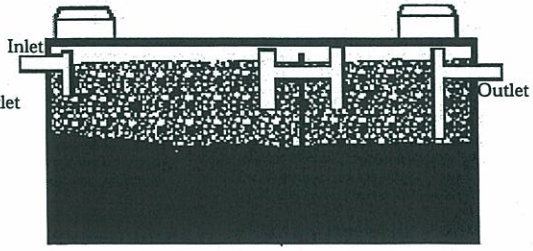
How To Maintain Your Septic System

Septic systems are a very simple way to treat household wastewater and are easy to operate and maintain. Although you need to taken an active role in maintaining your system, once you learn how your system works, it is easy to appreciate the importance of a few sound operation and maintenance practices.



A Properly Functioning Septic Tank



A Failed Septic Tank

How Septic Systems Work

There are two main parts to the basic septic system: the septic tank and the leach field.

The Septic Tank --

Household wastewater first flows into the septic tank where it should stay for at least 24 hours. In the tank, heavy solids in the wastewater settle to the bottom forming a layer of ***sludge***. Grease and light solids float to the top forming a layer of ***scum.***

The sludge and scum remains in the tank where naturally occurring bacteria breaks them down. The bacteria cannot completely break down all of the sludge and scum, however. This is why septic tanks need to be pumped periodically.

The separated wastewater in the middle layer of the tank is pushed out into the leach field as more wastewater enters the septic tank. If too much water is flushed in the septic tank in a short period of time, wastewater flows out of the tank before it has a chance to separate. This can happen on days when water use if unusually high (laundry day, for example), or more often if the septic tank is too small for the needs of the household.

The Leach Field -- When

wastewater leaves a septic tank too soon, solids can be carried with it to the leach field. Leach fields provide additional treatment for wastewater by allowing it to trickle from a series of perforated pipes, through a layer of gravel and down through the soil. The soil acts as a natural filter and contains organisms that help break down the treat the waste. Solids damage the leach field by clogging the small holes in the leach field pipes and the surrounding gravel.

How to Care For Your Septic System

Septic system maintenance is often compared to automobile maintenance because only a little effort on a regular basis can save a lot of money and significantly prolong the life of the system.

Sound septic system operation and maintenance practices include conserving water, being careful that nothing harmful is disposed of through the system and having the system inspected and pumped regularly.

By educating everyone in your household about what is and isn't good for septic systems, they can begin to develop good maintenance habits.

Use Water Wisely

Water conservation is very important for septic system because continual saturation of the soil in the leach field can affect the quality of the soil and its ability to naturally remove toxins, bacteria, viruses, and other pollutants from the wastewater.

The most effective way to conserve water is to take stock of how it is being wasted. Immediately repair any leaking faucets or running toilets, and use washing machines and dishwashers only when they're full. In a typical household, most water used indoors is in the bathroom. There are lots of little things that can be done to conserve water here.

For example, try to avoid letting water run while washing hands and brushing teeth. Avoid

taking long showers and install low flow faucets and shower heads. These devices can reduce water use by up to 50%. Ultra low flush toilets (ULFT) use 1.8 gallons per flush compared to the three to seven gallons used by conventional toilets. Using a toilet dam on a conventional toilet can reduce water use by 25%.

It is also important to avoid overtaxing you system by using a lot of water in a short period of time, or by allowing too much outside water to reach the leach field. Try to space out activities requiring heavy water use (laundry, dish washing) over several days. Also, divert roof drains, surface water, and sump pumps away from the leach field.

Know What Not To Flush

What you put into your septic system greatly affects its ability to do its job. As a general rule of thumb, do not dispose of anything in your septic system that can just as easily be put in the trash. Remember that your system is **not** designed as a garbage disposal. Solids build up in the septic tank and eventually need to be pumped out.

In the kitchen, avoid washing food scraps, coffee grinds, and other foods down the drain. Grease and cooking oils contribute to the layer of scum in the tank and also should not be put down the drain. Garbage disposals can increase the amount of solids in the tank up to 50% and are not recommended for use with septic systems.

The same common-sense approach used in the kitchen should be used in the bathroom. Don't use the toilets to dispose of plastics, paper towels, tampons, disposable diapers, kitty litter, etc. The only things that should be flushed down the toilet are wastewater and toilet paper.

Avoid Hazardous Chemicals

To avoid disrupting or permanently damaging your septic system, do not use it to dispose of hazardous household chemicals. Even small amounts to paints, varnish, thinners, waste oil, photographic solutions, pesticides ,and other chemicals can destroy helpful bacteria and the biological digestion taking place within your system. These chemicals also pollute groundwater. Some septic system additives that claim to help or clean you system contain hazardous chemicals and should be avoided.

Household cleaners, such as bleach, disinfectants, drain and toil bowl cleaners should be used in moderation and only in accordance with product labels. Overuse of these products can harm your system. It makes sense to try to keep all toxic and hazardous chemical out of your septic tank system when possible.

To prevent groundwater pollution, be sure to dispose of leftover hazardous chemicals by taking them to an approved hazardous waste collection center. For more information, call: *County of San Diego Regional Household Hazardous Waste Hotline (800) 246-1233.*

Pump Your Tank Regularly

Pumping your septic tank is probably the single most important thing you can do to protect your system. If the buildup of solids in the tank becomes too high, solids in the tank move into the leach field. This condition can clog and strain the system to the point where a new leach field may be needed.

Inspect Your System Annually

Inspecting your septic system annually is a good way to monitor its health. Inspection can reveal problems before they become serious and by checking the levels of sludge and scum in your tank, you can get a good idea of how often it should be pumped.

Protect Your System

Finally, it is important to protect your septic system from potential damage.

Don't plant anything but grass near your septic system. Roots from shrubs and trees can cause damage. Don't allow anyone to drive or operate heavy machinery over any part of the system. Also, don't build anything over the leach field. Grass is the most appropriate cover for a leach field.

Is Your Septic System Failing?

Septic system owners should be aware of the following warning signs of a failing system:

- **Slowly draining sinks and toilets**
- **Gurgling sounds in the plumbing**
- **Plumbing backups**
- **Sewage odors in the house or yard**
- **Ground wet or mushy underfoot**
- **Grass growing faster and greener in one particular area of the yard**

None of these warning signs can be considered a sure indication that a system has failed, but the appearance of one of more of them should prompt you to have your system inspected. Keep in mind, septic systems can fail **without** any of these warning sings. For this reason, yearly inspection of your septic system is recommended and even required by some communities.

Groundwater Pollution

Preventing groundwater pollution from failing septic systems should be a priority for every community. Contamination of groundwater sources can lead to the pollution of local wells, streams and ponds - exposing family, friends, and neighbors to waterborne diseases and other serious health risks.

When a septic system fails, inadequately treated domestic waste can reach the groundwater. Bacteria and viruses from human waste can cause dysentery, hepatitis, and typhoid fever. Many serious outbreaks of these diseases have been caused by contaminated drinking water.

Nitrate and phosphate, also found in domestic wastewater, can cause excessive algae growth in lakes and streams called algae blooms. These blooms cause aesthetic problems and impair aquatic life. Nitrate is also the cause of *methemoglobinemia* or blue baby syndrome; a condition that prevents the normal uptake of oxygen in the blood of infants under six months of age.

In addition, hazardous household chemicals like paints, varnishes, waste oils, and pesticides pollute the groundwater and should never be disposed of through a septic system. They can also kill the microorganisms in the system that break down the waste.

Warning!

Be sure to excersie appropriate caution when inspecting a septic tank. Never allow anyone to inspect a septic tank alone or go down into a septic tank. Toxic gases are produced by the natural treatment processes in septic tanks. These gasses can kill in minutes. Just looking in the tank can be dangerous

Estimated septic tank pumping frequency in years. Note - These figures assume that no garbage disposal unit is in use.

Tank Size in Gallons	Household Size - Number of People					
	1	2	3	4	5	6
500	5.8	2.6	1.5	1.0	0.7	0.4
750	9.1	4.2	2.6	1.8	1.3	1.0
900	11.0	5.2	3.3	2.3	1.7	1.3
1000	12.4	5.9	3.7	2.6	2.0	1.5
1250	15.6	7.5	4.8	3.4	2.6	2.0
1500	18.9	9.1	5.9	4.2	3.3	2.6
1750	22.1	10.7	6.9	5.0	3.9	3.1
2000	25.4	12.4	8.0	5.9	4.5	3.7
2250	28.6	14.0	9.1	6.7	5.2	4.2
2500	31.9	15.6	10.2	7.5	5.9	4.8

Pumping and Inspecting Your System: What To Expect

Annual inspections of your septic system are recommended to ensure that it is working properly and do determine when the septic tank should be pumped. By inspecting and pumping your system regularly, you can prevent the high cost of septic system failure

Inspecting Your System

Although a relatively simple inspection can determine whether or not your septic tank needs to be pumped, you should consider hiring a professional contractor. A professional can do a thorough inspection of the entire system and check for cracked pipes and the condition of the tees or baffles and other parts of the system.

A thorough septic system inspection will include the following steps:

Location the system - Even a professional may have trouble locating your system if access to your tank is buried. Once your system is found, be sure to keep a map of it on hand to save time on future service visits.

Uncovering the manhole and inspection ports - This may entail some digging in your yard. If they are buried, try to make access to the ports easier for future inspections. Install risers (elevated access covers) if necessary.

Flushing toilets - This is done to determine if the plumbing going to the system is working correctly.

Measuring the scum and sludge layers - There are two frequently used methods for measuring the sludge and scum layers inside your tank. The contractor may use a hollow clear plastic tube that is pushed through the different layers to the bottom of the tank. When brought back up, the tube retains a sample showing a cross section of the inside of the tank.

The layers can also be measured using a long stick. To measure the scum layer, a three-inch piece of wood is attached across the end of the stick to form a 'foot'. The stick is pushed down through the scum to the liquid layer. When the stick is moved up, the foot meets resistance on the bottom of the scum layer, and the contractor marks the stick at the top of the layer to measure total thickness. As a general guideline, if the scum layer is within three inches of the bottom of the inlet baffle, the tank should be pumped.

The sludge layer is measured by wrapping a cloth around the bottom of the stick and lowering it to the bottom of the tank. This should be done either through a hole in the scum layer or through the baffle or tee, if possible, to avoid getting scum on the cloth. If the sludge depth is equal to one third or more of the liquid depth, the tank should be pumped.

Checking the tank and the leach field - The contractor should check the condition of the baffles or tees, the walls of the tank for cracks, and the leach field for any signs of failure. If your system includes a distribution box, drop box, or pump, the contractor will check these as well.

When To Pump

How often your tank needs to be pumped depends on the tank size, the number of people living in your home, and the habits of your particular household. Garbage disposals and high-water use technologies, such as a hot tub or whirlpool, also affect the pumping frequency.

To estimate how often you should have your tank pumped, refer to the table on page four. This information combined with observations from annual inspections will help you to estimate your individual pumping schedule.

When it is time to pump your tank, be sure to hire a licensed contractor. He will have the appropriate equipment and will dispose the sludge at an approved treatment site. You can find a listing of licensed pumpers and haulers in the yellow pages under *Septic*.

It's a good idea to be present when your tank is being pumped. Make sure the contractor uses the manhole and not the inspection ports to pump the tank to avoid damaging the baffles or tees. Make sure all of the material in the tank is removed. It if not necessary to leave anything in the tank to 'restart the biological process, but it is also not necessary to scrub or disinfect the tank.

Thanks to the ***National Small Flows Clearing House*** at West Virginia University for the information in this newsletter.

WHERE TO GET MORE INFORMATION

This program was made possible by a grant from the State Water Resources Control Board
The Board oversees water quality issues throughout the state in 9 regions.
The San Diego Regional Water Quality Control Board can be contacted at:
(858) 467 - 2952
9771 Clairemont Mesa Blvd., Suite A
San Diego, CA 92124
http://www.swrcb.ca.gov/~rwqcb9

Further assistance can be obtained from the Natural Resources Conservation Service
(760) 745 - 2061
332 S. Juniper #110
Escondido, CA 92025
http://www.nrcs.usda.gov

Agricultural Commissioner's Office
(760) 736 - 5911 (858) 694 - 2739
5555 Overland Avenue Building 3
San Diego, CA 92123

San Diego County Department of Environmental Health
(619) 338 - 2222
1255 Imperial Avenue, 3rd Floor
San Diego, CA 92101
http://www.co.san-diego.ca.us/deh

This brochure was prepared by
The Mission Resource Conservation District
The District is an independent unit of local government organized under the provisions of Division 9 of the Public Resources Code of the State of California. The District actively promotes the wise use of land, water, and other natural resources. The District's board meetings are held on the fourth Tuesday of every month at 4:00 pm at the District office in Fallbrook.
The activities of the District are administered by a board of directors who live within its boundaries and serve without pay. Technical service is provided by District staff and by the United States Department of Agriculture Natural Resource Conservation Service (NRCS). All services are provided to the District's cooperators without charge.

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Water Conservation BMPs
RMWD Urban Water Management Plan

Water Conservation

Water conservation is addressed in the Rainbow Municipal Water District Urban Water Management Plan, as an element of the long-term strategy for meeting the water needs. The goals of the Rainbow Municipal Water District water conservation program are to 1) reduce the demand for imported water, 2) demonstrate continued commitment to the BMPs, and 3) ensure a reliable water supply.

- **BMP 1 - Water Survey Programs for Single-Family and Multi-Family Residential Customers**

The Residential Survey Program is free to residents, both single and multi-family and has been available since 1995. The survey includes an indoor water use review, help with identifying indoor leaks, and a complete educational packet, which includes information about other water conservation programs. The survey also includes a meter leak detection test, irrigation system maintenance check, individualized seasonal suggestions of watering schedules, and soil check, information about proper lawn maintenance measures, and tips about low-water use landscaping where appropriate.

- **BMP 2 - Residential Plumbing Retrofit**

The Rainbow Municipal Water District continues to distribute showerheads at outreach events as well as at the main office upon request. Because much of the Rainbow Municipal Water District service area is relatively new and most of the dwellings were built after 1992 and have newer plumbing fixtures, participation in the residential plumbing retrofit BMP is approaching saturation.

- **BMP 3 - System Water Audits, Leak Detection, and Repair**

Each local agency, including the Rainbow Municipal Water District, maintains an active distribution system-auditing program. This program evaluates the systems unaccounted-for water loss with a goal to stay under ten percent. The Rainbow Municipal Water District has consistently maintained about a six percent unaccounted-for water loss. The Rainbow Municipal Water District regularly conducts ongoing internal distribution system leak detection surveys. The comparison of water sold to water purchased also helps in the detection of water loss. The Rainbow Municipal Water District has incorporated this BMP into its operations and maintenance procedures, and established a six-year rotation schedule. Rainbow Municipal Water District crews survey at least three to four miles of water main and laterals per year on an ongoing basis.

- **BMP 4 - Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections**

The Rainbow Municipal Water District is 100 percent metered for all customer sectors, including separate meters for single-family residential, commercial, large landscapes, institutional, and governmental facilities. The Rainbow Municipal Water District has an inclining block rate structure, with a lifeline allotment of 5 billing units per customer per month for residential customers. A billing unit is one hundred cubic feet (748 gallons), commonly abbreviated as HCF. Since 1990 commercial, industrial, and institutional customers are also required to have separate irrigation meters for both potable and recycled water. The Rainbow Municipal Water District will continue to install and read meters on all new and existing services and will continue to conduct its meter calibration and replacement program.

- **BMP 5 – Large Landscape Conservation Programs and Incentives**

Since 1990, irrigation surveys are conducted for the large landscape customers (currently defined as one acre or greater), at no charge to the customer through the Professional Assistance for Landscape Management (PALM) program, sponsored by the Water Authority. During the survey, the survey team examines the irrigation system for distribution uniformity, matched irrigation components, and controller scheduling. The team calculates and recommends a water budget for the site, based on the size of the landscape, the plant material, and the climate. The Rainbow Municipal Water District continues to be one of the few water agencies in the state that maintains a landscape water budget program for its landscape customers. The Rainbow Municipal Water District will continue to implement this BMP by review of customers' water use and water budget and by offering ongoing follow-up evaluations to customers whose total water use exceeds their total annual water budget. In addition, in cooperation with the Water Authority, the Rainbow Municipal Water District will soon participate in a new program providing incentives to improve sprinkler efficiency, known as Commercial Landscape Incentive Program (CLIP).

- **BMP 6 – High-Efficiency Washing Machine (HEWM) Voucher Program**

Since 1995, the High Efficiency Washing Machine (HEWM) Voucher Program has been available to Rainbow Municipal Water District customers. New technology in washing machine design provides for more efficient use and water savings. Over the past few years, an increasing number of residential customers have taken advantage of the $125 voucher offer. The HEWM's installed in multi-family laundry rooms and laundromats are eligible to receive a $300 voucher through the commercial HEWM program. Vouchers are offered for residential, commercial, institutional, and industrial customers.

- **BMP 7 – Public Information Programs**

Water conservation public information programs consist of newsletters, annual water quality Consumer Confidence Reports, brochures, bill inserts, bill messages, event staffing, web page maintenance, an annual Water Wise Landscape Contest, and active participation in the Water Conservation Garden. The 4¼-acre Water Conservation Garden located at Cuyamaca College opened to the public in late 1999 and functions as a learning facility to further the education of visitors on how to effectively achieve water savings through xeriscape landscape techniques. The Water Conservation Garden is utilized for public and mid-week school tours, teacher in-service training, special events, seminars, classes, workshops, and community events.

The Rainbow Municipal Water District regularly encourages its customers to visit the Water Conservation Garden for landscape ideas and attend classes. The Rainbow Municipal Water District staff regularly develops bill inserts and messages in the water bill promoting landscape water efficiency and the Garden, and frequently writes articles on the Garden in its quarterly newsletter (the Pipeline). In addition, a "Welcome to Otay" brochure is distributed to all residential customers new to the Rainbow Municipal Water District, promoting the Garden, water-wise landscape practices, and other applicable water conservation programs.

- **BMP 8 – School Education Programs**

The Rainbow Municipal Water District works with all school districts in our service area to educate students about water issues through curriculum-based educational programs. The Rainbow Municipal Water District offers a full-service school education program, including classroom presentations, Water Conservation Garden tours, awards materials, and science fair participation. Grants for school site demonstration gardens and bus transportation are available as well. The Rainbow Municipal Water District participates in and coordinates educational programs sponsored by the Water Authority, including teacher in-service training and Water Authority mini-grants.

- **BMP 9 – Conservation Programs for Commercial, Industrial, and Institutional Accounts**

Since 1995, the Rainbow Municipal Water District has provided vouchers for water efficient devices to its commercial, industrial, and institutional accounts through shared-funding programs with the Water Authority and Metropolitan. Vouchers are available for low-flow and water-less urinals ($95), commercial clothes washers installed in laundromats and multi-family common areas ($300), commercial ULFT's ($95), and cooling tower conductivity controllers ($500). Incentives are now also available for multi-load commercial clothes washers, pre-rinse sprayers, and x-ray photo processing machines.

- **BMP 10 – Wholesale Agency Assistance Program**

This BMP applies only to wholesale agencies. The Water Authority provides conservation-related technical support and information to its member agencies, including ULFT and High Efficiency Clothes Washer Program vouchers, residential surveys; partial funding for water efficient devices in commercial, institutional, and industrial properties; large turf irrigation; and conservation-related rates and pricing. The Water Authority typically manages the programs on behalf of its member agencies and contributes ¼ of the cost for the incentive or survey. The Rainbow Municipal Water District contributes another ¼ of the cost, while Metropolitan typically provides ½ of the incentive.

- **BMP 11- Conservation Pricing**

Water rates vary among classifications. The rates for residential customers are based on an accelerated block structure; as more units are consumed, a higher unit rate is charged. Non-residential irrigation customers are charged a flat rate per unit. The recycled water rate is set at 85% of the potable water rate to provide an economic incentive for the use of the recycled water supply.

- **BMP 12 – Conservation Coordinator**

In accordance with the Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California, the Rainbow Municipal Water District established the full-time Water Conservation Coordinator position in 1991. In addition, the Rainbow Municipal Water District has a full-time Water Conservation Specialist position.

- **BMP 13 – Water Waste Prohibition**

The Rainbow Municipal Water District has a "No Waste" ordinance, which is actively enforced. Enforcement of the ordinance includes a water use investigator to educate customers and if necessary, issue warnings and citations for violations.

- **BMP 14 – Residential ULFT Replacement Program**

The Rainbow Municipal Water District established its ultra-low flush toilet (ULFT) replacement program in 1991. Residential customers are eligible to receive a $75 off the cost of a ULFT toilet. In addition, a $95 voucher is available toward the purchase of a dual-flush toilet (one that uses 30% less water than a standard ULFT). The Rainbow Municipal Water District worked closely with the Water Authority to develop a pilot incentive program to encourage builders to install dual-flush toilets in new construction. Currently, a $50 voucher is available to builders for every dual flush toilet installed.

Additional conservation or water use efficiency measures or programs practiced by the Rainbow Municipal Water District include the following:

Water Conservation Efforts with Developers and County of San Diego

The Rainbow Municipal Water District works closely with developers and the County of San Diego staff to provide materials and information on the latest water efficient technologies. The Rainbow Municipal Water District staff developed a list of water-wise publications and provided them to developers that are creating a new homeowner packet as required by the County of San Diego. The Rainbow Municipal Water District works closely with the County of San Diego staff to evaluate the water conservation plans of new developments and to encourage the installation of new technologies such as weather-based irrigation controllers and dual-flush toilets in new construction.

Metering

The Rainbow Municipal Water District requires the installation of water meters on all services throughout its distribution system for all classes of accounts. Any unmetered use generally occurs at fire hydrants or from distribution system breaks. Estimates are made and accounted for each occurrence of a known unmetered water use event.

The Rainbow Municipal Water District water meter replacement, calibration, and maintenance program has been practiced for decades. The purpose is to maintain low levels of accounted for water loss. This accomplished through scheduled water meter replacement and calibration efforts. The calibration of the meters larger than two inches is generally performed on an annual basis. Water meters two inches in diameter and smaller are generally replaced once every ten years on the average. Meter calibration and periodic replacement insures that customers are paying for all of the water they consume, and therefore encourages conservation.

Unaccounted-For Water Loss

Rainbow Municipal Water District's water meters, service line breaks, and other unusual events are not significant factors within the water system. The industry standard, based on the American Water Works Association, for unaccounted-for water loss is no more than nine to ten percent. The Rainbow Municipal Water District typically experiences about a six percent water loss, which is well below the industry standard threshold.

Landscape Conservation

The County of San Diego in cooperation with the Rainbow Municipal Water District enforces water efficient landscaping requirements for all commercial, industrial, and institutional developments. Included is a requirement that landscape plans be

designed by a registered landscape architect and that they include automatic irrigation systems, rain shutoff devices, in-line check valves to prevent low head drainage, and separate landscaping meters. Suggestions and recommendations are made regarding the use of xeriscape landscaping techniques based on conserving water through limiting the size of turf areas, maximizing the use of drought tolerant (low water consuming) plants, and appropriate maintenance.

The California Irrigation Management Information System (CIMIS), managed by the California Department of Water Resources, has a weather station at the U.S. Olympic Training Center facility (Station No. 147), owned by Rainbow Municipal Water District. This weather station monitors precipitation and evapotranspiration levels. The CIMIS information can be used for programming the irrigation cycles and watering time within the Rainbow Municipal Water District, reducing overall annual irrigation water use. This program is quite effective and is being monitored by the Rainbow Municipal Water District staff. This program also benefits water quality through the management of runoff.

In partnership with the Authority, the Rainbow Municipal Water District will begin offering an incentive to commercial and residential customers toward the installation of weather based irrigation controllers that will override a controller schedule with seasonal and perhaps real-time weather data.

Supervisory Control and Data Acquisition System

The Rainbow Municipal Water District implemented and has operated for many years a Supervisor Control and Data Acquisition (SCADA) system to control, monitor, and collect data regarding the operation of the water system. The major facilities that have SCADA capabilities are the water supply source, transmission network, pumping stations, and water storage reservoirs. The SCADA system allows for many and varied useful functions. Some of these functions provide for operating personnel to monitor the water supply source flow rates, reservoir levels, turn on or off pumping units, etc. The SCADA system aids in the prevention of water reservoir overflows and increases energy efficiency.

Water Conservation Ordinance

California Water Code Sections 375 et seq. permit public entities which supply water at retail to adopt and enforce a water conservation program to reduce the quantity of water used by the people therein for the purpose of conserving water supplies of such public entity. The Rainbow Municipal Water District Board of Directors established a comprehensive water conservation program pursuant to California Water Code Sections 375 et seq., based upon the need to conserve water supplies and to avoid or minimize the effects of any future shortage. A water shortage could exist based upon the occurrence of one or more of the following conditions:

1. A general water supply shortage due to increased demand or limited supplies.
2. Distribution or storage facilities of the Water Authority or other agencies become inadequate.
3. A major failure of the supply storage and distribution facilities of the Metropolitan, the Water Authority, or of the Rainbow Municipal Water District occurs.

The Rainbow Municipal Water District water conservation ordinance finds and determines that the conditions prevailing in the San Diego County area require that the available water resources be put to maximum beneficial use to the extent to which they are capable, and that the waste or unreasonable use, or unreasonable method of use, of water be prevented and that the conservation of such water be encouraged with a view to the maximum reasonable and beneficial use thereof in the interests of the people of the Rainbow Municipal Water District and for the public welfare.

APPENDIX D

Community Outreach

December 20, 2004 1982-174

MEETING MINUTES

Re: Preliminary Stakeholder Meeting for Rainbow Valley Basin Groundwater Management Plan

PARTICIPANTS

NAME	AGENCY	PHONE	FAX	EMAIL
Paul Gebert	SDCWA	[redacted]		[redacted]
Joe De Stefano	County of SD	[redacted]	[redacted]	[redacted]
Gene Buckley	Rainbow	[redacted]		[redacted]
Chris Trees	Dudek/Rainbow	[redacted]	[redacted]	[redacted]
Peter Quinlan	Dudek	[redacted]	[redacted]	[redacted]
Derek Reed	Dudek	[redacted]	[redacted]	[redacted]
Jay Jones		[redacted]		[redacted]
Steve Jepsen	Dudek	[redacted]	[redacted]	[redacted]

Please review the summary of the above-mentioned meeting, if there are any revisions required please notify Steve Jepsen by phone, fax or email within 48 hours.

The purpose of the above mentioned meeting was to discuss the Rainbow Valley Basin Groundwater Management Plan Project. The following was discussed during the meeting:

- Introductions
- Peter Quinlan gave a brief overview of the Department of Water Resources grant, basin characteristics and project objectives. The handouts provided for this discussion are attached.
- The groundwater level in the basin is unusually high. In some cases two feet below the ground surface. As a result, there has been a moratorium on building permits for the past 20 years.
- The area Elementary School has to pump groundwater in order to have an operable toilet discharging into the septic system.
- Nitrogen and Phosphate concentrations are elevated in the groundwater and Rainbow Creek.. Most of the Nitrate and Phosphates in Rainbow Creek are attributed to surface run-off from local agriculture operations. A very small portion of the Nitrogen and Phosphates may from the area wastewater septic systems.
- The current and future RWQCB water quality standards were discussed. Depending on which test data is used, water quality in Rainbow Creek is close to current standards.
- Most of the existing wells have a very low yield.
- Generally, the top 15-feet of soil is alluvium; the next 20 to 30-feet is weathered granite; below that is fractured granite.
- Total Dissolved Solids for the groundwater is roughly 1,000 parts per million (PPM).
- It is speculated that 1,000 to 3,000 acre feet (AF) can be removed from the basin and still achieve good or better groundwater recharge.

A conference call was held with Ray Mactari and Kathy Kunysz from Metropolitan Water District (MWD). The purpose was to discuss any programs that MWD has that will help with project

March 17, 2005

Public Work Shop - 9 Members of the Public Attended

Legend: Q = Question – A = Answer – S = Statement

- Introduction of Presenter - Derek Reed, Dudek and Associates, Inc.
  - AB 303 Grant.
  - $200,000 Grant.
  - $300,000 Total Study Cost.
- Q: Public ask if there is boron water quality data.

  A: Boron not measured.
- S: Public stated septic systems are flooded and not functioning in the basin.
- Q: Did Dudek do water sampling or well tests?

  A: No, this is a paper study.
- Q: What is safe number for nitrate?

  A: 10 PPM is drinking water standard.
- S: Rainbow Water is ± 500 PPM TDS.
- Q: Does Nitrate & Phosphate go up in wet weather?

  A: Yes.
- Q: What is considered a shallow well?

  A: 20 - 40 feet.
- Q: is there enough money left in grant to do drilling?

  A: No, at this point the state grant is for a paper study.
- Q: If water is collected what do you do with it?

  A: It would have to be treated, potential blending.
- S: Public would like to see info on water rights to the basin.

  A: Water rights will be addressed in the report.
- Q: How much would a treatment plant cost?

  A: $600 - $900 per AF over 10-years for potable water.
- Q: Are grants available for future work? How much?

  A: Yes, $250,000.
- Q: Is there a public comment potential

  A: There will be a public review period and one more work shop.
- Q: Is the Rainbow Valley public planning group appropriate?

  A: Yes, but the meeting place may be too small.
- Q: When can we submit grant application?

  A: Derek, requested by board and public to look in to grant deadlines.
- Derek to email power point to Dawn for public to review at their leisure.

RAINBOW
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INFORMATION

BOARD OF DIRECTORS

December 8, 2004

SUBJECT

Rainbow Valley Basin Groundwater Management Plan

DESCRIPTION

In an effort to reduce dependency on imported water the District, with assistance from the State Department of Water Resources, is conducting a preliminary Groundwater Management Plan for the Rainbow Valley Basin. The objectives of the plan are:

- Enhance the management of the Basin
- Improve water quality
- Create a reliable local water supply
- Assist in meeting statewide objectives of CALFED

STATUS

Preliminary data collection has produced the following water balance data for a typical year in the Rainbow Valley Watershed:

• Rainfall	9,485 acre feet
• Water delivered	1,170 acre feet
• Stream flow leaving the basin	1,665 acre feet
• Evaporation	9,000 acre feet
• Increase in groundwater storage	25 acre-feet

Initial professional opinions are that there are1,000 to 3,000 acre feet per year of water recoverable from the basin with the proper extraction wells. A draft Groundwater Management Plan will be completed in March and available for public review.

FISCAL IMPACTS

The total cost to complete the Rainbow Valley Basin Groundwater Management Plan is $300,000. Because the State Department of Water Resources recognizes this as an important project, it is funding 68% ($200,000) of the cost.

Greg L. Ensminger
General Manager

RAINBOW
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INFORMATION

BOARD OF DIRECTORS

February 2, 2005

SUBJECT

Rainbow Valley Basin Groundwater Management Plan – Information status report number 2.

DESCRIPTION

In an effort to reduce dependency on imported water the District, with assistance from the State Department of Water Resources, is preparing a preliminary Groundwater Management Plan for the Rainbow Valley Basin. The goals of the Plan as stated in the grant application are as follows:

- Provide a safe, reliable local water supply
- Reduce dependence on imported water
- Lower the groundwater table
- Improve water quality
- Educate the agricultural and residential communities

An Advisory Group will be formed. The stated intent of the Advisory Group is to work collaboratively to:

- enhance the management of the basin
- improve water quality
- create a reliable local water supply
- assist in meeting the statewide objectives of CALFED

STATUS

As an informational item to the Board of Directors, a brief verbal presentation of the status of the project will be provided by the Hydrogeology Engineering Team.

FISCAL IMPACTS

The total cost to complete the Rainbow Valley Basin Groundwater Management Plan is $300,000. Because the State Department of Water Resources recognizes this as an important project, it is funding 68% ($200,000) of the cost.

Greg L. Ensminger
General Manager

Editions of the North County Times Serving San Diego and Riverside Counties

Tuesday, March 22, 2005 Contact Us

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Tuesday, March 22, 2005

Last modified Saturday, March 19, 2005 11:29 PM PST

Rainbow looks at whether it could tap groundwater

By: LORELL FLEMING - Staff Writer

FALLBROOK ---- It started out as something of a pipe dream: the idea of tapping into water collected in the Rainbow Valley Basin as a safe, reliable and locally controlled source of water.

Now, the Rainbow Municipal Water District may be inching closer to making that dream a reality and reducing the district's dependency on imported water, which makes up 100 percent of the current supply.

Armed with a $200,000 state grant and $100,000 of its own money, the district has studied rainfall totals and other data in the basin and is starting to develop a groundwater-management plan.

The initial study showed the district could extract between 1,000 and 3,000 acre-feet of water from the basin each year ---- enough to address the needs of the nearly 2,000 Rainbow district customers, said engineer Chris Trees.

Trees works for Encinitas-based Dudek & Associates, an engineering firm that contracts regularly with the district and was hired to complete the basin study. About $90,000 of the grant money has been spent so far, Trees said.

Dudek staffers are expected to finish the first draft of the groundwater plan in early April, according to Derek Reed, the Dudek engineer overseeing the project. Once the draft is complete, there will be a 30-day period for public review, as well as public workshops to discuss the plan. The district held a workshop Thursday to discuss initial findings of the study.

The Rainbow district uses about 30,000 acre-feet of water to meet the needs of its 7,100 customers in the rural pockets of North San Diego County: Fallbrook, Bonsall, Rainbow and parts of Vista.

An acre-foot is a measurement of water that is equivalent to about 326,000 gallons, about the amount of water that two families with four members would use in a year.

The next step would be to apply for another grant to do a field study, an analysis of samples from the basin's soil and groundwater, according to Reed.

Even if it is feasible to draw water from the basin, the project could take years, officials said. Public hearings must be held, environmental impacts must be studied and reports must be compiled.

Reed said it could be five to 10 years before the district draws water from the basin, which is east of Interstate 15 and west of Rainbow Mountain. The basin's southern border is Rainbow Valley Boulevard. Its northern border is where Rainbow Valley Boulevard curves to meet Old Highway 395.

Idea takes root

One of the people who pushed the Rainbow district three years ago to pursue a grant for a groundwater study was the district's former Division 5 director, Paul Christensen, Trees said.

Efforts to reach Christensen about the groundwater study that is under way were unsuccessful Thursday.

But the grant paved the way for what could be the district's first step in cutting some of its dependency on outside water agencies.

And officials such as the district's general manager, Greg Ensminger, said that finding a local source that could provide up to 10 percent of the district's water would be a coup.

"Anytime we can move away from being solely dependent on one source, that's a good thing," Ensminger said.

Water views

Division 4 Director Russ Hatfield said he is reserving judgment on the idea until he sees whether getting water from the aquifer beneath the basin, treating it, and providing it to customers would be a financial asset or liability for the district.

"What do you do after you get the water out of there?" Hatfield said. "Do you build a treatment facility to treat the water? Where is the money coming from? It could be a huge capital venture. We're using a lot of our money on infrastructure (improvements, repairs and maintenance)."

Rainbow water board President Bill Bopf, Division 3 director, said he would like to move forward with the groundwater study to get those questions answered.

"We should go through with the next phase. Get a grant, do the field study and see if this is possible," Bopf said in an interview last week. "It would be good to reduce our dependency on imported water."

Rua Petty, a Rainbow resident and vice president of his community's planning group, said that using the basin to serve Rainbow customers is an idea that might be worth exploring further.

"It might be worthwhile if it's economically viable and the science works out," Petty said during a public workshop Thursday about the groundwater study. He also said he would like to see it determined who legally has rights to the groundwater.

"It's a huge, kind of unknown, variable," Petty added.

Division 2 Director Jack Griffiths said he agrees that water rights need to be determined.

"That reinforces my fear of putting more money into this without having the legalities settled," Griffiths said during the workshop.

Water flows

All of the water that comes to the Rainbow district is imported. Rainbow gets its supply from the San Diego County Water District, which gets its supply from the Metropolitan Water District. The Colorado River and the state water project in Northern California are the sources of the Metropolitan district, which gets about 4.4 million acre-feet of water annually to distribute to local water districts and agencies, according to Metropolitan spokesman Bob Muir.

Once coming from Metropolitan's sources, the water for Rainbow goes to Lake Skinner near Temecula for treatment, then to the county water authority.

Muir said Metropolitan's board supports local districts' efforts to diversify water sources.

"That increases the pool of water available for Southern California," Muir added.

Contact staff writer Lorell Fleming at (760) 731-5798 or lfleming@nctimes.com.

Rainbow Valley Groundwater Management Plan Workshop

Back to Calendar

Date: 3/17/2005
Time: 3:00-5:00 p.m.
Location: District Offices

Project Description

Development of a Groundwater Management Plan to implement projects and programs to further enhance the Basin and better serve the community

The Plan will reflect the collaborative effort of stakeholders, community groups and regulatory agencies through a Basin Advisory Group

The Group will work collaboratively to:

- enhance the management of the basin
- improve water quality
- create a reliable local water supply
- assist in meeting the statewide objectives of CALFED

Goals

- Provide a safe, reliable local water supply
- Reduce dependence on imported water
- Lower the groundwater table
- Improve water quality
- Educate the agricultural and residential communities

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P. O. Box 2500 Fallbrook, CA 92088-2500
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DUDEK & ASSOCIATES, INC.
Professional Teams for Complex Projects

PROJECT: RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

Preliminary Stakeholder Meeting

DATE: DECEMBER 7, 2004

LOCATION CODE:

DUDEK & ASSOCIATES PROJECT NO.:

SIGN-IN SHEET

Name	Organization	Telephone	Fax	E-mail	Cell Phone or Pager
Paul Gebert	SDCWA	[redacted]		[redacted]	
Derek Reed	Dudek	[redacted]		[redacted]	
STEVE JEPSEN	DUDEK	[redacted]	[redacted]	[redacted]	
Jay Jones	— " —	[redacted]		[redacted]	
PETER QUINLAN	"	[redacted]	[redacted]	[redacted]	
Gene Buckley	RMWD	[redacted]		[redacted]	
Joe DeSTEFANO	County of San Diego	[redacted]	[redacted]	[redacted]	
CHRIS TREES	DUDEK / RMWD	[redacted]	[redacted]	[redacted]	

DUDEK & ASSOCIATES, INC.
Professional Teams for Complex Projects

PROJECT: RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

Public Outreach
Preliminary ~~Stakeholder~~ Meeting

DATE: FEBRUARY 15, 2005 ~~DECEMBER 2, 2004~~

LOCATION CODE:

DUDEK & ASSOCIATES PROJECT NO.:

SIGN-IN SHEET

Name	Organization	Telephone	Fax	E-mail	Cell Phone or Pager
STEVE JEPSEN	DUDEK / RAINBOW	[redacted]	[redacted]	[redacted]	
GREG ENSMINGER	RMWD	[redacted]	[redacted]	[redacted]	
Jesse Westrup	Hines Horticulture - FALLBROOK	[redacted]	[redacted]	[redacted]	
Mike Gutierrez	HINES FB	[redacted]	[redacted]	[redacted]	
Judy Mitchell	mission RCD	[redacted]	[redacted]	[redacted]	
PETER QUINLAN	DUDEK	[redacted]	[redacted]	[redacted]	
Derek Reed	Dudek	[redacted]	[redacted]	[redacted]	
Nicole Peacock	Dudek	[redacted]	[redacted]	[redacted]	

DUDEK
& ASSOCIATES, INC.
Professional Teams for Complex Projects

PROJECT: RAINBOW VALLEY BASIN GROUNDWATER MANAGEMENT PLAN

DATE: FEBRUARY 15, 2005 ~~DECEMBER 2, 2004~~

Public Outreach
Preliminary ~~Stakeholder~~ Meeting

LOCATION CODE:

DUDEK & ASSOCIATES PROJECT NO.:

SIGN-IN SHEET

Name	Organization	Telephone	Fax	Email	Street Address or Postal Box
[illegible]	RAINBOW WATER DIST	[redacted]	[redacted]	[redacted]	[redacted]

PUBLIC NOTICE
for the
RAINBOW MUNICIPAL WATER DISTRICT
GROUNDWATER MANAGEMENT PLAN

Notice is hereby given that a Draft Groundwater Management Plan (GMP) has been issued for public review and comment by the Rainbow Municipal Water District (District) on April 25, 2005. The GMP is for Rainbow Valley Basin (Basin), located within the community of Rainbow. The GMP has been prepared in accordance with Assembly Bill 3030.

The GMP has been prepared in order to address three main issues related to groundwater in Rainbow Valley Basin; the use of only imported water, the high water table, and poor water quality. The objectives of the GMP are to provide a safe, reliable local water supply, reduce dependence on imported water, lower the groundwater table within Rainbow Valley, improve water quality, and educate the agricultural and residential communities regarding reducing discharges to the surface and groundwater.

The GMP and its companion document, Potential Projects in Rainbow Valley Basin, evaluate previously-collected data in order to estimate the state of the Basin and evaluate the potential for groundwater production projects within the Basin. The Biological Constraints Report, also a companion document to the GMP, presents potential constraints associated with groundwater production projects. The GMP also presents potential monitoring activities that may be used to further evaluate the Basin and potential groundwater production projects.

Copies of the Draft GMP, Potential Projects in Rainbow Valley Basin, and the Biological Constraints Report are on file at the District office at 3707 Old Highway 395, Fallbrook, CA 92028. Electronic copies of the Draft GMP are also available on the District's website at http://www.rainbowmwd.com/news.asp. A public workshop to discuss the Draft GMP will be held on Thursday, May 5, 2005 from 1:00 to 4:00 at the District office. The workshop will provide you with an opportunity to learn more about the GMP and to comment on the GMP. All written comments regarding the Draft GMP should be forwarded to Greg Ensminger, General Manager, Rainbow Municipal Water District at 3707 Old Highway 395, Fallbrook, CA 92028, or emailed to gensminger@rainbowmwd.com. All comments must be received by Monday, May 9, 2005 at 5:00 p.m.

RAINBOW
MUNICIPAL WATER DISTRICT
Committed to Excellence

NEWSLETTER

3707 Old Highway 395, Fallbrook CA 92028 | Issue No. 6 | February, 2005

LOOKING FOR WATER IN NEW PLACES

In last month's newsletter we read about where the water Rainbow customers use comes from, it is all imported. We also read about the residential and agricultural rate increases, two pass-through charges going directly to the water importers Metropolitan Water District (MWD) and San Diego County Water Authority (SDCWA). To help reduce our dependency on imported water, Rainbow Municipal Water District (RMWD) with assistance from the State Department of Water Resources, is preparing a preliminary Groundwater Management Plan for the Rainbow Valley Basin. The Rainbow Valley Basin has very high groundwater and may be a good location for a well system. The goals of the Plan as stated in the grant application are as follows:

- *Provide a safe, reliable local water supply*
- *Reduce dependence on imported water*
- *Lower the groundwater table*
- *Improve water quality*
- *Educate the agricultural and residential communities*

An Advisory Group will be formed and a public meeting will be held giving citizens an opportunity to provide input. The next newsletter will indicate the time and place of the public meeting. The stated intent of the Advisory Group is to work collaboratively to:

- *enhance the management of the basin*
- *improve water quality*
- *create a reliable local water supply*
- *assist in meeting the statewide objectives of CALFED*

Preliminary data collection has produced the following water balance data for a typical year in the Rainbow Valley Watershed:

- *Rainfall - 9,485 acre feet*
- *Water delivered by RMWD - 1,178 acre feet*
- *Stream flow leaving the basin - 1,665 acre feet*
- *Evaporation - 9,000 acre feet*

Initial professional opinions are that there are 1,000 to 3,000 acre feet per year of water recoverable from the basin with the proper extraction wells. A draft Groundwater Management Plan will be completed in March/April and available for public review. The cost to complete the Rainbow Valley Basin Groundwater Management Plan is $300,000; however, due to the fact the State Department of Water Resources recognizes this as an important project, it is funding 68% ($200,000) of the cost.

A REQUEST FOR WATER CONSERVATION

Starting February 27, 2005 and continuing through March 8, 2005, the San Diego County Water Authority will shutdown one of their aqueduct lines that serves RMWD to perform maintenance. This will reduce RMWD's allotment of water by approximately 80% for this 10 day period. You may notice a slight decrease in water pressure during this period of time. As long as weather conditions are cool, RMWD has enough storage water to handle the outage during this short period of time. We are asking all of our customers to assist us by conserving water during this period of time. If you have any questions please call the Operations Department (760) 728-1178 x143. We apologize for any inconvenience this may cause and appreciate your best efforts to conserve water during this period of time.

RAINBOW MUNICIPAL WATER DISTRICT

307 Old Highway 395
Fallbrook, CA 92029
760-728-1178
www.rainbowmwd.com

2005
BOARD OF DIRECTORS

Lawrence J. Sundram
Division 1
(760) 940-6362

Jack Griffiths
Division 2
(760) 940-8935

William "Bill" Bopf
Division 3
(760) 728-9019

(Vacant)
Division 4

Robert "Bob" Glick
Division 5
(760) 728-9343

STAFF

General Manager
Greg Ensminger

Administrative Manager
Joyce E. Tomlinson

Operations Manager
Chuck Sneed

Finance Manager
Gene Buckley

Human Resources
René Bush

District Engineer
Dudek & Associates
Chris Trees

BOARD PACKET DISTRIBUTION

In accordance with Board direction, the following procedure has been implemented for distribution of the Board meeting Agenda Packets.

A hard copy original of the packet will be delivered to ABS Copy Center located at 5521 Mission Road, Suite A, Bonsall, CA 92003 where copies will be made at the rate of $.04 per image/page to the District for distribution to all Directors, Management, as well as two ratepayers from each Division. It is Staff's intention to have the original to ABS no later than the Tuesday morning one week before to the meeting and have the copies at the District available for pick up by the ratepayers first thing the following Wednesday morning. Ratepayers will be able to contact the District front office in the late afternoon of said Tuesday to confirm the packets are ready for pick up the next morning. If for any reason due to unforeseen circumstances the packets are not available Wednesday the week before the meeting, Staff will provide an alternate time for ratepayer pick up.

As decided, there will be two packets available for each Division on a first-come-first-serve basis. There will be a sign-out book at the front counter; however, anyone picking up a package will need to have their Division verified by the front office staff. This will ensure fair distribution of the ten free copies. On the Friday before the actual Board meeting, any leftover copies of the packet will be available for anyone to pick up.

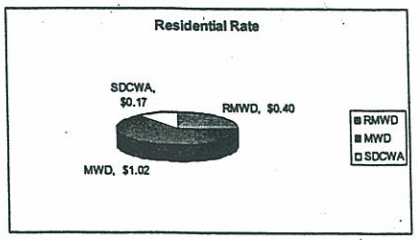
In the case of a ratepayer who regularly receives the packet on the monthly basis becoming indisposed, that ratepayer may contact the General Manager or Board Secretary to schedule an alternate means of delivery.

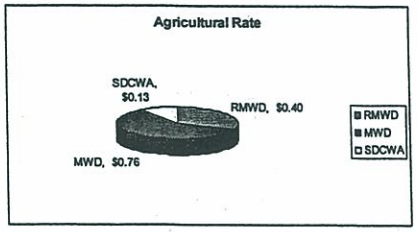
Should all ten free copies for the ratepayers be distributed and another would like to have a hard copy for his/her review, ABS Copy Center will store the information for thirty days and will print a hard copy at the rate of $.07 per image/page upon request. Any person desiring to have a copy mailed to them can contact ABS directly at 760-940-0138 and pay up front by credit card for the cost of the copies, postage and envelopes to receive this service. An alternative would be to purchase a copy at the District; however, the charge would be at $.10 per page for up to 99 pages and $.14 per page for any packet over 100 pages.

As has been the procedure over the past several months, the Agenda Packet will be available for review at www.rainbowmwd.com (please note this may be in two parts due to size).

This distribution procedure may be reviewed and modified as deemed necessary.

RATES





CURRENT INFRASTRUCTURE PROJECTS AS OF JANUARY 31, 2005

Project Desc.	LS #2 Replace.	LS #1 Replace.	Rice Canyon Rd Water Pipeline Replace.	Rainbow Glen Water Pipeline Replace.	Moosa Canyon Water Pipeline Replace.	Daisy Lane Water Pipeline Replace.	Reineman and Miller Line Replace.	Reservoir Chlorine Conversion
Job #	200336	200335	200441	200440	200442	200448	200438	200432
Budget	$832,000	$832,000	$5,193,000	$533,000	$5,719,000	$179,000	$420,000	$1,210,000
Actual Expense	$57,156	$29,919	$205,928	$92,486	$104,337	$88,051	$47,217	$918,846
% of Actual to Budget	6.9%	3.6%	4.0%	17.4%	1.8%	49.2%	11.2%	75.9%
% of Project Completed	5%	5%	5%	15%	2%	60%	10%	80%
Division	1	2	5	5	1	4	4	2,4,5
Area Served	All	All	Rainbow	Rainbow Glen	Camino Del Rey	Pala Mesa	Pala Mesa	All

Click here to go back.

Category: announcements

Description: PUBLIC NOTICE for the RAINBOW MUNICIPAL WATER DISTRICT GROUNDWATER MANAGEMENT PLAN Notice is hereby given that a Draft Groundwater Management Plan (GMP) has been issued for public review and comment by the Rainbow Municipal Water District (District) on April 25, 2005. The GMP is for Rainbow Valley Basin (Basin), located within the community of Rainbow. The GMP has been prepared in accordance with Assembly Bill 3030. The GMP has been prepared in order to address three main issues related to groundwater in Rainbow Valley Basin; the use of only imported water, the high water table, and poor water quality. The objectives of the GMP are to provide a safe, reliable local water supply, reduce dependence on imported water, lower the groundwater table within Rainbow Valley, improve water quality, and educate the agricultural and residential communities regarding reducing discharges to the surface and groundwater. The GMP and its companion document, Potential Projects in Rainbow Valley Basin, evaluate previously-collected data in order to estimate the state of the Basin and evaluate the potential for groundwater production projects within the Basin. The Biological Constraints Report, also a companion document to the GMP, presents potential constraints associated with groundwater production projects. The GMP also presents potential monitoring activities that may be used to further evaluate the Basin and potential groundwater production projects. Copies of the Draft GMP, Potential Projects in Rainbow Valley Basin, and the Biological Constraints Report are on file at the District office at 3707 Old Highway 395, Fallbrook, CA 92028. Electronic copies of the Draft GMP are also available on the District's website at http://www.rainbowmwd.com/news.asp. A public workshop to discuss the Draft GMP will be held on Thursday, May 5, 2005 from 1:00 to 4:00 at the District office. The workshop will provide you with an opportunity to learn more about the GMP and to comment on the GMP. All written comments regarding the Draft GMP should be forwarded to Greg Ensminger, General Manager, Rainbow Municipal Water District at 3707 Old Highway 395, Fallbrook, CA 92028, or emailed to gensminger@rainbowmwd.com. All comments must be received by Monday, May 9, 2005 at 5:00 p.m. NCT 1787852 April 24,2005
Location: CA
Date: 4/24/2005
Source: North County Times

Nicole, Here is a copy of the ~~for~~ ad as it will appear in the paper. The size is 2 x 7.5 the total cost will be $[redacted]. Thank You Kay

[redacted]

Village News

PUBLIC NOTICE
RAINBOW MUNICIPAL WATER DISTRICT
GROUNDWATER MANAGEMENT PLAN

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LEGAL 0674
PUBLISHED APRIL 28, 2005

FALLBROOK COMMUNITY PLANNING GROUP

Special Meeting
Monday, 2 May 2005, 7:00 P.M., Live Oak School, 1978 Reche Road, Fallbrook

AGENDA

1. Open Forum. Opportunity for members of the public to speak to the Planning Group on any subject matter within The Group's jurisdiction but not on today's agenda. Three minute limitation. Non-discussion, & Non-voting item.

2. Workshop on the Fallbrook Community Plan vis-à-vis the 2020 plan concerning the properties located in the north east corner of I-15 and SR-76 (Pala Road). County planners Ivan Holler and Neal LaMontagne 858-694-3722 will make a presentation on a proposal for this part of the Fallbrook Community Plan in the 2020 plan. Community input. Voting item.

NOTE: The Planning Group occasionally has openings on its Land Use (Jack Wood 731-3193), Circulation (Harry Christiansen 728-3725), Parks & Recreation (Carolyn Major 723-9519), Public Facilities (John Crouch 723-7305) and Design Review (Eileen Delaney 728-0900) Committees for non-elected citizens. Interested persons please contact the Chairman. This is a preliminary agenda. If any changes are made, a final agenda will be posted at the North County Fire District, 315 E. Ivy Street, Fallbrook, at least 72 hours prior to the meeting.

Jim Russell, Chairman, 205 Calle Linda, Fallbrook, California 92028, (760) 728-8081 Russellfarms@tfb.com

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NEWS

Draft Groundwater Management Plan (4/25/05)

A Draft Groundwater Management Plan (GMP) has been issued for public review and comment by the Rainbow Municipal Water District (District) on April 25, 2005. Copies of the Draft GMP, Potential Projects in Rainbow Valley Basin, and the Biological Constraints Report are on file at the District office at 3707 Old Highway 395, Fallbrook, CA 92028. A public workshop to discuss the Draft GMP will be held on Thursday, May 5, 2005 from 1:00 to 4:00 at the District office. All written comments regarding the Draft GMP should be forwarded to Greg Ensminger, General Manager, Rainbow Municipal Water District at 3707 Old Highway 395, Fallbrook, CA 92028, or emailed to gensminger@rainbowmwd.com. All comments must be received by Monday, May 9, 2005 at 5:00 p.m.

Click Here

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P. O. Box 2500 Fallbrook, CA 92088-2500
Phone : 760-728-1178

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5 MAY 2005 SIGN-IN SHEET

Public Hearing Rainbow Valley Groundwater Mgmt

NAME	AFFILIATION	PHONE	E-MAIL
NOAH WALKER	DUDEK	[redacted]	[redacted]
Nicole Peacock	Dudek	[redacted]	[redacted]
JACK GRIFFITHS	RMWD	[redacted]	—
HELENE BRAZIER	RAINBOW RATEPAYER	[redacted]	[redacted]
SHEILA WALSON	BARE	[redacted]	
[illegible]	[illegible]	[redacted]	
PETER QUINLAN	DUDEK	[redacted]	

Nicole Peacock

From: Dawn Washburn [dwashburn@rainbowmwd.com]
Sent: Tuesday, May 10, 2005 4:59 PM
To: Nicole Peacock
Subject: RE: GMP

Nicole –

I confirmed that nobody had made any comments nor did anybody come in to review the GMP.

Thanks,

Dawn