The Residential Runoff Reduction Study

Municipal Water District
of Orange County

Irvine Ranch Water District

July 2004

Study Participants

A & N Technical Services

CalFed Bay-Delta Progam

California Department of Pesticide Regulation

California Environmental Protection Agency

California Regional Water Quality Control Board

HydroPoint Data Systems, Inc.

Irvine Ranch Water District

Metropolitan Water District of Southern California

Montgomery Watson Labs

Municipal Water District of Orange County

National Water Research Institute

County of Orange

Southern California Coastal Water Research Project

State Water Resources Control Board

United States Department of the Interior Bureau of Reclamation

Contents

Appendices

Tables, Figures & Exhibits

Executive Summary

Study Background and Rationale

In 2001, the Irvine Ranch Water District (IRWD), the Municipal Water District of Orange County (MWDOC), and the Metropolitan Water District of Southern California (MWD) completed a small-scale study of weather-based evapotranspiration (ET) irrigation controllers. This study, known as the "Westpark Study," tested the effectiveness of ET controller technology in residential applications. After 40 such controllers were installed in the Westpark neighborhood of Irvine, California, water demand and runoff in the study area were measured. The resulting average water savings for this study were 37 gallons per day, or 7 percent of total household water use and 18 percent of irrigation water use.

Based upon the findings of the Westpark Study, IRWD and MWDOC partnered on new research, the Residential Runoff Reduction (R3) Study, in which the number of sites studied was increased, a baseline area where no changes were made was included, and an "education only" area where printed educational materials were distributed was also included. This made the R3 Study one of the first studies to attempt to quantify the effectiveness of public education alone versus a technology-based plus education approach to reducing residential irrigation water usage. Figure ES-1 presents the study participants and their respective roles within the R3 Study.

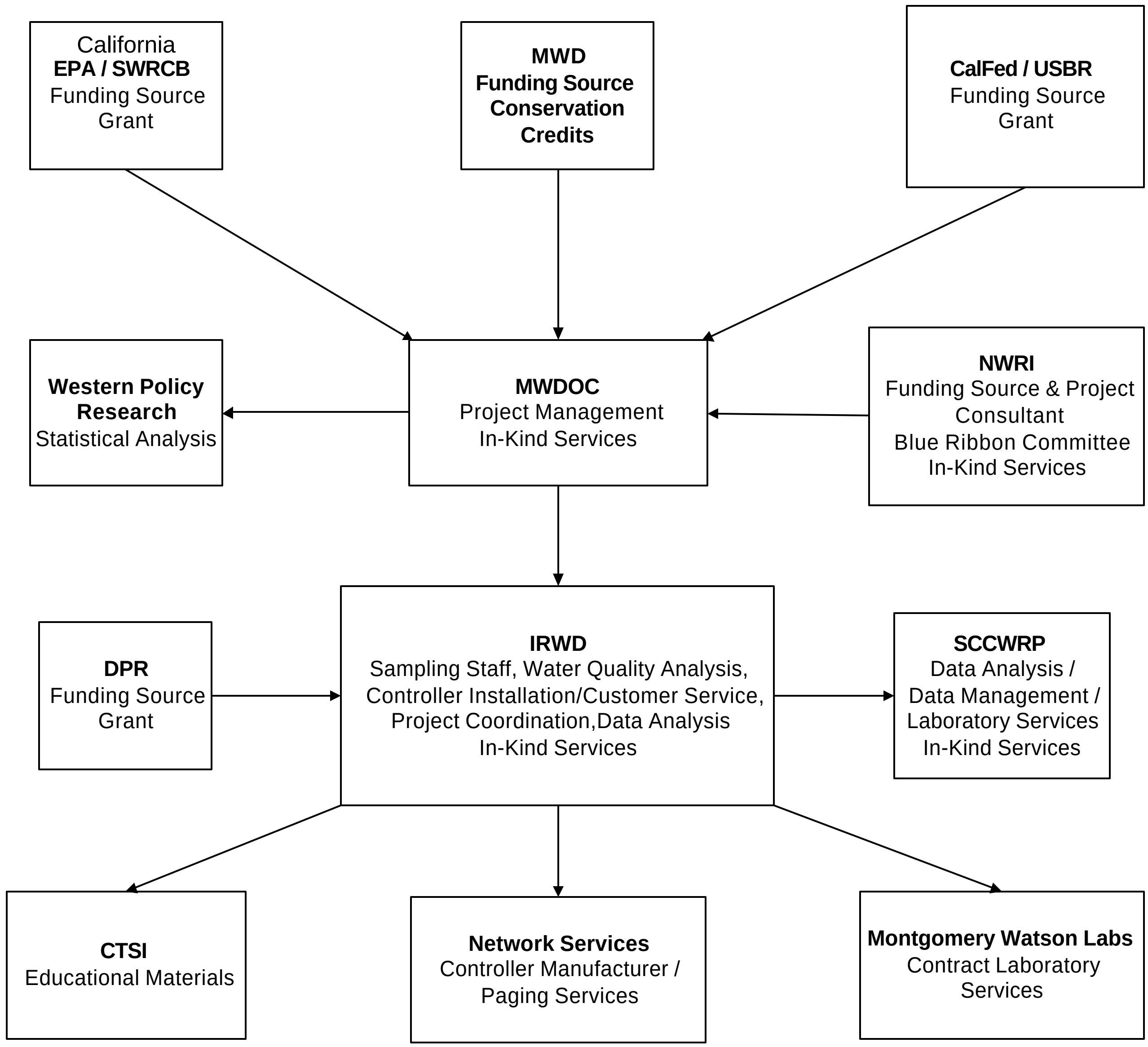
The R3 Study had four primary purposes:

1) To test the use of weather-based irrigation technology, also known as ET controllers, to manage irrigation water for residential homes and large landscape areas;
2) To evaluate the effectiveness of a targeted education program on residential homeowners;
3) To determine the correlation between proper water application in landscape irrigation and the quantity and quality of urban dry-season runoff; and
4) To gauge the acceptance of water management via the controller technology.

Study Methodology

The R3 Study area included five similar neighborhoods (Sites 1001 through 1005) in Irvine, California, each with its own single point of discharge into the urban storm drain system. The five sites are shown on Figure ES-2. At these points of discharge from each study area, the runoff volume was monitored and water quality samples were taken. The five sites were divided into three separate areas. The first area, Site 1001 (retrofit group), used ET controller technology and public education. The second area, Site 1005 (education group), received educational materials, but did not receive controllers. The third area (control group) consisted of three separate neighborhoods (Sites 1002, 1003, and 1004), which received neither ET controllers nor educational materials.

Figure ES -1
R3 Study Participants



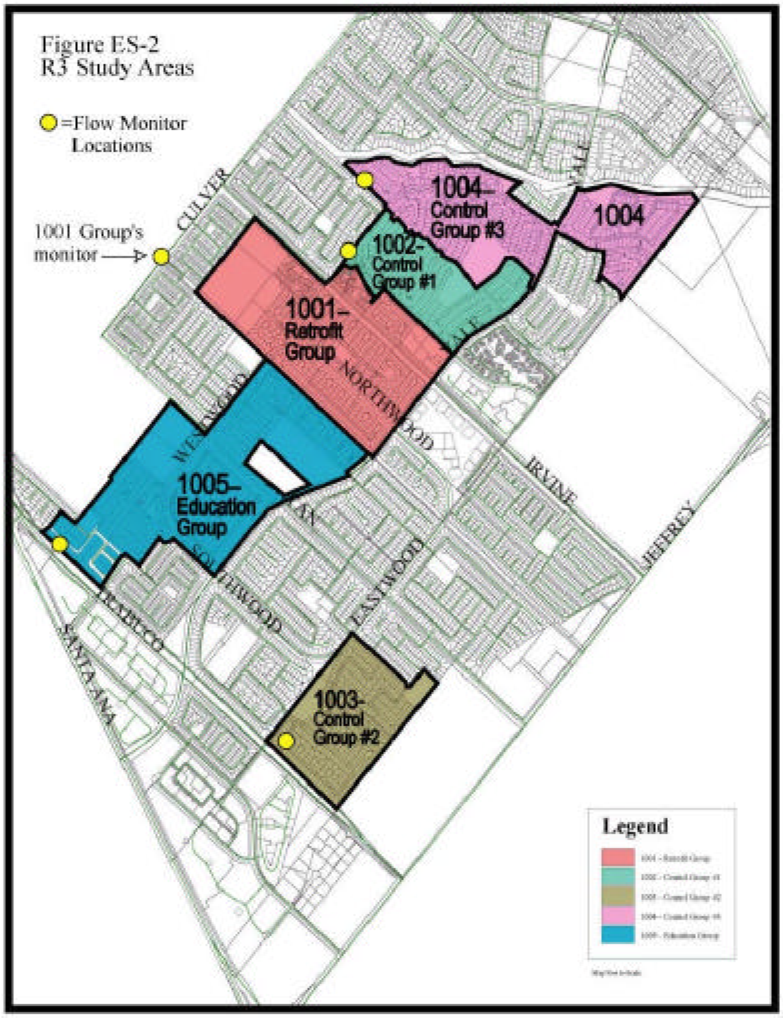


Figure ES-2
R3 Study Areas

Evaluation Results

After the initial 18-month study period was completed, the data was compiled and evaluated for water conservation savings, dry season runoff changes, and changes in the quality of the dry season runoff water. The following summarizes the results:

a) Water Conservation Savings
Water conservation savings from the typical participant in the retrofit group were 41 gpd, or approximately 10 percent of total household water use. The bulk of the savings occurred in the summer and fall (Figure ES-3. Residential Water Savings: Technology + Education). The education group residential customers saved 26 gpd, or about 6 percent of total water use. The savings from this group were more uniform throughout the year (Figure ES-4, Residential Water Savings, Education Only). The retrofit group also included 15 dedicated landscape accounts (ranging in size from 0.14 acres to 1.92 acres), which showed average water savings of 545 gpd. The net result was eight times more water savings than with the single-family residential controller, strongly indicating that the larger the landscape, the better the savings per controller.

Figure ES -3
Residential Water Savings: Technology + Education

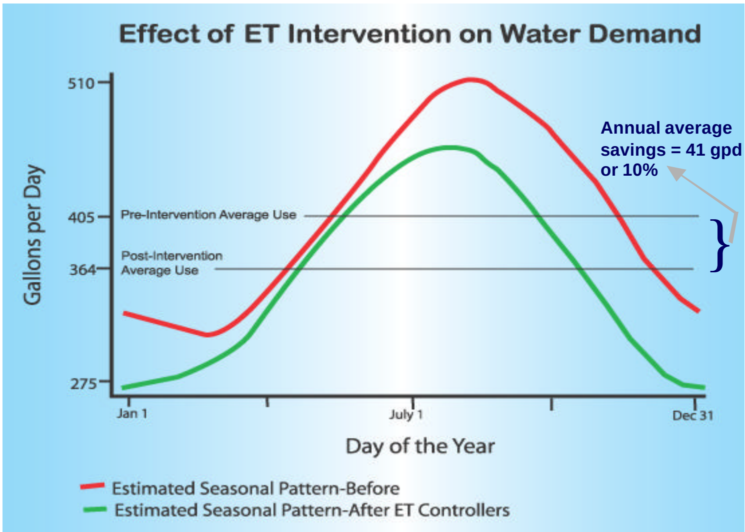


Figure ES -4
Residential Water Savings: Education Only

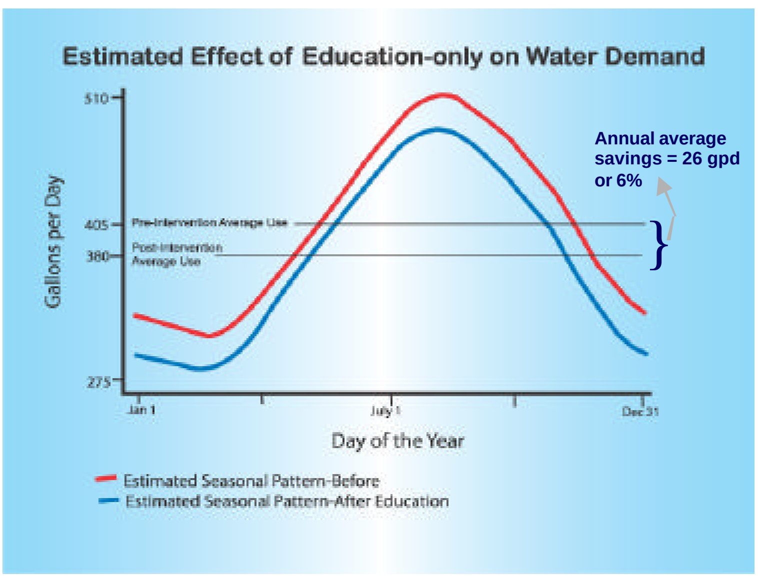


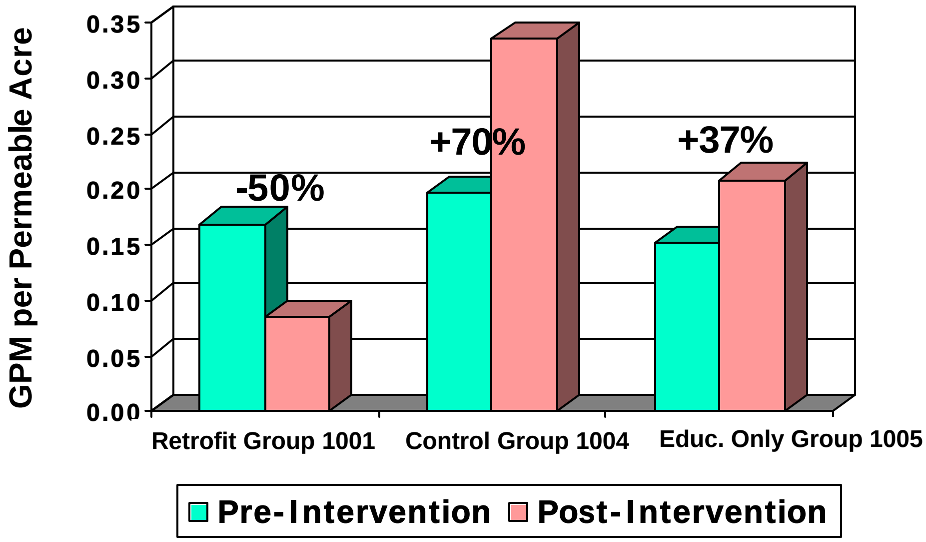
Figure ES -5
Changes in Runoff Within Each Site

b) Dry Season Runoff Changes

The retrofit group experienced a 50 percent direct reduction in water runoff (pre-intervention runoff compared to post-intervention runoff) during dry season periods. When the retrofit group is compared to the control group, the dry season runoff shows a statistical reduction of approximately 71 percent. In contrast, a comparison of direct pre-intervention and post-intervention runoff from the education group increased 37 percent, while runoff increased 70 percent within the control group. Other than the presence of an

ET controller, the primary difference between these groups is the participation of the 15 landscape accounts in the retrofit group. These accounts irrigated approximately 12 acres of landscape versus between 4 to 5 acres of total irrigated area for the 112 residential homes. Figure ES-5 presents R3 Study changes in runoff within sites.

Figure ES -5
Changes is Runoff Within Each Site



Note: It is also possible to compare post-intervention runoff *between* the study sites. These comparisons suggest a higher reduction in runoff for Site 1001 (between 64 and 71 percent) than was observed for the "within site" pre and post comparison, and a <u>reduction</u> in runoff of 21 percent for Site 1005. However, as described more fully in the text, these comparisons are less reliable than the "within site" pre and post comparisons shown here.

c) Changes in Runoff Water Quality
The study gathered a great deal of information on the water quality constituents present in urban runoff. In almost all cases, the data showed no changes in the concentration of these constituents in the runoff. The most significant fact to come out of the urban runoff water quality data is that the decrease in runoff volume from the retrofit group did not appear to result in an increase in the concentration of pollutants in the runoff. Thus, it is probable that a reduction in total pollutant migration could be achieved by reducing total dry season urban runoff.

d) Public Acceptance of Water Management
While there were some customer service-related issues, the retrofit group had a generally positive response to the ET controller, with 72 percent of participants indicating that they liked the controllers. The retrofit group also found that the controller irrigation either maintained or improved the appearance of the landscape. This has very positive implications. The water district customers receive a desired benefit of a healthy landscape, and the community receives several important environmental benefits from

the conservation of valuable and limited water resources and the reduction in dry season urban runoff.

Findings, Conclusions, and Recommendations

The R3 Study showed that weather-based irrigation controllers, which provide proper landscape water management, resulted in water savings of 41 gpd in typical residential settings and 545 gpd for larger dedicated landscape irrigation accounts. The observed reduction in runoff from the retrofit test area was 50 percent when comparing pre-intervention and post-intervention periods and 71 percent in comparison to the control group. The education group saw reductions in water use of 28 gpd, and a reduction in runoff of 21 percent in comparison to the control group. Water quality parameters in both study areas were highly variable, and very few differences in the level of monitored constituents were detected. In terms of water savings per controller (and cost-effectiveness), the study clearly indicated that larger landscape areas (parks and street medians) should provide the initial targets for the expansion of similar programs.

Chapter 1: Introduction

1.1 Overview

Weather-based evapotranspiration (ET) irrigation control has long been a tool of large agricultural operations, maximizing crop yields through pinpoint management of crop watering. The Residential Runoff Reduction (R3) Study was conducted to evaluate the applicability of ET technology for other uses. This chapter of the study report presents the following:

- Background information on study rationale;
- Specific study goals and objectives;
- Identification of study partners and their roles/contributions to the study.

The organization of this report is also described, and commonly-used abbreviations and acronyms are listed. References used during the study are presented in Appendix A.

1.2 Background

Approximately 58 percent of residential water demand is used for outdoor purposes, primarily for home landscape irrigation (AWWARF Residential End Uses of Water, 1999). Excess irrigation results in inefficient use of valuable water supplies and increased runoff that is the transport mechanism of pollutants that enter natural waterways and, ultimately, the Pacific Ocean for areas along the west coast.

Landscape water use efficiency/water conservation and watershed management in the urban sector are linked. Water agencies throughout the state are implementing 14 Best Management Practices (BMPs) to increase the efficient use of urban water supplies including landscape irrigation efficiency. Cities and counties are also implementing National Pollutant Discharge Elimination System (NPDES) permit requirements containing BMPs for watershed management focused on runoff reduction.

Recent studies in Orange County have had promising results. In 1998-1999, Irvine Ranch Water District (IRWD), Municipal Water District of Orange County (MWDOC), and the Metropolitan Water District of Southern California (MWD) conducted a study that evaluated the use of weather-based ET irrigation control technology at 40 residential homes in the Westpark area of Irvine. The report from this research, entitled “Residential Weather-Based Irrigation Scheduling: Evidence from the Irvine ‘ET Controller’ Study,” showed water savings that translated to 37 gallons per day (gpd), or 7 percent of total household water use/16 percent of irrigation water use.

In April 2001, water savings from the ET Controller study in Westpark were evaluated through September 2000, or the second post-retrofit year. This evaluation confirmed the persistence of water savings observed during the initial evaluation. More specifically, this evaluation concluded that ET Controllers were able to reduce total household water consumption by roughly 41 gallons per household per day, representing an 8 percent reduction in total household use, or an 18 percent reduction in estimated landscape water use.

The R3 Study represents the next phase of research associated with the new irrigation control technology linking benefits to watershed management.

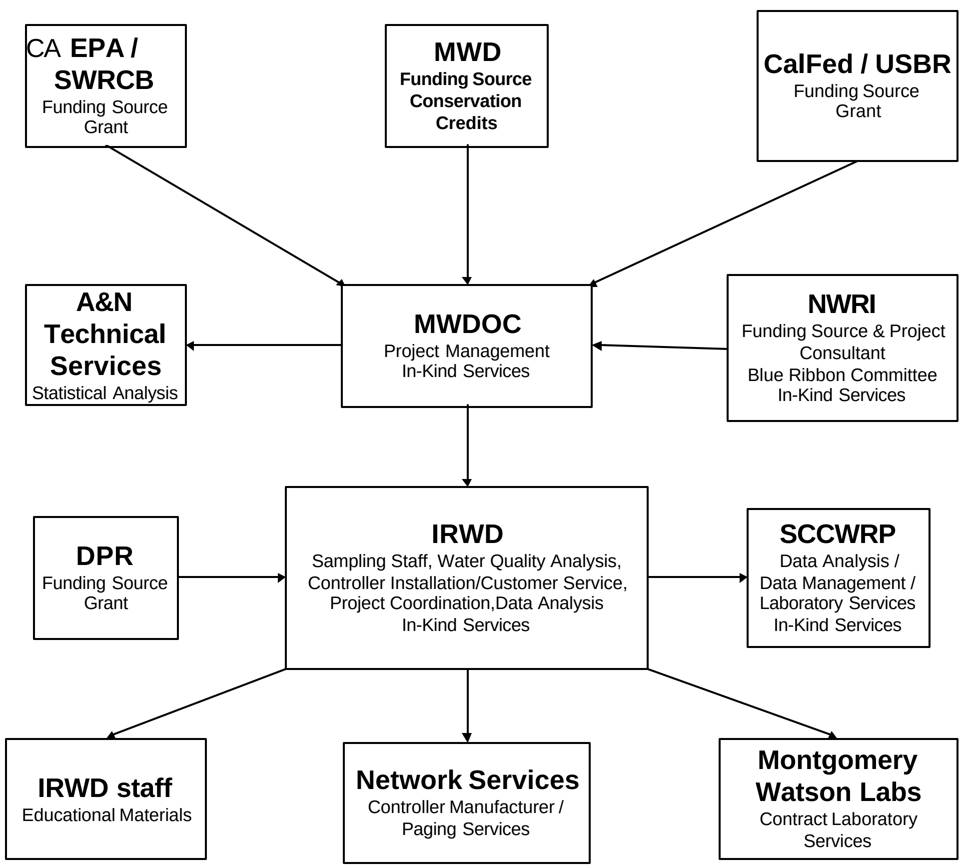
1.3 Study Goal and Objectives

The goal of the R3 Study was to quantify ET Controller savings for single-family residences and large landscape users. The study had four primary purposes: 1) to develop and expand the application and use of pager-signal (electronic controller) technology to manage irrigation water for residential homes and large landscape areas; 2) to evaluate the effectiveness of a targeted education program; 3) to determine the connection between proper water use in the landscape and the quantity and quality of dry weather runoff; and 4) to gauge the acceptance of water management via the controller technology.

1.4 Study Partners

The R3 Study was made possible through a partnership of agencies and organizations committed to improved water use efficiency and watershed management. The members of the partnership are shown on Figure 1-1. The figure also indicates the roles played by each study partner.

Figure 1-1
R3 Study Partners



As shown on Figure 1-1, the R3 Study involved a diverse mix of study participants and funding agencies bringing equally diverse interests and visions to the project. In general, the study was based on the premise that runoff from poor irrigation practices from urban areas in the San Diego Creek watershed constitutes non-point source pollution and contributes to water quality problems both in the Creek and in Newport Bay, the receiving water for the Creek. Although water quality problems in the Creek and Bay have been well documented, data on the specific sources of these pollutants is limited.

The R3 Study was intended to focus on and analyze both the quality and quantity of runoff from relatively small sub-areas of the watershed to provide insight into the sources of pollution in the Creek and Bay. In addition to providing this baseline information, the study was intended to evaluate the effectiveness of two methods of reducing runoff and improving water quality: 1) education; and 2) education combined with ET controller technology. Furthermore, since irrigation runoff is 100 percent water waste, the water agency participants were very interested in the ability of the study intervention methods to reduce customer water usage.

The R3 Study presented a good opportunity to develop valuable information about the relative effectiveness of structural (retrofit) versus non-structural (public education) controls. A technology + education (retrofit group) BMP was applied in one neighborhood, an education-only BMP was applied in a second neighborhood, and a control was established through three additional neighborhoods.

A more detailed discussion of the study participants is provided below. For purposes of simplicity, the organizations are categorized as agencies responsible for water quality, agencies responsible for water supply, and "supporting participants." However, in many cases, these objectives are overlapping and are not mutually exclusive.

1.4.1 Agencies Responsible for Water Quality

Study participants whose major area of responsibility is water quality include the California Environmental Protection Agency (CAEPA), the State Water Resources Control Board (SWRCB), the Regional Water Quality Control Board (RWQCB), the California Department of Pesticide Regulation (DPR), the County of Orange, and the Southern California Coastal Water Research Project (SCCWRP). These agencies are charged with regulating, enforcing, implementing, or researching and monitoring federal and state laws pertaining to water quality and the control of constituents which may degrade water quality. For example, the RWQCB is responsible for establishing limits on the amount of pollutants that can be discharged to Newport Bay. These limits are defined as "Total Maximum Daily Load" (TMDL). The County of Orange, which provided indirect funding to the study through DPR, is the primary permittee on the Municipal Separate Storm Sewer System (MS4) Permit issued by the RWQCB. The County's primary interest in the study relates to their efforts to implement a comprehensive program of BMPs to meet the TMDLs as required by the MS4 permit. In addition to providing improved baseline water quality and runoff information, these agencies focus on gauging the effectiveness of the two study intervention methods in reducing the quantity of runoff and improving the quality of the water that does run off.

l.4.2 Water Agencies

IRWD and MWDOC are water districts whose primary mission is to provide safe and reliable water service to customers within their respective service areas. The reliability of water service, in particular, is directly related to the efficiency of water use. In other words, since supplies of reasonably priced water are essentially fixed, increases in efficiency can result in additional supplies being available for storage until they are needed during periods of supply shortages.

Both IRWD and MWDOC, as well as MWDOC's "parent" agency, MWD, operate various water efficiency/conservation programs within their service areas. Some progress has been made on increasing water use efficiency from programs targeting outside use for landscape irrigation (which generally accounts for about 50 percent of total urban water use). However, water use in this sector remains closely linked to the ability and responsiveness of landscape personnel with responsibility for controlling and adjusting irrigation control timers.

Two basic issues are associated with this "people to water use efficiency" link. First, there is a wide variation in the abilities of personnel to properly set baseline irrigation schedules based on site factors (type of plant material, soil, exposure, slope, irrigation equipment, etc.). Second, for various reasons, it is believed that very few of these timers are adjusted on a sufficient frequency to promote optimum water use efficiency. Consequently, the water agencies are very interested in technologies such as the irrigation controller tested as a part of the R3 study. This technology allows irrigation schedules to be automatically adjusted based on real-time weather conditions. Equally important, the technology provides the ability to set appropriate base irrigation schedules by site conditions, particularly the soil type (infiltration capacity) and slope. This capability is critical to reducing runoff.

In addition to the potential effectiveness of the water management/irrigation controller program, IRWD and MWDOC were also very interested in determining if the focused educational and communication efforts tested in the study could yield customer water savings. This is particularly important since these efforts can be a very cost-effective way to achieve water savings.

In addition to water conservation, water agencies are becoming increasingly aware of their role as providers of water which, if not used efficiently, may ultimately become a nuisance or source/carrier of non-point source pollution. Consistent with its vision to optimize the use of resources as demonstrated by its globally-recognized recycled water reuse program, IRWD in particular has taken a leadership role in addressing irrigation runoff/non-point source pollution within its service area, which covers a majority of the San Diego Creek watershed. In addition to the current study focusing on potential source control measures, IRWD has prepared a master plan outlining a system of constructed wetlands which will capture and treat runoff and improve water quality in the watershed and Newport Bay.

1.4.3 Supporting Participants

The remaining study participants provided vital support for various aspects of the study. Network Services Corporation (now HydroPoint Data Systems, Inc.) manufactured the ET controllers used in the study and was responsible for compiling weather data and transmitting this information to the controllers. The National Water Research Institute (NWRI) provided input on the study design and evaluation, and A&N Technical Services prepared the detailed analysis of water savings and runoff reduction under a contract. Similarly, a portion of the water quality analysis was conducted under a contract by Montgomery Watson.

1.5 Report Organization

The R3 Study report is organized into two main parts: a body, consisting of seven chapters, followed by eight Appendices containing references and the analyses prepared by the study partners and presented in their entirety.

The first two sections of this report (Chapters 1 and 2) present general information about study goals and methodology. Chapter 1 presents study rationale, goals and objectives, and participating organizations. Chapter 2 describes how the study area was developed and presents the methodology used to develop information on the four main study areas: water conservation savings, dry season runoff/reduction savings, water quality impacts, and customer acceptance/public education.

Chapters 3 through 6 present the evaluations for the four main study areas, respectively, water conservation, dry season runoff, water quality, and customer acceptance. Each chapter provides an overview, summarizes the evaluation approach, presents results, and summarizes major conclusions. More detailed information on the evaluations is presented in the Appendices.

The final section of this report (Chapters 7) integrates study results and describes relevance for future planning and policy. Key findings, conclusions, and recommendations are presented.

The Appendices to this report contain eight sections. Appendix A, References, lists reports, articles, and other documents utilized during the R3 Study. Appendix B, Study Design, provides support information for Chapter 2, Study Methodology, and provides details on the techniques and methods used for data collection, sampling, and analysis. Appendix C, Water Conservation, presents the detailed water conservation evaluation conducted by A&N Technical Services, Inc., and includes detailed information on data models developed for the analysis. Appendix D1, Statistical Analysis of Urban Runoff Reduction, and Appendix D2, 2003 Runoff Data, present the detailed statistical analysis of runoff reduction. These analyses were also prepared by A&N Technical Services, Inc., and include detailed information on the data collection and analysis approach. Appendix E1 and E2 present Water Quality information. E1 was prepared by SCCWRP, and E2 was prepared by GeoSyntec Consultants. Finally, Appendix F, Public Education, presents information on customer acceptance and public involvement.

1.6 Abbreviations and Acronyms

The following abbreviations and acronyms are used in this report:

ADP	antecedent dry period
ANOVA	analysis of variance between groups
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
BACI	before-after control impact
BMPs	Best Management Practices
CAEPA	California Environmental Protection Agency
Calfed	consortium of state and federal agencies who address California and San Francisco Bay-Delta water issues
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CTR	California Toxic Rule
DPR	California Department of Pesticide Regulation
ET	evapotranspiration
fps	feet per second
GIS	geographic information system
gpd	gallons per day
HOA	homeowners association
IRWD	Irvine Ranch Water District
K-W	Kruskal-Wallis
mgd	million gallons per day
mg/acre/day	milligrams per acre per day
mg/L	milligrams per liter
mL	milliliters
MPN	most probable number
MS4	Multiple Separate Storm Sewer System
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
NPDES	National Pollutant Discharge Elimination System
NWRI	National Water Research Institute
OCPFRD	Orange County Public Facilities and Resources Department
OP	organophosphorus
ng/L	nanograms per liter
PCF	pressure control facility
R3	Residential Runoff Reduction Study
RWQCB	Regional Water Quality Control Board
SCCWRP	Southern California Coastal Water Research Project
SWRCB	State Water Resources Control Board
TIN	total inorganic nitrogen
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TN	total nitrogen

TP	total phosphorous
ug/L	micrograms per liter
USBR	United States Bureau of Reclamation
USEPA	Untied States Environmental Protection Agency

Chapter 2: Study Methodology

2.1 Overview

Historically, water agencies have utilized educational programs and in some cases allocation-based rate structures to achieve improved irrigation efficiency in urban landscapes. With the introduction of "smart" weather-based irrigation controller technology, which in early studies generated quantifiable and reliable irrigation water savings over time, water agencies may now have a new and effective management tool to introduce to residential and other customers. The R3 Study compared, in a controlled setting, water savings and watershed management benefits of a remote, weather-based "ET" automated irrigation controller technology. This chapter of the report presents information on the methodology used in the following areas:

- Study design, including study area development, flow monitoring and water quality sampling procedures, and determination of a viable ET irrigation controller operation and selection process.
- Evaluation of water conservation savings.
- Quantification of dry season runoff reduction savings.
- Assessment of water quality impacts.
- Approach to public acceptance/public education.

More information on study design is presented in Appendix B. Evaluation-specific information on study design, data collection/analysis, and results is presented in Chapters 3 through 6 for water conservation, dry season runoff reduction, water quality, and public education, respectively. Additional details are provided in Appendices C through F.

2.2 Study Design

Study design included developing a viable study area, which provided for accurate data collection and comparison. Identifying appropriate flow monitoring equipment and determining an effective ET irrigation controller operation and selection were also important.

The goal of this study is to compare the effectiveness of technological BMPs versus public education for reducing the volume, concentrations, and mass emissions of potential pollutants in dry weather runoff from irrigated landscapes. The technological BMP consisted of ET controllers that communicate with irrigation systems of individual households and selected large landscapes, such as street medians, parks, etc. This technology is designed to optimize watering times for landscaped areas, hence reducing over-watering and resultant runoff. (See Section 2.2.3.) The public education campaign focused both on appropriate watering times and on the correct application of pesticides, herbicides, and fertilizers. (See Section 2.3.4.) These two types of BMPs were tested in residential neighborhoods, typically the most common land use in urban watersheds (Wong et al.1997). The goal was to determine if technology or education provides more pollutant reduction so that urban runoff managers can select optimal runoff pollutant minimization strategies.

2.2.1 Development of the Study Area

When developing the R3 Study area, the study partners focused on identifying watersheds with similar characteristics that would enable them to confirm water savings identified in the previous "Westpark" study, a water conservation evaluation (IRWD, MWDOC and MWD, 200l). Because a parallel purpose was to expand upon the findings of the Westpark study by measuring changes in dry weather volume (dry season runoff evaluation) and pollutant content of residential runoff (water quality evaluation) associated with improved irrigation management practices, both single-family residences and medium-size landscapes were considered. The R3 Study area is located within IRWD's service area as shown on Figure 2-1.

The R3 Study involved data collection and evaluation not previously attempted at such a large scale. In order to ensure reliable and accurate results, the study team sought to minimize the effects of outside variables that might produce "skewed" results. The team designated a study area that included five similar neighborhoods in Irvine, California. The study area was configured so that meaningful data could be provided for the water conservation, dry weather runoff reduction, and water quality evaluations. Runoff from each of the neighborhoods could be isolated and sampled at a single point from within the municipal sewer system, enabling each neighborhood to be treated individually. At these points of drainage, the runoff volume was monitored, and water quality samples were taken. The five neighborhoods are summarized in Table 2-1 and depicted graphically on Figure 2-2.

Table 2-1
Summary of Neighborhoods

Name	Description/Purpose	Comments
Site 1001 Retrofit Group	The homes in this group were retrofitted with an ET controller and also received education information.	The Retrofit Group area consisted of: • 112 residential landscapes • 12 City of Irvine streets • 2 condominium associations • 1 homeowners association
Sites 1002 – 1004 Control Groups	The homes in this group were monitored as experimental control groups and received no ET controller and no public education materials.	The Control Group area had evaluation-specific variations in size and configuration. In addition, some evaluations assessed "matched" and "unmatched" controls from within and outside of the study area.
Site 1005 Education Group	The homes in this group received information materials only (the same education information as supplied to the Retrofit Group).	The Education Group consisted of 225 homes identified by visual selection. This area also included one large school site.

Figure 2-1
Location of R3 Study Area Within Southern California

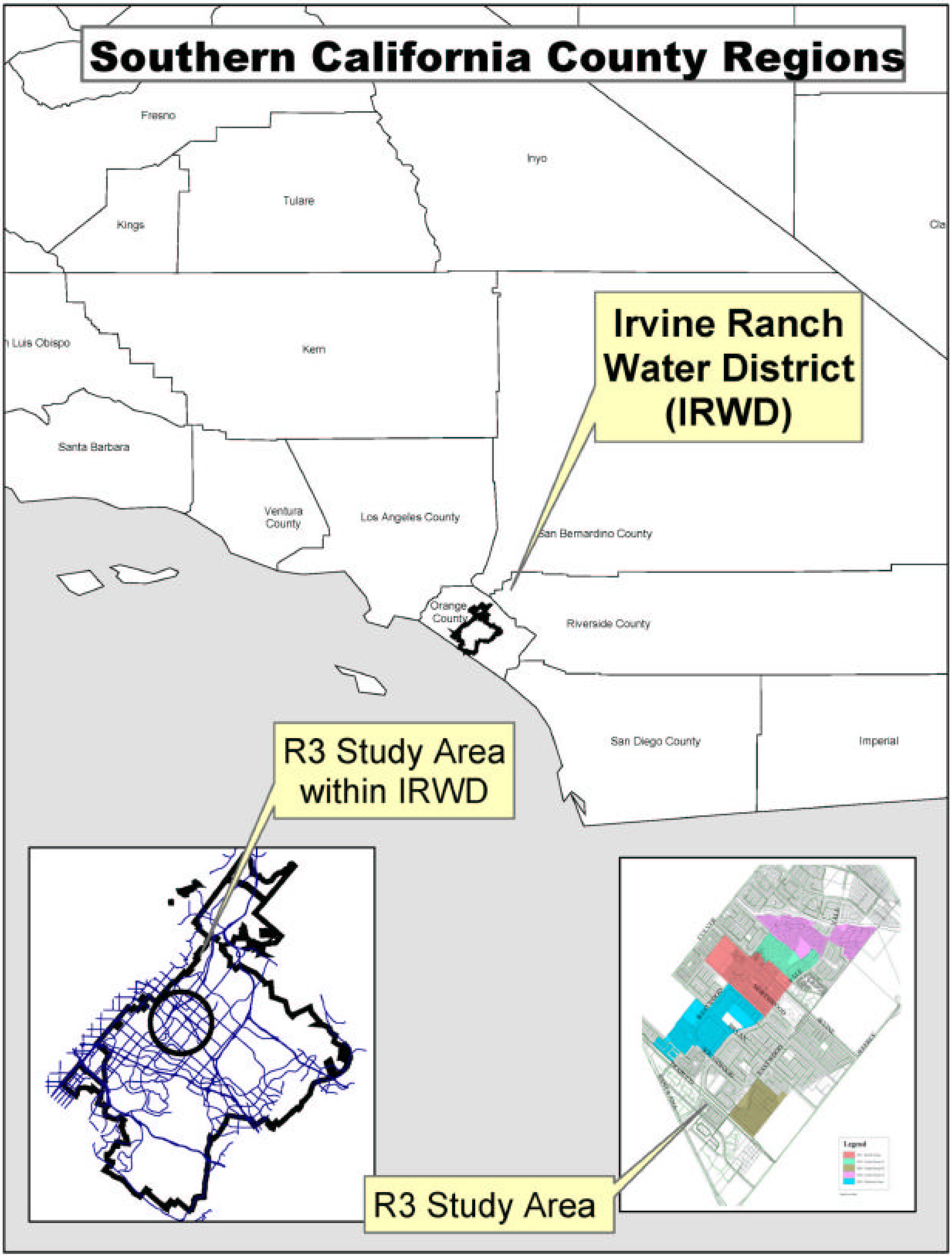
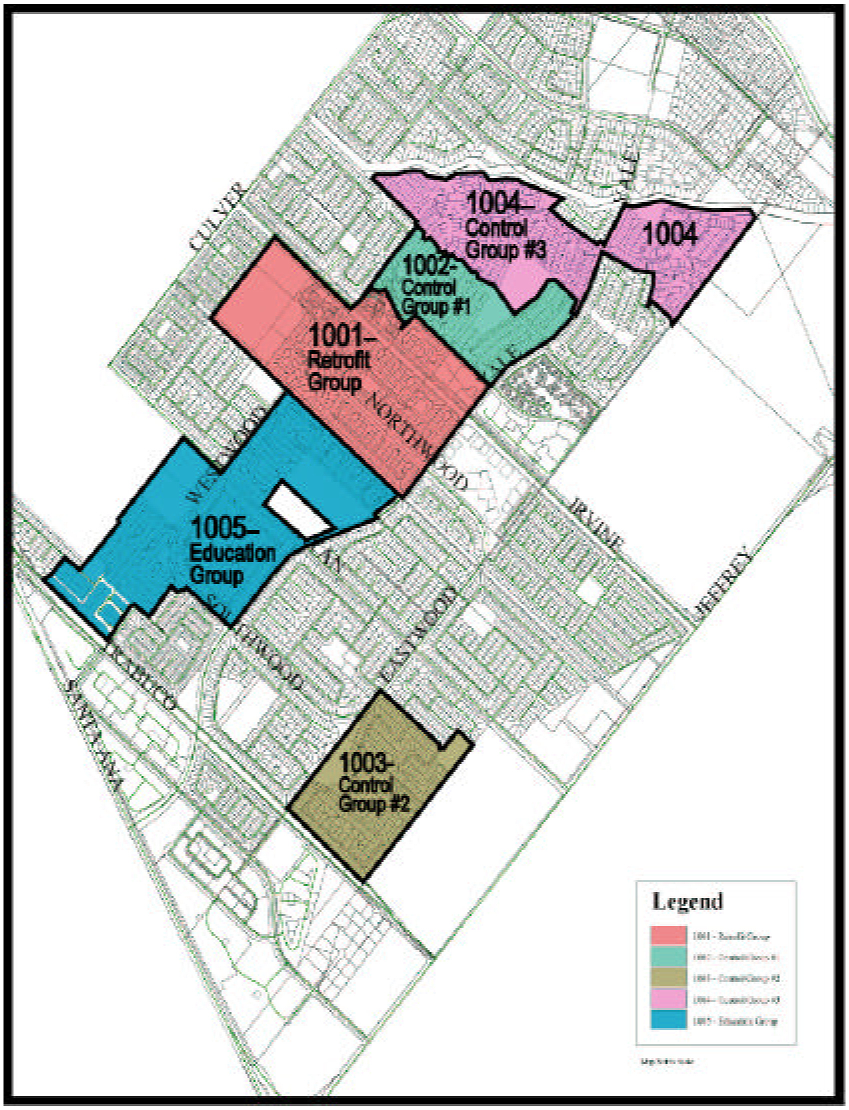


Figure 2-2
R3 Study Neighborhood Areas



In the first of the neighborhoods (Site 1001 or retrofit group), participating homes received a site evaluation and installation of an ET controller to automatically adjust irrigation schedules. Additionally, the residents at these homes received information regarding environmentally-sensitive landscape maintenance practices. The controllers were installed in 112 residential homes, 12 city street landscapes in the City of Irvine, two condominium associations' landscapes, and one homeowners association (HOA) landscape. The HOA landscape had three distinctive sites: 1) pool/park/tennis courts, 2) park, and 3) streetscapes.

The second neighborhood (Site 1005, or education group) received the same environmentally-sensitive landscape maintenance information as the first group, as well as a suggested irrigation schedule.

The three remaining neighborhoods (Sites 1002 – 1004, or control group) did not receive ET controllers and were not provided educational materials. Residents in the control groups had no knowledge of the study and were used only for comparison purposes. The make-up of the control group varied depending upon the evaluation. In the water conservation evaluation, "matched controls" were used in addition to the control group sites. In the water conservation and the dry weather runoff evaluations, only data from Site 1004 was used, as discussed in Sections 2.3.1 and 2.3.2. Data from all three sites was used in the water quality evaluation.

The five neighborhoods were selected based on the following criteria: 1) isolation from other neighborhood watersheds, 2) climate, 3) land use, 4) development age, and 5) irrigation water management techniques. These parameters are described in greater detail in Appendix B.

2.2.2 Flow Monitoring / Water Quality Sampling

This section summarizes the approach to flow monitoring and water quality sampling.

2.2.2.1 Flow Monitoring

Two main criteria were established for the study's flow monitoring equipment. First, the monitor could not alter the pipe or channel. Second, the monitoring had to be sufficiently accurate to distinguish seasonal flow changes and any flow change that resulted from the two study treatments (retrofit and education). Because the storm drain systems used for flow monitoring are designed to convey peak storm flows, and the focus of the R3 study was on changes in dry season (low flow) runoff associated with the treatments, the flow monitors had to be able to detect relatively small differences in low volume flows in large diameter storm drains. This situation was exacerbated by the fact that only a portion of each tributary neighborhood received the study treatments. Two flow monitoring technologies were determined to meet these criteria:

- Manning's equation plus a level sensor
- Velocity sensor and level monitor (area-velocity)

The area-velocity method was chosen due to lack of slope information for the storm drain system. The selected equipment was an American Sigma 950, which is battery-operated and can record data every minute. The equipment has an ultrasonic transmitter and a velocity sensor, both of which were installed in the storm drain. The ultrasonic transmitter establishes the water surface level and area, while the velocity sensor determines the velocity of the water in the pipe. Flow is calculated by the equation:

- Flow = Area x Velocity

Because four of the five monitoring locations were in a pipe, several variations on the ultrasonic transmitter / velocity sensor were tested before the combination of sonic and velocity wafer were finalized.

The accuracy of the flow monitoring equipment was tested at all study sites. This was accomplished by metering flow (at three different levels) from a fire hydrant within each tributary watershed and comparing these metered flows to flows measured at the flow monitoring locations. As expected, the accuracy of the flow monitors varied from site to site depending on the nature and condition of each storm drain. For example, some settling of the storm drain was noted near the flow monitor for Site 1002, resulting in an accumulation of sediment. This physical "anomaly" altered the hydraulic characteristics of the pipe and affected the accuracy of flow measurements. However, based on the flow test results, it was believed that these issues were manageable. The subsequent analysis of flow data as presented in Chapter 4 of this report suggests that this belief was partially correct; although flow monitoring problems required data from two of the three control sites to be discarded, the data from the other three sites (two treatments and one control) was sufficiently accurate to allow for the determination of meaningful statistical results.

2.2.2.2 Water Quality Sampling

The water quality sampling program quantified constituents found in residential runoff flows. This program consisted of two phases: 1) pre-study and 2) dry weather sampling. More information about water quality sampling and analysis is provided in Section 2.3.3, Chapter 5 and Appendices B and E.

2.2.3 ET Irrigation Controller Operation and Selection Process

The technology-based BMP consisted of an ET controller + education. The ET controller selected was similar to most automatic sprinkler timers available at home improvement stores and nurseries, but with the capacity to receive radio signals that will alter sprinkler timing based on current weather conditions. If the weather is hot and dry, the radio signal calls for longer or more frequent irrigation. If the weather is cool and moist, such as recent precipitation, the radio signals call for shorter or less frequent irrigation. For the R3 Study, the existing sprinkler timers that are set manually by the homeowner were replaced with the radio-controlled ET controller systems. Trained technicians were used to ensure successful installation because the ET controller requires programming for each valve including area (size of yard or planter per valve), soil type (clay, sand, etc.), and landscape type (turfgrass, shrubbery, etc.). The remaining irrigation system was unchanged, including piping and sprinkler head configuration.

Since residential areas include landscapes other than the homeowners, these "common area" and streetscape landscape areas ("medium-size" landscapes) were included in the water management component of the R3 Study. As shown in Table 2-2, the medium-size landscapes accounted for an estimated 70 percent of the total landscape area treated in the retrofit group (Site 1001). The installation process for both residential and medium-size landscapes is described in Appendix B.

2.2.3.1 Controller Installation

The study evaluated the performance of the engineering of irrigation management techniques to reduce the consumption and residential runoff while maintaining the quality of the landscape. A typical irrigation controller is difficult to program and limited in the scope of the scheduling ability. Proper scheduling requires calculations based on real time ET data, landscape topography, and plant type, which are beyond the capabilities of typical controllers. The landscaper in the field is left to guess or rely on past experience as to the correct amount of water, the correct runtime to prevent runoff, and the correct number of days of the week to water.

The controllers were installed following the general principle that an ET controller is a water management tool and that professional operation should result in conservation and reduction of runoff. A picture of the controller is shown on Figure 2-3. More information is provided in Appendix B.

Figure 2-3
ET Controller

2.2.3.2 ET Controller Operation

The operation of the ET controller in this study was optimized by proper irrigation scheduling. As discussed further in Chapter 4 and Appendices B, D1 and D2, the ET controller must meet three key criteria: cost, ease of operation, and ability to conserve water and reduce runoff.

2.3 Study Evaluations

This section summarizes the water conservation evaluation, the quantification of changes in dry season runoff reduction savings, the analysis of water quality impacts, and the approach to customer acceptance / public education.

Table 2-2
Study Sites Land Use and Treatment Summary

Site 1001

Land Use	No. of Lots	Acres	Treatment Sites	Treatment Acreage*	No. of Controllers
SFR	565	66.8	112	6.6	112
Condo	109	10.3	2	1.9	8
HOA	4	5.9	1	0.9	3
School	2	4.6			
Landscape	10	19.4	12	11.2	15
Street	97	49.7			
Unmetered	64	11.5			
Total	**851**	**168.1**	**127**	**20.5**	**138**

***Note: All acreage except SFR were considered "medium-size" landscapes.**

Site 1002

Land Use	No. of Lots	Acres	Treatment Sites	Treatment Acreage	No. of Controllers
SFR	-	-	control	control	control
Condo	-	-	control	control	control
HOA	-	-	control	control	control
School	-	-	control	control	control
Landscape	-	-	control	control	control
Street	-	-	control	control	control
Unmetered	-	-	control	control	control
Total	**-**	**-**			

Table 2-2 (continued)
Study Sites Land Use and Treatment Summary

Site 1003					
Land Use	**No. of Lots**	**Acres**	**Treatment Sites**	**Treatment Acreage**	**No. of Controllers**
SFR	-	-	control	control	control
Condo	-	-	control	control	control
HOA	-	-	control	control	control
School	-	-	control	control	control
Landscape	-	-	control	control	control
Street	-	-	control	control	control
Unmetered	-	-	control	control	control
Total	**-**	**-**			

Site 1004					
Land Use	**No. of Lots**	**Acres**	**Treatment Sites**	**Treatment Acreage**	**No. of Controllers**
SFR	417	47.8	control	control	control
Condo	-	-	control	control	control
HOA	1	0.9	control	control	control
School	1	8.0	control	control	control
Landscape	2	0.0	control	control	control
Street	42	25.0	control	control	control
Unmetered	61	7.1	control	control	control
Total	**524**	**88.8**			

Site 1005					
Land Use	**No. of Lots**	**Acres**	**Treatment Sites**	**Treatment Acreage**	**No. of Controllers**
SFR	559	67.9	225	13.0	n/a
Condo	-	-	-	-	n/a
HOA	1	1.5	-	-	n/a
School	2	12.1	-	-	n/a
Landscape	2	0.0	-	-	n/a
Street	45	0.0	-	-	n/a
Unmetered	8	2.7	-	-	n/a
Total	**617**	**84.2**	**225**	**13.0**	**0**

2.3.1 Water Conservation Evaluation

The water conservation evaluation was conducted by A&N Technical Services, Inc. The firm performed a statistical analysis of historical water consumption records from, roughly, July 1997 to August 2002. Two main types of water use were reviewed: single-family residences and medium-size landscapes. For the single-family residences, data was compared among the retrofit group, the education group, and the control group. For the medium-size landscape accounts, a slightly different approach was used. Accounts within the study area were compared to "matched" and "unmatched" controls in the City of Irvine, both within and outside of the study area. Matched controls were similar in sun exposure, irrigation type, soil type, etc. Unmatched controls were areas not similar enough to be used for direct comparison but areas that could be used for weather normalization. A detailed description of the methods used to evaluate water savings for the single-family residence and medium-size landscape sites is provided in Chapter 3 and Appendix C of this report.

2.3.2 Dry Season Runoff Reduction Savings Quantification

In addition to the water conservation evaluation, A&N Technical Services, Inc., performed a statistical analysis of the reduction of runoff induced by ET controller and irrigation education. With the assistance of IRWD staff, who collected runoff data, A&N developed regression models to estimate mean runoff by site.

Two of the control sites (1002 and 1003) had recurring measurements issues that produced generally unreliable data. Site 1002 was found to have a physical hydraulic jump, which caused sediments to build in such a way that flows avoided the monitor. At Site 1003, there was an occurrence of illegal dumping of cement into the storm drain. This event reshaped the monitoring area, led to continuous collection of debris, and caused the monitor to perform erratically. Thus, it was only possible to use data from Site 1004. More details are provided in Chapter 4 and Appendices D1 and D2.

2.3.3 Water Quality Impacts Assessment

As described in Section 2.2.2.2, the water quality sampling program quantified constituents found in residential runoff flows. Two independent reviews of the water quality data were performed. The initial review, conducted by SCCWRP, used parametric statistical techniques (t-test; analysis of variance [ANOVA]), which provide a good descriptive review of the study. However, these techniques are generally considered to have less power for detecting differences in data than other statistical tests. A subsequent statistical overview was performed by Geosyntec Consultants to review alternative and possibly more "robust" data analysis techniques. This work, which included the review of only a portion of the data set, focused on additional descriptive techniques (time series plots; box plots; probability distributions) and the use of non-parametric statistical techniques (rank-sum test; Kruskal-Wallis [K-W]). The SCCWRP and Geosyntec Consultants reports are presented in Appendix E-1 and E-2, respectively.

2.3.4 Public Acceptance / Public Education Approach

The public acceptance evaluation was conducted to compare the effectiveness of proposed BMPs for ET controller technology + education and education only. The participating ET technology retrofit group homes received a site evaluation and installation of an ET controller to manage the irrigation system. Additionally, the residents of these homes received information regarding environmentally-sensitive landscape practices. The education-only group received an initial informational packet containing three items: an introductory letter, an informational booklet, and a soil probe to measure the water content of landscaped soils.

In addition to the initial packet, monthly reminders were mailed to each homeowner that included tips for maintaining the irrigation system. Suggested sprinkler run times (for the non-ET controller neighborhood) and tips on fertilizer or pesticide application usage, including non-toxic alternatives, were also provided in the monthly newsletter. A telephone log was kept to monitor incoming customer calls relating to the R3 Study, and a pre- and post-program survey was developed to measure customer impact of the study. More details are provided in Chapter 6 and Appendix F.

Chapter 3: Water Conservation

3.1 Overview

This chapter describes the statistical analysis of water savings (water conservation) among customers who installed ET controllers and customers given irrigation education in the study area. Specific information includes:

- A summary of study methods and evaluation approach.
- Evaluation results for large landscape customers and for single-family residences.
- Effect of ET controllers on seasonal peak demand.

More detailed information is provided in Appendix C.

3.2 Evaluation Approach

This section summarizes the overall evaluation approach, the records, review process, and data assessment techniques.

3.2.1 Overall Evaluation Approach

Historical water consumption records for a sample of participants and for a sample of nonparticipating customers were examined statistically. The hypothesis was that installation of new irrigation technology or better management of existing equipment would reduce the observed water consumption of customers participating in this program. This study empirically estimates the water savings that resulted from two types of "interventions"—1) customers receiving both ET controllers and follow-up education and 2) customers receiving an education-only intervention. Both single-family residences and medium-size landscapes were evaluated. (See Tables 3-1 and 3-2.)

Table 3-1
Summary of Water Conservation Evaluation Approach for Single-family Residences

Site	Number of Usable Accounts	
Site 1001 Retrofit Group	Retrofit Non Participants	97***** 213
Site 1004 Control Group		264
Site 1005 Education Group	Education Non Participants .	192***** 346

*****Note: These sample numbers are smaller than the total number of original participants in each group due to changes in tenants, anomalous data, and other data quality issues.

Table 3-2
Summary of Water Conservation Approach for Medium-size Landscapes

Type	Number of Usable Accounts	Average Acres Per Account
Participating Landscapes	15*	0.93
Matched Controls	76	0.92
Unmatched Controls	895	0.96

Note: This sample number is smaller than the total number of original study participants due anomalous data, and other data quality issues.

Since installation of ET controllers required the voluntary agreement of the customer to participate, this sample of customers can be termed "self-selected." Customers in the education–only group were initially approached by mail about their interest in participating in the study. 137 customers initially expressing interest were included in the study group. However, because sufficient interest in the study was not generated through this mailing to meet the study saturation goals for this group, the remaining 112 participants self selected. While this analysis does quantitatively estimate the reduction of participant's water consumption, one may not directly extrapolate this finding to nonparticipants. This is because self-selected participants can differ from customers who decided not to participate.

The explanatory variables in these models include:

- Deterministic functions of calendar time, including
    - the seasonal shape of demand
- Weather conditions
    - measures of air temperature
    - measures of precipitation, contemporaneous and lagged
- Customer-specific mean water consumption
- "Intervention" measures of the date of participation and the type of intervention

3.2.2 Records Review Process

Consumption records were compiled from IRWD's customer billing system for customers in the study areas. Billing histories were obtained from meter reads between July 1997 and August 2002. It is important to note that a meter read on August 1 will largely represent water consumption in July. Since the ET controllers were installed in May and June of 2001, the derived sample contained slightly more than one year of data for each participant. More information is presented in Appendix C.

The landscape-only customers (15 accounts) were handled separately. Two control groups were developed for these irrigation accounts: A matched control group was selected by IRWD staff by visual inspection, finding three-to-five similar control sites for each participating site. Similarity was judged by irrigated area and type of use (HOA, median, park, or streetscape). Since the City of Irvine was improving irrigation efficiency on the City-owned sites during the post-intervention period, this matched control group also had potential water savings. A second control group was developed where the selection was done solely based on geographic area. In this way, the statistical models could separately estimate the water savings effects for each group. (See Appendix C.)

3.2.3 Data Assessment Techniques

The first major issue with using meter-read consumption data is the level and magnitude of noise in the data. The second major issue is that records of metered water consumption can also embed non-ignorable meter mis-measurement. To keep either type of data inconsistencies from corrupting statistical estimates of model parameters, the modeling effort employed a sophisticated range of outlier-detection methods and models. These are described in Appendix C.

Daily weather measurements—daily precipitation, maximum air temperature, and evapotranspiration—were collected from the California Irrigation Management Information System (CIMIS) weather station located in Irvine. Daily weather histories were collected as far back as were available (January 1, 1948) to provide the best possible estimates for “normal” weather through the year. Thus, 54 observations were available upon which to judge “normal” rainfall and temperature for January 1^{rst} of any given year.

Robust regression techniques were used to detect which observations were potentially data quality errors. This methodology determines the relative level of inconsistency of each observation with a given model form. A measure is constructed to depict the level of inconsistency between zero and one; this measure is then used as a weight in subsequent regressions. Less consistent observations are down-weighted. Other model-based outlier diagnostics were also employed to screen the data for any egregious data quality issues.

3.3 Evaluation Results

This section presents evaluation results for single-family residences and landscape-only customers. The effect of ET controllers on peak demand is also discussed.

3.3.1 Estimated Single-family Residential Water Demand

Table 3-3 presents the estimation results for the model of single-family water demand in the R3 study sites. Twenty-one variables are listed. This sample represents water consumption among 1,525 single-family households between June 1997 and July 2002. This sample contains 97 ET controller/education participants (in Site 1001) and 192 education-only participants (in Site 1005). This sample is smaller than the total number of participants in each group due to changes in tenants and anomalous data.

The constant term (1) describes the mean intercept for this equation. (A separate intercept is estimated for each of the 1,525 households, but these are not displayed in Table 3-3 for reasons of brevity.) The independent variables 2 to 8—made up of the sines and cosines of the Fourier series described in Appendix C (Equation 2)—are used to depict the seasonal shape of water demand.

Table 3-3
Single-family Residential Water Demand Model

Dependent Variable: Average Daily Metered Water Consumption in gallons per day (gpd)		
Independent Variable	**Coefficient**	**Std. Error**
1. Constant (Mean intercept)	405.6593	3.1660
2. First Sine harmonic, 12 month (annual) frequency	-45.4215	0.9636
3. First Cosine harmonic, 12 month (annual) frequency	-89.1494	0.9629
4. Second Sine harmonic, 6 month (semi-annual) frequency	3.6549	0.6798
5. Second Cosine harmonic, 6 month (semi-annual) frequency	1.0709	0.6733
6. Third Cosine harmonic, 4 month frequency	1.7312	0.7151
7. Fourth Sine harmonic, 3 month (quarterly) frequency	4.4016	0.7403
8. Fourth Cosine harmonic, 3 month (quarterly) frequency	3.3491	0.7865
9. Interaction of contemporaneous temperature with annual sine harmonic	48.7897	17.1559
10. Interaction of contemporaneous temperature with annual cosine harmonic	-72.4672	22.3626
11. Deviation from logarithm of 31 or 61 day moving average of maximum daily air temperature	284.7163	13.542
12. Interaction of contemporaneous rain with annual sine harmonic	10.1102	1.8546
13. Interaction of contemporaneous rain with annual cosine harmonic	5.9969	2.6904
14. Deviation from logarithm of 31 or 61 day moving sum of rainfall	-34.0117	1.8931
15. Monthly lag from rain deviation	-13.3173	1.0549
16. Average Effect of ET controller/Education (97 participants)	**-41.2266**	**4.0772**
17. Interaction of ET intervention with annual sine harmonic	38.9989	5.3327
18. Interaction of ET intervention with annual cosine harmonic	-6.3723	4.8980
19. Average Effect of Education-only intervention (192 participants)	**-25.5878**	**2.8081**
20. Interaction of Ed.-only intervention with annual sine harmonic	6.0357	3.5870
21. Interaction of Ed.-only intervention with annual cosine harmonic	-3.0703	3.3826
Number of observations	94,655	
Number of customer accounts	1,525	
Standard Error of Individual Constant Terms		120.85
Standard Error of White Noise Error		129.81
Time period of Consumption	June 1997 - July 2002	

The predicted seasonal effect is the shape of demand in a normal weather year. This seasonal shape is important because it represents the point of departure for the estimated weather effects (expressed as departure from normal). The effect of the landscape interventions on this seasonal shape was also tested.

The estimated weather effect is specified in "departure-from-normal" form. Variable 11 is the departure of monthly temperature from the average temperature for that month in the season. (Average seasonal temperature is derived from a regression of daily temperature on the seasonal harmonics.) Rainfall is treated in an analogous fashion (Variable 14). One month lagged rainfall deviation is also included in the model (Variable 15). It is also noted that the contemporaneous weather effect is interacted with the harmonics to capture any seasonal shape to both the rainfall (Variables 12 and 13) and the temperature (Variables 9 and 10) elasticities. Thus, departures of temperature from normal produce the largest percentage effect in the spring growing season. Similarly, an inch of rainfall produces a larger effect upon demand in the summer than in the winter.

The effect of the landscape conservation program interventions is captured in the following rows. The parameter on the indicator for ET controllers/education (Variable16) suggests that the mean change in water consumption is 41.2 gpd (reduction) while the education only participants (Variable 19) saved approximately 25.6 gpd. Because residential meters serve both outdoor and indoor demand, the model cannot say whether education-only participants saved this water through improved irrigation management or by also reducing indoor water consumption. Since the sample includes only one year of post-intervention data, the model cannot say how persistent either effect will be in future years.

3.3.2 Estimated Landscape Customer Water Demand

Table 3-4 presents the estimation results for the model of medium-size landscape (irrigation-only) customer water demand in the R3 study sites. Seventeen variables are listed. This sample represents water consumption among 992 accounts between June 1997 and August 2002 and contains 21 ET controller accounts, 76 matched control accounts, and 895 unmatched control accounts.

The constant term (1) describes the intercept for this equation. The independent variables 2 to 9—made up of the sines and cosines of the Fourier series described in Appendix C (Equation 2)—are used to depict the seasonal shape of water demand. The estimated weather effect is specified in "departure-from-normal" form. Variable 10 is the departure of monthly temperature from the average temperature for that month in the season. (Average seasonal temperature is derived from a regression of daily temperature on the seasonal harmonics.) Rainfall is treated similarly (Variable 11). One month lagged rainfall deviation is also included in the model (Variable 12). The next variable accounts for the amount of irrigated acreage on the site. (Note that while measured acreage is available for all irrigation-only accounts, this is not true for single-family accounts.)

The effect of the landscape conservation program interventions is captured in the following rows. The parameter on the indicator for ET controllers (Variable 14) suggests that the mean change in water consumption is 545 gpd (reduction), approximately 21 percent of the pre-intervention water use. The matched control group (Variable 16) did experience water savings, approximately 241 gpd or 8.7 percent of their pre-intervention water use. As noted previously, this group included City of Irvine landscape accounts for which a parallel water efficiency program was conducted. The variables testing for differences in pre-intervention use cannot distinguish any differences between the different types of accounts.

Table 3-4
Landscape Customer Water Demand Model

Dependent Variable: Average Daily Metered Water Consumption (in gallons per day)		
Independent Variable	**Coefficient**	**Std. Error**
1 Constant (Mean intercept)	2624.0890	235.5602
2. First Sine harmonic, 12 month (annual) frequency	-810.6712	26.4690
3. First Cosine harmonic, 12 month (annual) frequency	-1979.1650	26.1149
4. Second Sine harmonic, 6 month (semi-annual) frequency	103.7890	26.7195
5. Second Cosine harmonic, 6 month (semi-annual) frequency	-18.6126	27.1067
6. Third Sine harmonic, 4 month frequency	-123.5511	28.2926
7. Third Cosine harmonic, 4 month frequency	106.4412	28.6328
8. Fourth Sine harmonic, 3 month (quarterly) frequency	38.3819	30.6999
9. Fourth Cosine harmonic, 3 month (quarterly) frequency	-61.4848	30.9128
10. Deviation from logarithm of 31 or 61 day moving average of maximum daily air temperature	6293.6890	565.6084
11. Deviation from logarithm of 31 or 61 day moving sum of rainfall	-748.2235	52.1792
12. Monthly lag from rain deviation	-209.9027	46.5477
13. Irrigated Acreage (in acres)	485.1284	140.1746
14. ET controller sites, test for difference in pre-intervention use	-327.6321	1511.6870
15. Average Effect of ET controller (21 accounts)	-545.3841	330.3669
16. Matched accounts, test for difference in pre-intervention use	-166.6455	693.9447
17. Average Effect of city efficiency improvements (76 accounts)	-240.4067	148.4015
Number of observations		56666
Number of customer accounts		977
Standard Error of Individual Constant Terms		5766.8
Standard Error of White Noise Error		4189.5
Time period of Consumption	June 1997 - July 2002	

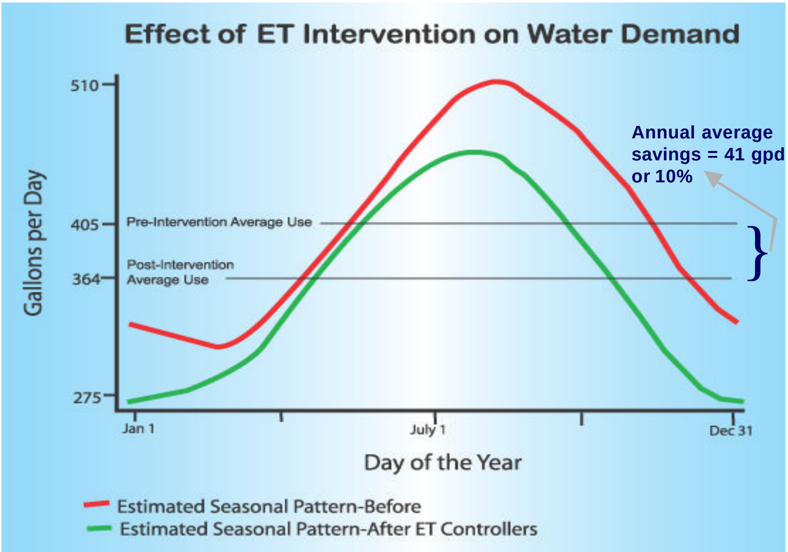
3.3.3 Effect of ET Controllers on Seasonal Peak Demand (Single-family Residential)

The question of how these programs affected the seasonal shape of water demand can be interpreted from the remaining interactive effects—the indicators interacted with the first sine and cosine harmonics.

When the pre / post seasonal patterns are combined with their pre / post mean water consumption, the following before and after picture can be seen throughout the year.

On Figure 3-1, several observations should be made. First, the difference between the two horizontal lines corresponds to the estimated mean reduction of approximately 41 gpd. Second, the assumption of a constant 41 gpd effect does not hold true throughout the year. The reduction is barely noticeable in the spring growing season and is much larger in the fall.

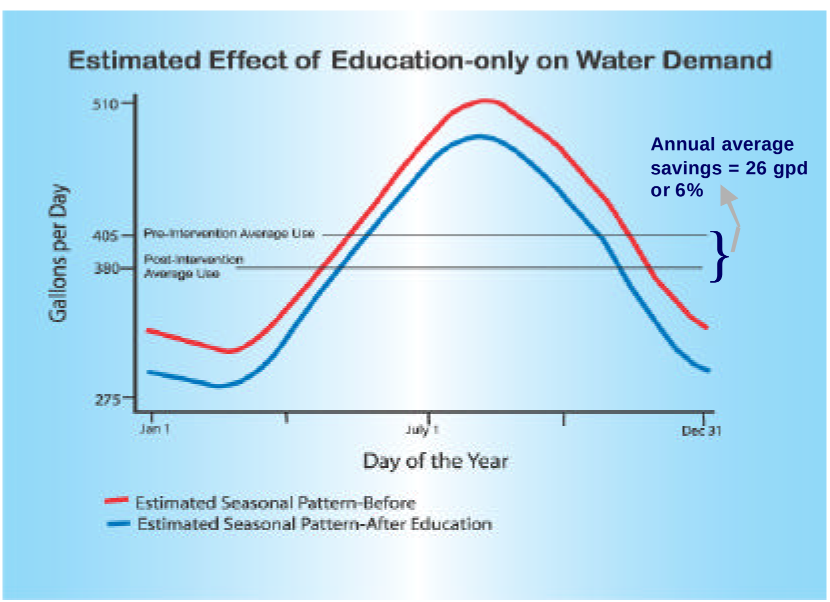
Figure 3-1
Effect of ET Intervention on Seasonal Water Demand for Single-family Residential



The reduction in peak demand—though dependent upon how the seasonal peak is defined—is greater than the average reduction. The estimated peak day demand, occurring on August 8, is reduced by approximately 51 gallons. This "load-shaping" effect of the ET controller intervention can translate into an additional benefit to water agencies. The benefits from peak reduction derive from the avoided costs of those water system costs driven by peak load and not average load—the costs for new treatment, conveyance, and distribution all contain cost components driven by peak capacity requirements

Figure 3-2 plots the corresponding estimates for the education-only intervention. The reduction in average demand is less—approximately 25 gpd. The effect upon the estimated seasonal shape of demand is much more muted. In fact, the change to the estimated seasonal shape of demand induced by the education-only intervention is not significantly different from zero at classical levels of significance.

Figure 3-2
Estimated Effect of Education-only on Seasonal Water Demand for Single-family Residential



3.4 Conclusions

This modeling effort focused on developing the best depiction of net changes in water consumption due to the landscape interventions of ET controllers and / or education. Much of the modeling effort was expended on data cleaning, diagnosis, and validation. The most serious data issues were identified and appropriately handled. To the extent that future data quality can be improved, future work could provide several statistical refinements in model specification. These are described in Appendix C.

The documentation provided in this report describes the shape of water savings achieved by the landscape interventions of ET controllers and / or education. Households participating in these programs saved significant amounts of water. Savings for the education-only program were less than for the retrofit group, but were still significant. The ET controller / education program changed both the level and shape of water demand.

Chapter 4: Runoff

4.1 Overview

This chapter presents the statistical analysis of the reduction of runoff induced by ET controllers and irrigation education. Specific information includes:

- Description of flow meters used and the data collection approach
- Discussion of the runoff analysis and analytical methods
- Presentation of evaluation results

More detailed information is provided in Appendices D1 and D2.

4.2. Evaluation Approach

The evaluation approach is summarized in Table 4-1 and discussed in more detail below.

Table 4-1
Summary of Dry Weather Runoff Evaluation Approach

Site	Description/Purpose	Controllers	Measuring Points
Site 1001 Retrofit Group	The study site contained 565 single-family residences. Of these, 112 participated in the ET/education program. In addition, 15 medium-size landscape sites also received ET controllers.	The accounts listed in Table 2-1 were allocated controllers as follows: • 112 for residential landscapes • 15 for 12 City of Irvine streets • 8 for the condominium associations • 3 for the HOA	1
Sites 1004 Control Group	This site contained 417 single-family residences and 44 large landscapes.	Not Applicable	1
Site 1005 Education Group	At this site, 225 residential customers participated in the irrigation education program.	Not Applicable	1

4.2.1 Data Collection

To measure dry weather runoff, flow monitors were installed at the five locations shown on Figure 4-1. The study used Sigma 950 flow monitors manufactured by Hach. The flow monitor applies an area-velocity calculation. The basic formula for flow is: flow (Q) equals the velocity (V) of the water multiplied by the area (A) of the water (Q=VA).

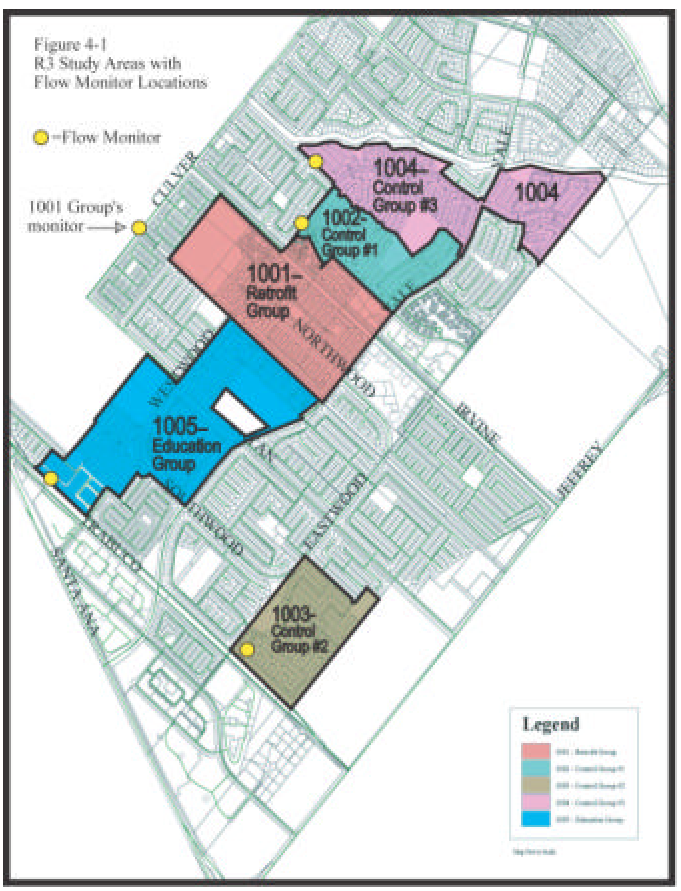
The first variable in the equation, velocity, was measured by velocity wafers placed below the surface of the runoff stream to measure the velocity of the water. These electronic devices were attached to metal plates positioned at the bottom of the concrete pipes that carried runoff. Each velocity wafer was centered to the width of the water flowing in the pipe. Once it is correctly positioned, the wafer measures the velocity of the water by measuring the speed of the particles in the water. This information is then transmitted via cable to the Sigma 950.

The second variable in the water flow equation, the area of the water, also referred to as the cross sectional area, was obtained by multiplying the depth of the water by its width. This calculation is based on geometry, the diameter of the pipe, and the depth of the water. Since the geometry of the area is the arc of a circular pipe of known diameter, the Sigma 950 was able to internally calculate this measurement using data from a sonic sensor. The sonic sensor measures the depth of the water by hanging above the water surface and sending out a sonic pulse that reflects off the surface of the water.

The Sigma 950 contains a central processing unit that recorded the time, water depth, water velocity, and flow every five minutes.

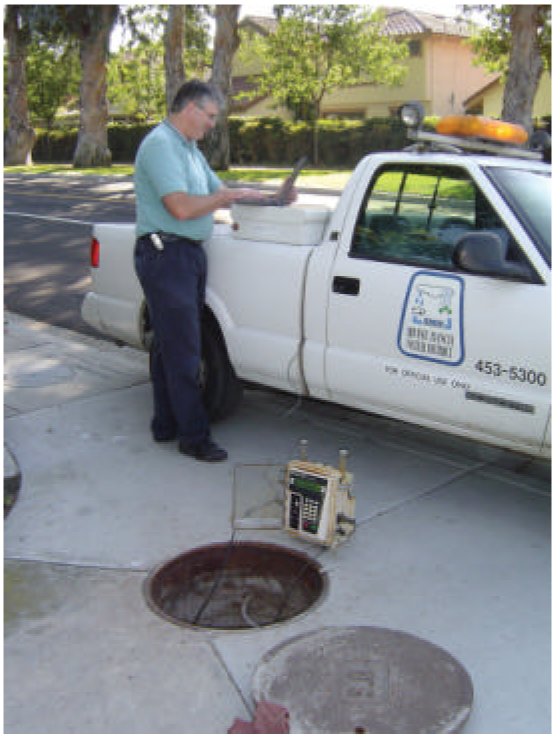
Maintaining the flow monitors in good working order required an R3 Study field staff member to visit each of the five data collection locations twice per week. At each site, staff would open the manhole and lift out the monitor. Then, the storm drainpipe would be inspected for any obstruction or interference with the flow or with the devices (velocity wafer and sonic sensor) used to measure flow.

Figure 4-1
Flow Monitor Locations



Next, staff would measure the depth of the water with a tape measure and recalibrate the flow monitor to this measurement. The velocity wafers could not be calibrated. They were adjusted for accuracy, however, during low flow and low velocity periods. To accomplish this, staff would observe an object on the surface of the water. As the object moved with the flow, staff would estimate its speed as feet per second (fps). This speed was compared to the value simultaneously registered on the flow monitor. If the observed velocity was much slower than that recorded by the monitor, staff would disconnect the velocity wafer. This action would usually reset the velocity wafer. If the problem persisted, the wafer would be replaced.

Figure 4-2:
Downloading Data from Sigma 950 Flow Monitor to Laptop



4.2.2 Ranking Collected Data

Twice per week during each site visit, data was downloaded from the flow monitor to a laptop computer. This process is depicted on the adjacent figure (Figure 4-2). When staff returned to IRWD's operations building, the data was downloaded to the District's central computer. Here the data was transferred from a text file to an excel file. At this point, staff would rank the data for each download of each site. After observing the site, recalibrating the flow monitor, and reviewing the data graphs, staff would add ranking to each site's data. The following process assigned these ranks: a) if staff observed nothing unusual and had no reason to suspect any data collection problems, the flow, depth and velocity received a ranking of "zero," b) if one of these factors was suspect or the data graph had an unusual jump in value, the rank indicator was a "one," c) if staff noted a problem which may have affected the data and changed its values beyond the tolerances of the equipment, the data was ranked with a "two."

4.2.2 Data Methods

Robust regressions techniques were used to detect which observations were potentially data quality errors. This methodology determines the relative level of inconsistency of each observation with a given model form. A measure is constructed to depict the level of inconsistency between zero and one; this measure is then used as a weight in subsequent regressions. Less consistent observations are down-weighted. Other model-based outlier diagnostics (Cook's distance, DFBETA statistics, and residual diagnostics) were also employed to screen the data for any egregious data quality issues

After screening for the known data quality problems, using the "rank" indicator, all raw meter reads were first converted to average hourly values. These were then aggregated by date to convert to daily runoff, available in both mean hourly flow and total daily volume.

Precipitation taken from the Irvine weather station was matched to the daily data and used to separate wet from dry days. It should be noted that wet weather flows were monitored and evaluated in a parallel study that assessed pesticide contributors from residential land use during dry and wet weather (SCCWRP, 2003). However, the focus of the R3 study was runoff reduction during the peak irrigation season (i.e., dry weather).

Wet weather storm flow can be a more complicated phenomenon to predict, as it depends on the timing and magnitude of the rainfall event, the moisture deficit of soils, and other factors. The relative lack of large storm events in the post-intervention period precluded examination of these more complicated forces and the effect that the landscape interventions might have on wet day runoff.

Area-standardized measures of site runoff were also created for dry/wet days, where total daily volume was divided by the estimated permeable/total area. Estimates of area for the study sites were derived from the IRWD geographic information system (GIS) system. The GIS system was queried to produce estimates of the number of lots and total area for the different land use classifications (single family residence, condo, HOA, school, landscape, street, and unknown). The GIS system also provided an estimate of the number of buildings, and building area. The area taken up by buildings is treated as impermeable. The remaining area was separated into permeable and impermeable area using a land use classification-specific assumption of impermeability. Table 4-2 provides the raw data used to construct the estimated site area. (Due to lack of usable flow measures, Sites 1002 and 1003 are not separately reported.) Table 4-3 aggregates the data by site.

Table 4-2
Estimated Area of Study Sites by Land Use

R3 GROUP	#Lots	Classification	Total Area in square feet. (sq. ft.)	Building Area in sq. ft.	Assumed Impermeable Coefficient %	Estimated Impermeable Area in sq. ft.	Estimated Permeable Area in sq. ft.
1001	64	Unmetered	499885		0	0	499885
1001	565	SFR	2911227	976574	0.5	1943900	967326
1001	109	Condo	447096	189721	0.9	421358	25738
1001	4	HOA	255208		0.75	191406	63802
1001	2	School	198676		0.9	178808	19868
1001	10	Landscape	845529		0	0	845529
1001	97	Street	2163105		1	2163104	0
1004	61	Unmetered	307556		0.0	0	307556
1004	417	SFR	2081636	719485	0.5	1400560	681076
1004	1	HOA	40165		0.8	30123	10041
1004	1	School	348739		0.9	313865	34874
1004	2	Landscape	1136		0.0	0	1136
1004	42	Street	1089143		1.0	1089143	0
1005	8	Unmetered	118370		0.0	0	118370
1005	559	SFR	2957363	1033197	0.5	1995280	962083
1005	1	HOA	66421		0.8	49816	16605
1005	1	School	264236		0.9	237812	26424
1005	1	School	261089		0.9	234980	26109
1005	2	Landscape	773206		0.0	0	773206
1005	45	Street	1736098		1.0	1736098	0

Table 4-3
Estimated Area of Study Sites

R3 Group	Estimated Impermeable Area sq.ft.	acres	Estimated Permeable Area sq. ft.	acres	Total Area sq. ft.	acres
1001	4,898,578	112.5	2,422,148	55.6	7,320,724	168.1
1004	2,833,691	65.1	1,034,683	23.8	3,868,374	88.9
1005	4,253,986	97.7	1,194,553	44.1	6,176,783	141.8

4.3 Evaluation Results

Table 4-4 presents the robust regression estimation results for the model of dry day runoff in R3 study Site 1001 (containing some customers receiving the ET controller/education intervention), Site 1004 (whose customers received no treatment), and Site 1005 (containing some customers receiving the education-only treatment). This sample represents metered dry day runoff, standardized by estimated site permeable area, between February 2001 and June 2002.

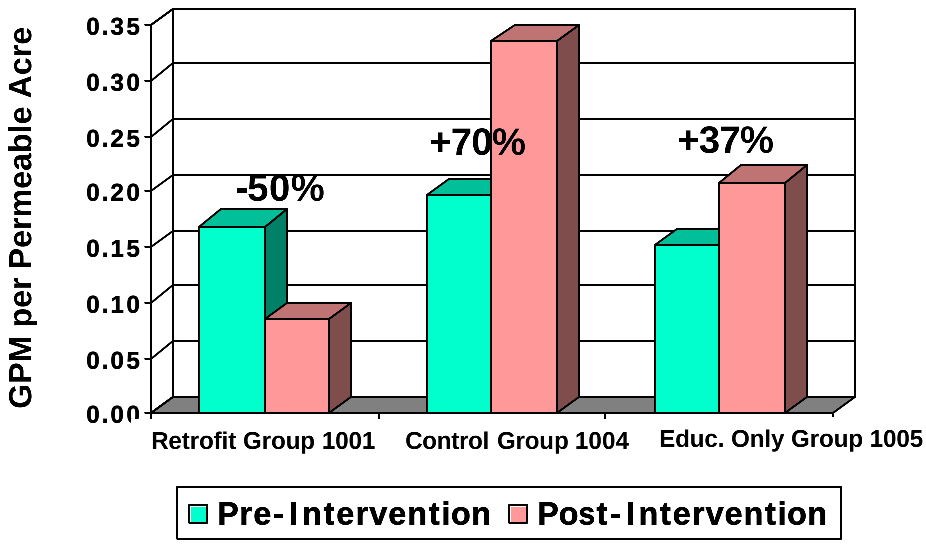
The changes in runoff estimated during the R3 study are summarized on Figure 4-3 and described in more detail below. Additional descriptions of the regression models are presented in Appendices D1 and D2.

Table 4-4
Robust Regression Estimates of Mean Dry Day Runoff

Dependent Variable: Dry Day Runoff Height (in hundredths inches per unit area) (Height=Runoff Volume/Site Area)

Variable	Coefficient	Std. Error	t	Prob.>|t|
Mean Runoff: Feb-May 2001				
1. Intercept (1001 mean runoff)	0.898563	0.120838	7.44	0
2. Difference of Site1004 in pre-period	0.143721	0.157245	0.91	0.361
3. Difference of Site1005 in pre-period	-0.092260	0.151479	-0.61	0.543
Change in Runoff: June 2001-June2002				
4. Change of Site 1001 in post-period	-0.445390	0.134540	-3.31	0.001
5. Change of Site 1004 in post period	0.878089	0.113737	7.72	0
6. Change of Site 1005 in post period	0.202553	0.106973	1.89	0.059
Number of observations	950			
F (5, 944)	74.92			
Prob. > F	0			
Quasi-R-Squared	0.35			

Figure 4-3
R3 Study's Changes in Runoff (Within Sites)



4.3.1 Pre-intervention Period

The constant term (Variable 1) in Table 4-4 defines the intercept for the model equation and can be interpreted as the mean daily runoff in Site 1001—about 0.898 hundredths of an inch per permeable acre (equal to 0.00898 inches). Variables 2 and 3, the indicators for Sites 1004 and 1005 in the pre-period, suggest that estimated difference in mean runoff is not statistically distinguishable from zero (standard error > coefficient). The estimated pre-period site mean runoff for these sites can also be inferred from these coefficients:

$$m_{4,\mathrm{Pre}} \equiv m_1 + d_{4,\mathrm{Pre}} \approx 0.899 + 0.144 = 1.042 \text{ hundredths of an inch and}$$

$$m_{5,\mathrm{Pre}} \equiv m_1 + d_{5,\mathrm{Pre}} \approx 0.899 - 0.092 = 0.806 \text{ (See Table 4-5.)}$$

Table 4-5
Study Site Comparisons of Pre Period Flow vs. Post Period Flow

	1001 Pre	1001 Post	1004 Pre	1004 Post	1005 Pre	1005 Post
Permeable Square feet	2,422,148	2,422,148	1,034,683	1,034,683	1,922,797	1,922,797
Permeable Acres (Table 4-3)	55.6	55.6	23.8	23.8	44.1	44.1
Coefficient from Table 4-4 (Hundredths of in/day/perm acre)	0.899	-0.445	0.144	0.878	-0.092	0.203

Table 4-5 (continued)

	1001 Pre	1001 Post	1004 Pre	1004 Post	1005 Pre	1005 Post
Hundredths of in/day/perm acre flow	0.899	0.453	1.042	1.777	0.806	1.101
in/day/perm acre flow	0.0090	0.0045	0.0104	0.0178	0.0081	0.0110
feet/day	0.04164	0.02063	0.0081	0.0178	0.0081	0.0110
Raw GPM	9.42	4.75	4.67	7.96	6.71	9.71
GPM/perm acre	0.169	0.085	0.197	0.335	0.152	0.208
Percent change in flow (Pre to Post)	**-50%**		**+70%**		**+37%**	

4.3.2 Post-intervention Period

The formal test for the change in runoff in the post-intervention period (June 2001-June 2002) can be found in the following three terms: variables 4, 5 and 6 as shown in Table 4-4. The estimated change in dry day runoff for Site 1001 (Variable 4 in Table 4-4), is -0.44 hundredths of an inch. In relative terms, this works out to approximately a 50 percent reduction. The implied mean post-intervention dry day runoff for Site 1001, is 0.89-0.44˜0.45 hundredths of an inch. This reduction in runoff is statistically distinguishable from zero at classical levels of confidence.

It should be noted that the pre- and post- periods are not comparable. The post-intervention period, June 2001 to June 2002, includes 13 months, but would be fairly close to an annual average. The period of time covered by the pre-intervention period for all sites, February to May 2001, includes at most four months. For Site 1001, the pre-intervention period only includes the months of April and May in 2001 because the flow meter produced enough invalid reads in February and March to necessitate its relocation to a new site in April. Since these are not the highest months for urban runoff, it would be reasonable to expect runoff in the post-intervention period to increase. For this reason, the reduction of 50 percent from the pre-intervention period would be a lower bound on the true estimate of runoff reduction. An examination of the other two valid sites would provide insight into how much runoff would have increased in the post-intervention period.

The estimated change in dry day runoff for Site 1004 (Variable 5 in Table 4-4) is +0.88 hundredths of an inch. This increase in runoff is statistically distinguishable from zero at classical levels of confidence. The implied mean post-intervention dry day runoff for Site 1004, is (0.89+0.88˜) 1.77 hundredths of an inch. In relative terms, this works out to a fairly large (1-{1.77-1.03}/1.03˜) 70 percent increase in the post-intervention period.

The estimated change in dry day runoff for Site 1005 (Variable 6 in Table 4-4) is +0.20 hundredths of an inch. This increase in runoff is statistically distinguishable from zero at close to classical levels of confidence. The implied mean post-intervention dry day runoff for Site 1005, is (0.89+0.20˜) 1.09 hundredths of an inch. In relative terms, this works out to a more modest (1-{1.09-0.80}/0.80=) 37 percent increase in the post-intervention period.

4.3.3 Comparison Across Sites

The last and potentially most vulnerable inference compares the time change in runoff across sites. If Site 1001 had experienced the same change in runoff as its neighbor sites 1005 or 1004, then dry day runoff would have increased from 37 to 70 percent in the post-intervention period. In absolute terms, this would imply a prediction of non-intervention runoff of 1.24 to 1.53 hundredths of inches per acre. Compared to the realized 0.45 hundredths of inches of runoff in the post-intervention period, this reduction would translate to reduction in runoff from 64 to 71 percent.

A similar counterfactual exercise for Site 1005 would require assuming that Site 1004 is a good matched control site. Then dry weather runoff in Site 1005 would have increased by 72 percent in the post-intervention period, a level of 1.38 hundredths of inches per acre. Compared to the realized 1.09 hundredths of inches of runoff in the post-intervention period, the reduction would translate into a modest but non-ignorable 21 percent decrease in runoff.

Both of these exercises require use of Site 1004 as a control site. While the unadjusted flow measures for Sites 1001 and 1005 are fairly close in the pre-intervention period, the same cannot be said for the flow measures from Site 1004. There are uncertainties as to which of the three estimates of reduction runoff for Site 1001 should be used. The direct within-site estimate of a 50 percent runoff reduction is likely biased low; runoff in the post-intervention period should have increased. The estimate of 64 percent, based on Site 1005 as a control site, may also be biased on the low side. Though Site 1005 did have pre-intervention runoff that reasonably matched Site 1001, Site 1005 also contained more than 200 homes that participated in the education-only intervention with monthly follow-up. These homes did have quantified water savings, some of which is likely to have resulted from reduced runoff. Site 1004 did not receive any treatment, but did have measurement issues. Thus, the estimate of a 71 percent reduction, using Site 1004 as a control site, has an unknown bias.

The bigger inferential uncertainties lie in how these conservation interventions will work as they are scaled in a larger program or in how implementations of these programs would work in other areas.

4.4 Conclusions

The difficulties encountered in calibrating custom configured equipment to measure dry season / low flow runoff limited the amount of pre-intervention data. This in turn precluded simple before and after comparisons of mean runoff flow. Nonetheless, a sufficient length of baseline data was collected to allow quantitative estimates of runoff reduction. If additional flow data can be collected, additional analysis would be possible: 1) the runoff reduction under wet conditions could be examined, and 2) an estimate of the seasonal shape of runoff could be included in the models to improve the precision of the estimated runoff reduction.

Because the runoff measurement is not at a customer level, it was not possible to distinguish the relative contribution of different customers to urban runoff reduction. Thus, for Site 1001, it was not possible to determine how much the single-family ET controller/education contributed relative to the ET controller intervention with medium-size landscape customers.

However, because the medium-size landscapes accounted for an estimated 70 percent of the area "treated" with ET controllers (Table 2-2), on strictly a proportional basis it is likely that the medium-size landscapes contributed to the majority of the observed runoff reduction for Site 1001.

Chapter 5 Water Quality and Watershed Implications

5.1 Overview

This chapter describes the water quality evaluations conducted as a part of the R3 Study and outlines the potential implications of these evaluations on the San Diego Creek Watershed. Specific information includes:

- A discussion of two approaches to the evaluation of water quality
- A summary of the study methods relating to water quality
- Development of "before and after" assessments of water quality to evaluate the effectiveness of ET technology and public education
- Detailed discussions of the evaluation approaches and findings based on these approaches
- A discussion of the implications of the findings for water quality in the San Diego Creek Watershed, focusing on TMDL constituents

More detailed information is provided in Appendices E1 and E2.

5.2 Introduction

Two independent reviews of water quality measurements were conducted as a part of this study. The initial review was conducted by SCCWRP as a part of its participation in the R3 Study and is included in its entirety as Appendix E1. This review used parametric statistical techniques (t-test; ANOVA), which provide a good descriptive review of the study data, but are generally considered to have less statistical power for detecting differences in data than other statistical tests. In general, because of the variability of the data and limitations in sample quantities, this review concluded that there was virtually no difference in either the concentration or "flux" (concentration times flow) of pollutants over time or between study treatments.

A subsequent statistical overview by Geosyntec Consultants was commissioned by IRWD to review alternative and possibly more "robust" data analysis techniques that might identify differences in study data not uncovered during the initial review. This work, which included the review of only a portion of the data set, focused on additional descriptive techniques (time series plots; box plots; probability distributions) and the use of non-parametric statistical techniques (rank-sum test; K-W). For some of the parameters reviewed, these techniques suggest that differences in measured water quality did occur across time and between study treatments. The entire Geosyntec report is provided in Appendix E2.

As noted above, both of the completed statistical reviews of the study data are included in the Appendices of this report. The remainder of this chapter of the report discusses the key findings of each review.

5.3 SCCWRP Water Quality Review

This section describes the SCCWRP evaluation approach, sampling and laboratory analysis, data analysis, and interpretations of the results. Watershed implications are also discussed.

5.3.1 Evaluation Approach

A before-after, control-impact (BACI) design was used to evaluate the effectiveness of both the sprinkler technology and public education. Each neighborhood was sampled every other week between December 2000 and June 2001. In June 2001, homes in one of the neighborhoods were outfitted with the ET controllers. Since homeowners with the retrofitted ET controllers were simultaneously being educated, a well-defined public education campaign was also begun with these homeowners. To ascertain the difference between education and ET technology, homeowners in a second neighborhood were targeted with an identical public education campaign, but without effect of the ET retrofit technology. There was no education or technology intervention in the remaining three neighborhoods, which served as control neighborhoods to document the effect of no treatment. Sampling at the five neighborhoods continued every other week from June 2001 to June 2002.

5.3.2 Sampling and Laboratory Analysis

Each neighborhood was hydrologically self-contained and drained to a single underground pipe. At each of these five locations, samples were collected for flow and water quality. Stage (water depth) and velocity were recorded at 5-minute intervals using an ultrasonic height sensor mounted at the pipe invert and a velocity sensor mounted on the floor of the pipe. Flow was calculated as the product of velocity and wetted cross-sectional area as defined by the stage and pipe circumference. Despite the relatively continuous measurement of flow, many of the flow measurements were excluded due to faulty readings. Synoptic flow and water quality measurements were only available for two sites over the course of the entire study (i.e. before and after intervention), including the ET controller + education and education only sites. Flow measurements at the time of water quality sampling for the three control sites were considered faulty and discarded.

Grab samples for water quality were collected just downstream of the flow sensors in the early morning using peristaltic pumps and pre-cleaned Teflon tubing. Samples were placed in individual pre-cleaned jars, placed on ice, and transported to the laboratory within one hour. Each sample was analyzed for 19 target analytes, five microbiological parameters, and four toxicity endpoints (Table 5-1). Target analytes included trace metals, nutrients, and organophosphorus (OP) pesticides. Microbiological parameters included fecal indicator bacteria and bacteriophage. Toxicity was evaluated using two marine species, the purple sea urchin *Strongylocentrotus purpuratus* and the mysid *Americamysis bahia*. All of the laboratory methodologies followed standard protocols developed by the USEPA or Standard Methods.

5.3.3 Data Analysis

Data analysis consisted of five steps: 1) comparison of water quality among the five neighborhoods prior to intervention; 2) comparison of water quality concentrations over time by neighborhood; 3) comparison of water quality concentrations before and after intervention by treatment type; 4) comparison of pollutant flux before and after intervention by treatment type; and 5) correlation of toxicity measures with potential toxicants in dry weather runoff.

Comparison of water quality concentrations among the five neighborhoods prior to intervention was conducted to assess if there were inherent differences among treatment sites for each

Table 5-1
Reporting Level and Method for Target Parameters

	Reporting Level	Method
Metals (ug/L)		
Antimony	0.2	EPA 200.8
Arsenic	1.5	EPA 200.8
Barium	0.2	EPA 200.8
Cadmium	0.2	EPA 200.8
Chromium	0.3	EPA 200.8
Cobalt	0.1	EPA 200.8
Copper	1.5	EPA 200.8
Lead	0.3	EPA 200.8
Nickel	0.2	EPA 200.8
Selenium	5.0	EPA 200.8
Silver	0.4	EPA 200.8
Zinc	5.0	EPA 200.8
Nutrients (mg/L)		
Ammonia as N	5.0	EPA 350.1
Nitrate/Nitrite as N	5.0	EPA 353.2
Total Kjeldahl Nitrogen	10.0	EPA 351.2
Ortho-Phosphate as P	0.5	EPA 365.1
Total Phosphorus	1.0	EPA 365.4
OP Pesticides (ng/L)		
Chlorpyrifos	20.0	IonTrap GCMS
Diazinon	20.0	IonTrap GCMS
Microbiology		
Enterococcus (MPN/100 mL)	2	SM9230B
Fecal Coliform (MPN/100 mL)	2	SM9221B
Total Coliform (MPN/100 mL)	2	SM9221B
MS2 Phage (PFU/100 mL)	2	EPA 1602
Somatic Phage (PFU/100 mL)	2	EPA 1602
Toxicity (% effluent)		
Sea Urching Fertilization EC50	NA	EPA 1995
Sea Urching Fertilization NOEC	NA	EPA 1995
Mysid EC50	NA	EPA 1993
Mysid NOEC	NA	EPA 1993

Note: ug/L = micrograms per liter; MPN/100 mL=most probable number per 100 milliliters; PFU/100mL=plaque forming units per 100 milliliters; mg/L=milligrams per liter; ng/L=nanograms per liter.

constituent. This analysis was conducted using ANOVA using Tukey's post hoc test for identifying the significantly different neighborhoods. All data was tested for normality and homogeneous variance prior to testing. Only the microbiological data was determined to be non-normally distributed, so these results were log transformed prior to data analysis.

Comparison of water quality concentrations over time was accomplished by creating temporal plots of monthly mean concentration. Comparisons of water quality concentration before and after intervention by treatment type were accomplished using a standard t-test of the mean concentration before versus mean concentration after intervention. The mean concentrations for ET controller + education, education only, and ET controller + education – education only for each sampling event were normalized by the grand mean of the control sites for the same sampling event.

Pollutant flux estimates were calculated by the product of the concentration and volume at the time of sampling and then normalized to the area of the sampled neighborhood. Pollutant flux before and after treatment was compared somewhat differently since the lack of flow data at the control sites did not permit an estimate of flux for these neighborhoods. Mean pollutant flux before and after intervention was compared using standard t-tests at the ET controller + education and education only neighborhoods without normalization to control values.

Correlation of toxicity with toxicant concentrations was accomplished using a Pearson product moment correlation. These correlations are inferential only and do not presume resulting correlations automatically identify the responsible toxicants. In order to help identify potential causative toxic agents, concentrations of the correlated constituents were compared to concentrations known to induce toxicity in the respective test organisms.

5.3.4 Evaluation Results

There were significant differences in water quality among sites prior to intervention (Appendix E1, Table WQ3). Site 1004, the control site, had the greatest mean concentrations for 15 of the 24 constituents evaluated prior to the ET controller intervention. In particular, all of the mean nutrient concentrations were greater at Site 1004 than the other sites. On the other hand, Sites 1001 and 1002 generally had the lowest average concentrations prior to the ET controller intervention. Cumulatively, these sites had the lowest mean concentrations for 17 of the 24 constituents evaluated. Site 1002 also had the least toxicity, on average, of all five sites. Finally, Site 1003 had an intermediate status. Mean concentrations of enterococcus and fecal coliforms at this site were greater than any other site (fecal coliforms significantly greater than Sites 1001 and 1002), but the mean concentrations of five trace metals (chromium, copper, cobalt, nickel, selenium) were lowest at this site.

Water quality concentrations and toxicity were highly variable over time during the study period. Temporal plots of concentrations and toxicity for each site demonstrated that there was no seasonal trend and no overall trend with time. There were, however, occasional spikes in concentrations for many constituents that appeared to fall into one of two categories. The first category was recurring spikes in concentration that were unpredictable in timing and location. The second category of concentration spike was single or infrequent peaks. Occasionally these spikes would occur across multiple sites, without commensurate changes in concentration at the treatment sites (1001 or 1005). More often, infrequent spikes were isolated to a single site. For example, concentrations of chlorpyrifos climbed to over 10,000 ng/L in July 2001, but averaged near 50 ng/L the remainder of the year at site 1005. Similarly, concentrations of ammonia and total phosphorus spiked 10 and 25-fold prior to June 2001 at the control site (1004) with less variability and overall lower concentrations the remainder of the study.

There were few significant differences that resulted from the intervention of education, ET controller + education, or ET controller + education – education only, relative to control sites (Table 5-2). Only six of the 24 constituents evaluated showed a significant difference between pre and post-intervention concentrations after normalizing to mean control values. These significant differences were a net increase in concentrations of ammonia, nitrate/nitrite, total phosphorus, chlorpyrifos, diazinon, and fecal coliforms. These statistical analyses were the result of one of two circumstances. In the first circumstance, there were individual large spikes in concentration at treatment sites, but not at control sites following intervention. Therefore, the net difference in concentrations between controls and treatments increased following the intervention. In these cases, removal of the outlier samples resulted in no significant difference among treatment effects relative to controls before intervention compared to after intervention. In the second circumstance, there were large spikes in concentrations at control site(s) prior to the intervention that later subsided, while treatment site concentrations and variability remained steady. Therefore, the difference between treatments and controls changed following interventions, although it was not a result of the education or technology.

Although there were no significant differences in pollutant flux as a result of the intervention, significant differences were noted in pollutant flux among sites prior to intervention. Site 1001, the ET controller + education site, had the greatest mean flux for 22 of the 24 constituents evaluated prior to the ET controller intervention. The mean flux for 20 of these 22 constituents was significantly greater at Site 1001 than the mean flux at Site 1005 (t-test, $p<0.05$). Site 1005 had greater mean fluxes only for MS2 phage and ammonia. The differences among the fluxes prior to (and after) intervention were the result of two factors: greater flow and, at times, greater concentrations at Site 1001 compared to Site 1005. Mean dry weather flow at the time of water quality sampling was nearly three times greater at Site 1001 than Site 1005.

Toxicity was inconsistently found at all five of the sampling sites, and there was no change in toxicity as a result of the intervention (Table 5-3). The two species tested did not respond similarly either among sites, among treatments, or over time. Correlation of toxicity with constituent concentrations yielded few significant relationships for either species (Table 5-3). Mysid toxicity was correlated with diazinon and several trace metals, but the strongest relationship was with diazinon concentration. Moreover, the concentrations of diazinon were well above the levels known to cause adverse effects in mysid, while trace metals were not. Sea urchin fertilization toxicity was only correlated with concentrations of zinc. The concentrations of zinc were well above the level known to induce adverse effects in this species.

Table 5-2
Significance of ANOVA Results for the Effect of ET Controller + Education, Education Alone, and the Difference Between ET Controller + Education and Education Alone Relative to Control Concentrations. (No data indicates p > 0.05)

	Effect of ET Controller + Education	Effect of Education Alone	Difference Between ET Controller + Education and Education Alone
Metals			
Antimony			
Arsenic			
Barium			
Cadmium			
Chromium			
Cobalt			
Copper			
Lead			
Nickel			
Selenium			
Silver			
Zinc			
Nutrients			
Ammonia as N	0.03	0.02	
Nitrate/Nitrite as N	0.02		
Total Kjeldahl Nitrogen			
Ortho-Phosphate as P			
Total Phosphorus		0.03	
OP Pesticides			
Chlorpyrifos	<0.01	<0.01	<0.01
Diazinon		<0.01	
Microbiology			
Enterococcus			
Fecal Coliform	0.04		
Total Coliform			
MS2 Phage			
Somatic Phage			
Toxicity			
Fertilization EC50			
Fertilization NOEC			
Mysid EC50			
Mysid NOEC			

Table 5-3
Correlation Coefficients (and p value) of Constituent Concentrations with Toxicity Endpoints (No Observed Effect Concentration, NOEC and Median Effect Concentration, EC50) in Dry Weather Discharges from Residential Neighborhoods in Orange County, CA. (No data indicates p > 0.05)

	Sea Urchin Fertilization NOEC	Mysid Survival NOEC	Sea Urchin Fertilization EC50	Mysid Survival EC50
Antimony		-0.273 (0.009)		
Arsenic		-0.3396 (0.001)		
Barium				
Cadmium				
Chromium		-0.244 (0.021)		-0.219 (0.044)
Cobalt		-0.330 (0.002)		-0.279 (0.010)
Copper				
Lead		-0.215 (0.042)		
Nickel				
Silver		-0.260 (0.013)		-0.229 (0.035)
Zinc	-0.277 (0.005)		-0.274 (0.006)	
Chlorpyrifos				
Diazinon		-0.426 (0.001)		-0.468 (0.001)
Ammonia				

5.3.5 Interpretation of Results

The evaluation was unable to find large, significant reductions in concentration or pollutant flux as a result of education and/or ET controller retrofit technology. This may indicate that the technology and/or education are inefficient for improvements in water quality. Equally as important, however, was the absence of meaningful increases in concentrations. Of the small number of concentrations that showed significant increases, most could be explained by highly variable spikes in concentrations reminiscent of isolated entries to the storm drain system, as opposed to ongoing chronic inputs or the effects of best management practices evaluated in this study.

If significant changes did occur, the evaluation design may not have detected these changes due to two factors. First, the variability in concentrations within and between sites is naturally high and the evaluation simply collected too few samples. After taking into account the variability and relative differences in mean concentrations, zinc was used as an example constituent to determine what sample sizes would be required to detect meaningful differences. Assuming that the sampling yielded the true mean and variance structure that actually existed at the five sites, power analysis indicated that a minimum sample size of no less than five-fold would have been required to detect the differences observed in zinc concentrations during this study.

The second factor that could have hindered the ability to detect meaningful differences in water quality is that the technology and education treatments were applied at the spatial scale of individual homes, while the evaluation design sampled at the neighborhood scale. This problem was exacerbated because only a fraction (approximately one-third) of the homes within the neighborhoods sampled had the technological or educational treatments. Therefore, the treatments were effectively diluted, decreasing the ability to detect differences in water quality.

5.3.6 Watershed Implications

It appears that residential dry weather flows measured in the R3 Study may contribute significant proportions of some constituents to overall watershed discharges. The study sites were located within the San Diego Creek watershed, the largest tributary to Newport Bay. The Orange County Public Facilities and Resources Department (OCPFRD) publishes monitoring data on San Diego Creek to provide environmental managers the information they need to properly manage the Bay (OCPFRD 2002). The dry weather monitoring data was compiled at the mouth of San Diego Creek from OCPFRD during 2001-2002 and compared the concentrations to our results from residential neighborhoods (Table 5-4). Mean concentrations of chlorpyrifos, diazinon, copper and zinc were much higher in upstream residential neighborhoods than concentrations measured at the mouth of San Diego Creek. These residential dry weather contributions were amplified by the fact that the San Diego Creek watershed is primarily composed of residential land uses. In contrast, concentrations of selenium, arsenic, and total phosphorus in the residential dry weather discharges were much lower than the cumulative dry weather discharges from San Diego Creek, indicating that residential areas may not be the primary source of these constituents.

Table 5-4
Comparison of Mean Concentrations (95% Confidence Intervals) in Residential Dry Weather Discharges from this Study Compared to Concentrations in Dry Weather Discharges from San Diego Creek at Campus Drive During 2001-2002. (Data from OCPFRD)

	San Diego Creek	Residential
Parameter	**Mean (95% CI)**	**Mean (95% CI)**
Nitrate	5.16 (0.72)	4.76 (1.96)
Phosphate	1.98 (0.07)	1.16 (0.20)
Diazinon	0.13 (0.07)	1.52 (0.52)
Chlorpyrifos	0.05 (0.01)	0.35 (0.44)
Copper	11.59 (2.83)	23.59 (5.65)
Arsenic	6.58 (0.40)	2.68 (0.26)
Selenium	21.22 (2.65)	2.46 (0.03)
Zinc	22.08 (2.75)	60.09 (8.26)

5.4 Geosyntec Water Quality Review

This section presents examples of alternative approaches to data analysis, data analysis methods, example results, and watershed implications.

5.4.1 Examples of Alternative Approaches to Data Analysis

These example analyses focus on TMDL constituents: nutrients (total nitrogen [TN] and total phosphorus [TP]), metals (copper, lead, zinc, cadmium), pesticides, and pathogens (fecal coliform). The analyses also focus on dry weather flows, as reduction of these flows was a major objective of the R3 Study.

5.4.2 Data Analysis Methods

Exploratory Data Analysis

Visual inspection of data and exploration of factors that could potentially influence data (e.g. seasonal trends, rain events)

1. Divide data into pre and post- intervention groups.
2. Construct time series plots to visually inspect data and visually examine for seasonal trends. Overlay storm event markers to identify any relation to rainfall volume or antecedent dry period (ADP).
3. Investigate normality or log normality of data sets. Select appropriate statistical tests.
4. Construct probability plots for pre-intervention and post-intervention periods.
5. Prepare quantile plots.
6. Prepare side-by-side box plots.
7. Calculate descriptive statistics

Hypothesis Testing

Test data for skewness, normality, and statistically significant differences. Skewness and normality tests are only needed if parametric approaches are conducted. Use of non-parametric approaches is recommended for consistency because normality will not be met in all cases. Nonetheless, examples are provided to show that several of the data sets do not come from a normal distribution.

1. Skewness hypothesis test for symmetry.
2. Shipiro-Wilkes normality test.
3. Mann-Whitney rank-sum test.
4. For the data sets that have greater than 50 percent censored data (i.e., data only known to be less than the detection limit), hypothesis tests for differences in proportions.

5.4.3 Example Results

The first step in the data analysis was to construct individual time-series plots for each site to identify seasonal periodicity, step-trends, and monotonic trends. Plotting each site individually reveals more information than plotting all sites together. Also, by overlaying storm events, the role of rainfall volumes and the ADP may be more apparent and may indicate whether additional analyses are warranted (e.g., correlating ADP with concentration). Figure 5-1 is an example time-series plot with storm event markers overlain for TP for Site 1001. As shown on the figure, the pre-intervention period had much more rainfall, which likely added to the variability in runoff concentrations and fluxes. However, it is apparent that the winter and spring concentrations appear to be lower and less variable during the post-intervention period. The irrigation controllers may have had an effect on the runoff concentrations by reducing the amount of irrigation during moister weather conditions (i.e., high soil moisture). A similar effect for TN is shown on Figure 5-2. Additional time-series plots are provided in Appendix E2.

Figure 5-1
Example Time-series Plot of Total Phosphorus with Storm Event Markers.

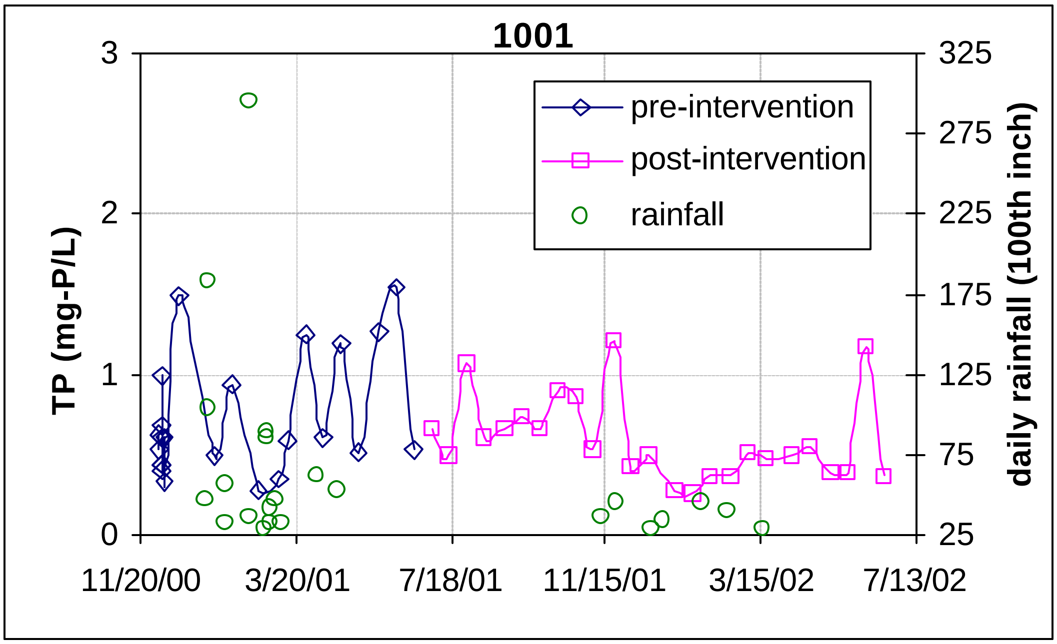
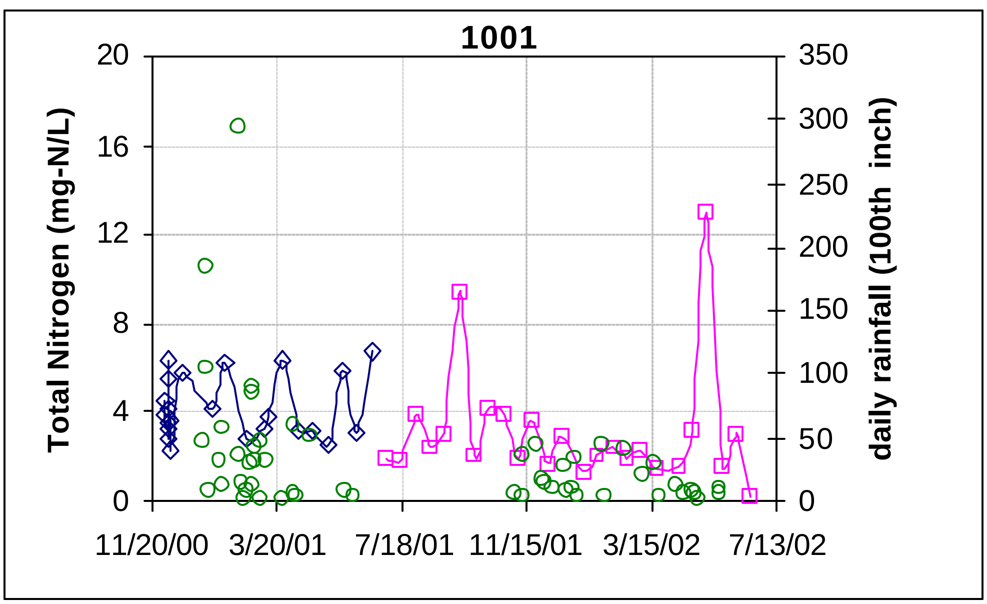


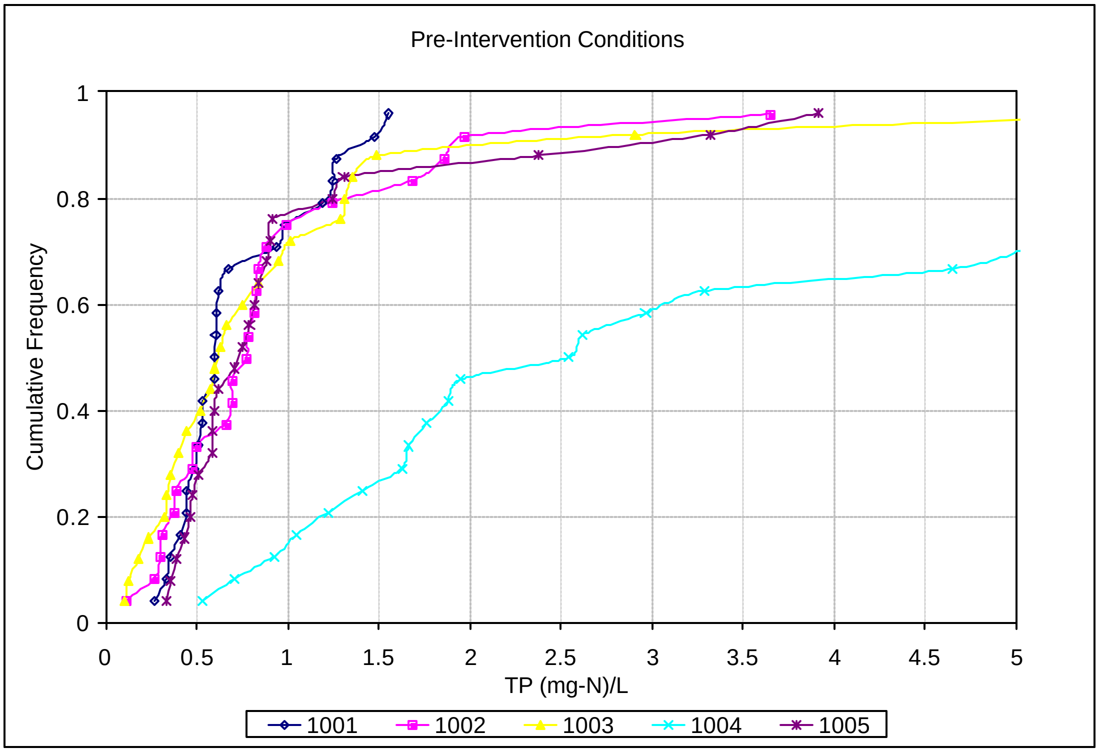
Figure 5-2
Example Time-series Plot of Total Nitrogen with Storm Event Markers.



5.4.3.1 Comparison of Water Quality Data Prior to Intervention

To visually investigate whether the test sites have similar runoff characteristics, probability plots were constructed. Figure 5-3 is an example of a probability plot for TP for all of the test sites. The figure shows that all of the sites have a similar distribution except for Site 1004.

Figure 5-3
Example Probability Plot of Total Phosphorus for All Sites Prior to Intervention.



The next step in the data analysis was to calculate parametric and non-parametric descriptive statistics. Table 5-5 is an example table of descriptive statistics for TN for all sites for both the pre- and post-intervention periods. (Additional descriptive statistics are included in Appendix E2). Table 5-5 includes the number of data points (n), the detection percent (%>MDL/RL), the mean, median, 25 percent trimmed mean, min, max, 25th percentile, 75th percentile, standard deviation, interquartile range (IQR), and the coefficient of skewness (g_s). Also included in the table are critical skewness coefficients (g_{cr}), which are readily available in statistics texts. If the coefficients of skewness are less than these critical values, then the data is symmetric. It should be noted that the measures of central tendency (mean and median) and variability (standard deviation) of the sites during the pre-intervention period are quite different, indicating the data arises from different distributions. The median values are consistently smaller than the mean (in some cases substantially smaller), demonstrating the influence of the outliers on the measure of central tendency. Only three pre-intervention data sets are symmetric, and none of the post-intervention data sets are. Failure to pass the symmetry test indicates the data is not normal. However, passing the symmetry test does not indicate the data is normal; this requires a normality test. The symmetry test, which is easier to conduct than normality tests, serves as an initial screen for normality to reduce the number of data sets needing further investigation.

Table 5-5
Example Table of Descriptive Statistics for Total Nitrogen for Each Site for Pre- and Post-intervention.

Parameter	Statistic	1001 Pre	1001 Post	1002 Pre	1002 Post	1003 Pre	1003 Post	1004 Pre	1004 Post	1005 Pre	1005 Post
TN (calculated)	n	23	25	23	25	23	25	23	25	23	25
(mg-N/L)	% > MDL/RL	100%	80%	98%	90%	98%	96%	98%	96%	100%	98%
	Mean	4.24	3.09	5.31	3.44	3.66	4.42	48.00	10.18	6.89	7.74
	Median	3.84	2.27	3.95	2.55	2.66	2.50	19.01	5.57	5.06	4.36
	Trimmed mean	3.94	2.40	4.53	2.76	2.93	3.01	33.11	6.47	5.08	4.42
	min	2.30	0.30	1.50	0.78	1.46	0.45	3.28	0.74	2.48	1.07
	max	6.76	12.99	13.83	11.40	12.12	19.91	141.06	40.80	20.41	67.12
	25th percentile	3.20	1.79	2.27	2.10	2.11	2.04	9.05	2.71	3.52	3.47
	75th percentile	5.68	3.13	8.02	4.36	4.81	5.17	94.79	19.18	7.07	5.62
	St Dev	1.41	2.67	3.56	2.51	2.48	4.39	49.17	10.73	5.29	12.85
	IQR	2.48	1.34	5.75	2.26	2.70	3.13	85.74	16.47	3.55	2.15
	Skewness, g_s	0.55	2.82	0.84	1.87	2.13	2.27	0.74	1.37	1.88	4.46
	g_{cr}	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	Symmetric ($g_s < g_{cr}$)?	Y	N	Y	N	N	N	Y	N	N	N

The non-parametric equivalent to the ANOVA test is the K-W test, which tests for a difference between the medians of independent data groups. The K-W test will also test whether the datasets are derived from the same distribution.

Comparison of the mean ranks in Table 5-6 provides an indication of whether the data groups are derived from the same distribution. A p values < 0.05 indicates that two or more of the data groups have different distributions. Examination of the mean ranks in Table 5-6 shows that Sites 1001, 1002, and 1005 have somewhat similar mean ranks, and Sites 1003 and 1004 have somewhat different mean ranks. This suggests that Sites 1003 and 1004 have a different distribution than the other sites. Thus, the K-W test was performed on just Sites 1001, 1002, and 1005. These results are shown in Table 5-7. The p-value is now greater than 0.05, so the distributions of the TN data are not significantly different. Based on this analysis, Site 1002 was determined to be the only control site for comparison of TN data. Furthermore, it is clear that Site 1004 should not be considered as a control site for TN, and Site 1003 should be used with caution.

Table 5-6
Example of Kruskal-Wallis Test Results for Total Nitrogen at the Test Sites Prior to Intervention.

Test:	**Kruskal-Wallis ANOVA**		
Comparison:	**Total Nitrogen: 1001, 1002, 1003, 1004, 1005**		
Performed by:	**GeoSyntec Consultants**		
n	115		
Total Nitrogen	**n**	**Rank sum**	**Mean rank**
1001	23	1128.0	49.04
1002	23	1162.0	50.52
1003	23	774.0	33.65
1004	23	2150.0	93.48
1005	23	1456.0	63.30
Kruskal-Wallis statistic	41.71		
p	<0.0001	(chisqr approximation)	

Table 5-7
Example of Kruskal-Wallis Test Results for Total Nitrogen at Sites 1001, 1002, and 1005 Prior to Intervention.

Test:	**Kruskal-Wallis ANOVA**		
Comparison:	**Total Nitrogen: 1001, 1002, 1005**		
Performed by:	**GeoSyntec Consultants**		
n	69		
Total Nitrogen	**n**	**Rank sum**	**Mean rank**
1001	23	710.0	30.87
1002	23	761.0	33.09
1005	23	944.0	41.04
Kruskal-Wallis statistic	3.27		
p	0.1948	(chisqr approximation)	

5.4.3.2 Comparison of Water Quality Data Before and After Intervention

Side-by-side box plots and probability plot comparisons of pre-intervention and post-intervention were constructed to identify any apparent differences in the central tendency and concentration distributions between the two data sets. Figure 5-4 shows side-by-side box plots of total nitrogen at all of the test sites. Site 1004 was omitted due to its high variability. The figure shows that Site 1001 has a distinct decrease in TN while the other sites do not. However, other sites do show a decreasing trend in median concentration and inter-quartile ranges.

Figure 5-4
Side-by-side Box Plots of Pre- versus Post-Intervention for Total Nitrogen at All Sites.

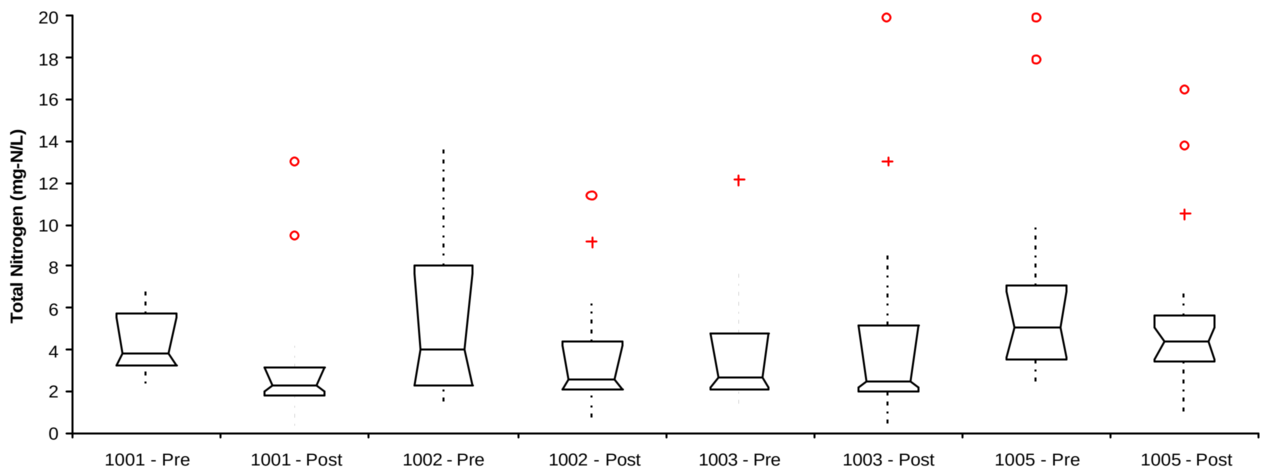
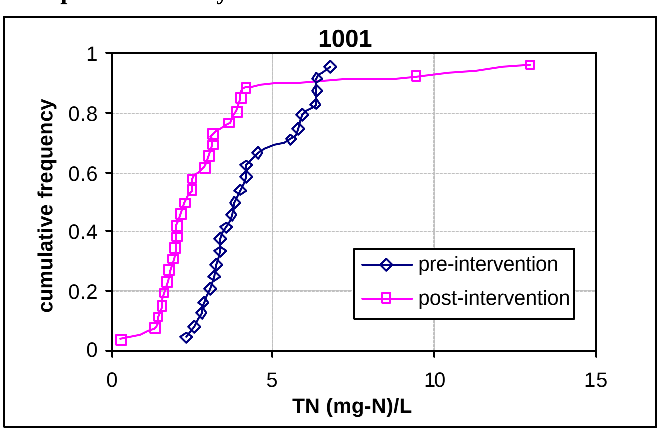


Figure 5-5 is a probability plot of TN for Site 1001 before and after intervention. (Additional probability plot comparisons are included in Appendix E2.) This figure shows a distinct reduction in TN at the site. However, since the data is from different time-periods, this difference could be related to temporal variability.

Figure 5-5
Example Probability Plot of Pre- versus Post-intervention for Total Nitrogen at Site 1001.



To evaluate if temporal variability caused by the different monitoring periods has anything to do with the difference in TN concentrations, the probability plots of the pre- and post-intervention period for Site 1001 were plotted with those for Site 1002 and Site 1005 (as these were determined to be the only valid control sites). These comparison plots are shown on Figure 5-6 and Figure 5-7. For pre-intervention, the distribution of Site 1001 more closely follows the distribution of Site 1005 than that of Site 1002, and for post-intervention the opposite is true. This indicates that the year-to-year variability alone cannot explain the reduction in TN at Site 1001.

Figure 5-6
Example Probability Plot for Total Nitrogen of Site 1001 versus Site 1002 for the Pre- and Post-Intervention Periods.

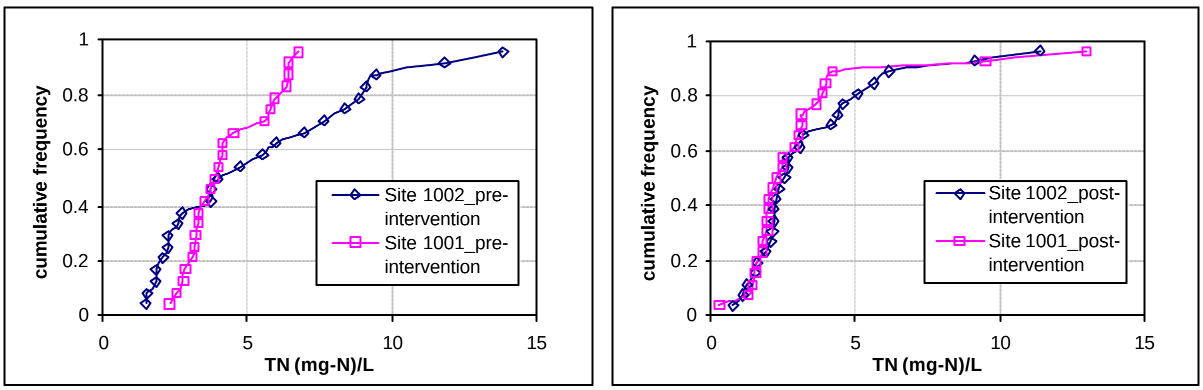
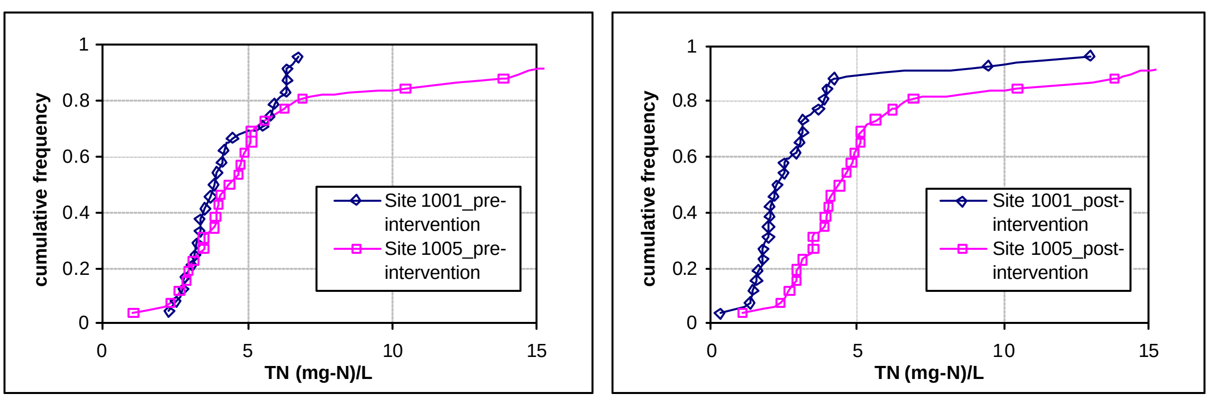


Figure 5-7
Example Probability Plot for Total Nitrogen of Site 1001 versus Site 1005 for the Pre- and Post-Intervention Periods.



The Mann-Whitney test (rank-sum) was used to determine if there is a statistical difference in the median values of two independent data sets (by rejecting the hypothesis that they are the same). Tables 5-8 through 5-10 show the output of the Mann-Whitney tests on Sites 1001, 1002, and 1005, respectively. The tables show a statistically significant difference ($p<0.05$) in the medians between the pre- versus post-intervention TN data at both Sites 1001 and 1002, but not at Site 1005. Furthermore, the difference in the medians at Site 1001 is at a higher level of confidence (more statistically significant) than the difference at Site 1002 (i.e., greater than 99 percent significant compared to about 96 percent significant). The magnitudes of these differences (Hodges-Lehmann estimator) are about 1.5 and 1.3 milligrams of nitrogen per liter (mg-N/L) for Sites 1001 and 1002, respectively. These tests indicate that the difference in the TN medians at Site 1001 from pre-intervention to post-intervention cannot be explained by the year-to-year variation alone (e.g., the intervention appears to have had an effect). It also indicates that the public education applied to Site 1005 did not appear to make a significant difference.

Table 5-8
Example Mann-Whitney Test for Difference in Medians for Total Nitrogen at Site 1001 from Pre- Versus Post-intervention.

Test :	**Mann-Whitney test**			
Alternative hypothesis	**1001: Pre versus Post**			
Performed by:	**GeoSyntec Consultants**			
n	48			
1001	**n**	**Rank sum**	**Mean rank**	**U**
Pre	23	736.0	32.00	115.0
Post	25	440.0	17.60	460.0
Difference between medians	1.497			
95.2% CI	0.883	to +?	(normal approximation)	
Mann-Whitney U statistic	115			
1-tailed p	0.0002	(normal approximation)		

Table 5-9
Example Mann-Whitney Test for Difference in Medians for Total Nitrogen at Site 1002 from Pre- Versus Post-Intervention.

Test:	**Mann-Whitney test**			
Alternative hypothesis:	**1002: Pre versus Post**			
Performed by:	**GeoSyntec Consultants**			
n	48			
1002	**n**	**Rank sum**	**Mean rank**	**U**
Pre	23	651.0	28.30	200.0
Post	25	525.0	21.00	375.0
Difference between medians	1.289			
95.2% CI	0.065	to +?	(normal approximation)	
Mann-Whitney U statistic	200			
1-tailed p	0.0355	(normal approximation)		

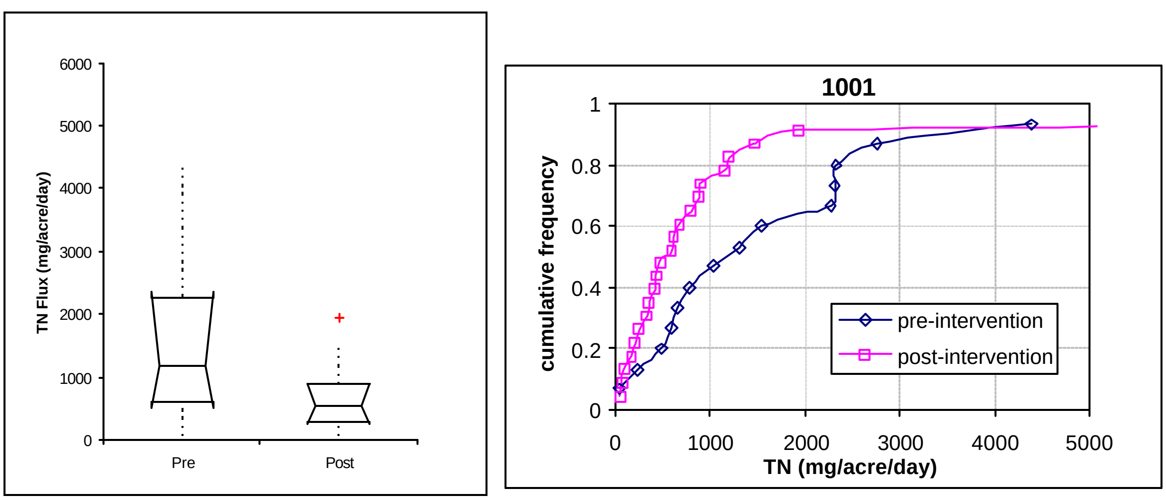
Table 5-10
Example Mann-Whitney Test for Difference in Medians for Total Nitrogen at Site 1005 from Pre- Versus Post-intervention.

Test:	**Mann-Whitney test**			
Alternative hypothesis:	**1005: Pre versus Post**			
Performed by:	**GeoSyntec Consultants**			
n	48			
1005	**n**	**Rank sum**	**Mean rank**	**U**
Pre	23	610.0	26.52	241.0
Post	25	566.0	22.64	334.0
Difference between medians	0.530			
95.2% CI	-0.446	to +?	(normal approximation)	
Mann-Whitney U statistic	241			
1-tailed p	0.1686	(normal approximation, corrected for ties)		

5.4.3.3 Comparison of Constituent Fluxes Before and After Intervention

The statistical procedures applied to the concentrations examples above were also applied to the constituent fluxes (mass loadings). For completeness, an abridged example analysis is provided here. Figure 5-8 includes side-by-side box plots and probability plots of total nitrogen flux data milligrams per acre per day (mg/acre/day) for Site 1001 at pre- and post-intervention. There appears to be a significant decrease in the median, as well as an overall reduction in the distribution of values.

Figure 5-8
Side-by-side Box Plot and Probability Plots of Pre- Versus Post-Intervention for Total Nitrogen Flues at Site 1001.



Table

Table 5-11 shows the results of the Mann-Whitney test (rank-sum) for the total nitrogen flux at Site 1001. The medians from pre- to post-intervention are statistically significantly different at the 95 percent confidence level ($p<0.05$). The magnitude of the difference (the Hodges-Lehmann estimator) is approximately 530 mg/acre/day, indicating a relatively large reduction in total nitrogen loads from the neighborhood. However, as discussed below, the extent to which the ET controllers contributed to this reduction is unclear.

The nitrogen fluxes used in this analysis were computed as the product of the measured concentration and the average daily flow. Therefore, the reduction in TN flux could be due to a reduction in flow, a reduction in concentration, or a combination of both. Analyses presented earlier showed a statistically significant reduction in median TN concentration at Site 1001 between the pre- and post-intervention periods. Similarly, analyses discussed elsewhere in this report indicate that there was a statistically significant reduction in flow at Site 1001 between the pre- to post-intervention periods; however, it was cautioned that the pre- and post-intervention periods are not comparable due to seasonal differences in the data collection period. Thus, observed reductions in flow in 1001 could be influenced by seasonal factors. Therefore, the extent to which the ET controllers contributed to a reduction in flow is unknown. Consequently, reductions in TN flux could be attributed to a combination of TN reduction, flow reduction, and/or seasonal factors.

Table 5-11
Example Mann-Whitney Test for Difference in Medians for Total Nitrogen Flux at Site 1001 from Pre-Versus Post-intervention.

Test :	**Mann-Whitney test**			
Alternative hypothesis	**1001 flux (mg/acre/day): Pre vs. Post**			
Performed by:	**GeoSyntec Consultants**			
n	36			
1001_flux (mg/acre/day)	**n**	**Rank sum**	**Mean rank**	**U**
Pre	14	320.0	22.86	93.0
Post	22	346.0	15.73	215.0
Difference between medians	529.389			
95.1% CI	115.985	to +?	(normal approximation)	
Mann-Whitney U statistic	93			
1-tailed p	0.0239	(normal approximation)		

The above results suggest that it would be valuable to complete a more robust statistical evaluation of the data because some significant management implications could be determined.

5.4.4 Watershed Implications

The water quality evaluation results were examined in the context of existing TMDLs in the San Diego Watershed. Most of the existing TMDLs are reviewed below, and possible inferences and implications of the R3 Study data for TMDL compliance are discussed. The sediment and organophosphorus pesticide TMDLs were not reviewed because sediment data was not collected (the vast majority of sediments are transported by storm flows) and because Schiff and Tiefenthaler (SCCWRP, 2003) have previously conducted an extensive analysis of the OP pesticide data.

5.4.4.1 Comparisons with Regulatory Requirements

Mean dry-season concentrations for nutrients, toxics, metals, and pathogens at the R3 Study Sites were compared with regulatory objectives including TMDL's, California Toxics Rule (CTR) criteria, and Basin Plan objectives in Tables 5-12 and 5-13. These comparisons are strictly descriptive and provide a rough sense of dry-season residential water quality in comparison to regional water quality objectives. This comparison shows substantial variability between neighborhoods and among constituents.

Table 5-12
Comparison of Dry Season Concentrations of Nutrients and Toxics at R3 Study Sites with Regulatory Objectives

Parameter/Location	Objective	Site 1001	Site 1002	Site 1003	Site 1004	Site 1005
TIN (San Diego Creek Reach 1 / Reach 2)	13 mg/L / 5 mg/L (RWQCB-TMDL)	4.079 mg/L	0.464 mg/L	2.18 mg/L	18.16 mg/L	4 mg/L
		Percent of Samples above Toxics TMDL				
		Site 1001	**Site 1002**	**Site 1003**	**Site 1004**	**Site 1005**
Chlorpyriphos -Acute (San Diego Creek Reach 1)	18 ug/L (RWQCB-TMDL)	36.59	N/A	N/A	22.76	43.9
Chlorpyriphos - Chronic- (San Diego Creek Reach 1)	12.6 ug/L (RWQCB-TMDL)	46.34	N/A	N/A	26.02	49.59
Diazinon - Acute- (San Diego Creek Reach 1)	72 ug/L (RWQCB-TMDL)	70.73	N/A	N/A	69.11	73.17
Diazinon - Chronic- (San Diego Creek Reach 1)	45 ug/L (RWQCB-TMDL)	74.80	N/A	N/A	75.61	77.24

Table 5-13
Comparison of Dry Season Concentrations of Metals and Pathogens at R3 Study Sites with Regulatory Objectives

		Percent of Samples above CTR Criteria				
Parameter	**Objective**	**Site 1001**	**Site 1002**	**Site 1003**	**Site 1004**	**Site 1005**
Copper -Acute	13 ug/L (CTR Criteria for Metal Toxicity*)	43.59	43.59	46.14	46.15	71.79
Copper -Chronic	9 ug/L (CTR Criteria for Metal Toxicity*)	74.36	56.41	76.92	74.36	87.18
Lead -Acute	65 ug/L (CTR Criteria for Metal Toxicity*)	0	0	0	0	0
Lead -Chronic	2.5 ug/L (CTR Criteria for Metal Toxicity*)	10.26	28.21	10.26	12.82	28.21
Zinc -Acute	120 ug/L (CTR Criteria for Metal Toxicity*)	0	7.69	5.13	7.69	15.38
Zinc -Chronic	120 ug/L (CTR Criteria for Metal Toxicity*)	0	7.69	5.13	7.69	15.38
		Median Dry Season Fecal Coliform				
Parameter	**Objective**	**Site 1001**	**Site 1002**	**Site 1003**	**Site 1004**	**Site 1005**
Fecal Coliform	200 MPN/100 mL (RWQCB Basin Plan)	1400 MPN/100 mL	3000 MPN/100 mL	5000 MPN/100 mL	13000 MPN/100 mL	65000 MPN/100 mL

5.4.4.2 Nitrogen

Nitrogen Water Quality Objectives and TMDLs **–** The Basin Plan water quality objectives for nitrogen in San Diego Creek are 13 milligrams per liter (mg/L) Total Inorganic Nitrogen (TIN) in Reach 1, and 5 mg/L TIN in Reach 2 (RWQCB, 1995). Reach 1 extends from Newport Bay to Jeffrey Road, and Reach 2 extends from Jeffrey Road to the headwaters. There is no numeric standard for nitrogen in Upper Newport Bay in the Basin Plan.

The nitrogen TMDL for Upper Newport Bay is based on the general goal of reducing nutrient loads to Newport Bay by 50 percent, to levels observed in the early 1970s (USEPA, 1998b). The nitrogen TMDL sets phase-in limits on TN loads to Newport Bay (see Table 5-14). Separate loads are established for the dry and wet seasons (dry season is from April 1 to September 30). In addition, the winter load is exclusive of storm flows with an average daily flow greater than 50 cubic feet per second (cfs) in San Diego Creek at Campus Drive.

There is no TMDL for nitrogen loads in San Diego Creek, Reach 1 because it was reasoned that attainment of the 50 percent reduction in nitrogen loads to Newport Bay would result in compliance with the Basin Plan in-stream water quality standard for Reach 1 (13 mg/L TIN). However, for Reach 2, it was determined that the average in-stream nitrogen concentrations would likely remain close to or above the Basin Plan in-stream water quality standard (5 mg/L TIN), even with attainment of the Newport Bay TMDLs. Therefore a TMDL of 14 lbs/day TN was established for Reach 2 (see Table 5-14) and is applicable for all flows exclusive of storm flows greater than an average daily flow of 25 cfs in San Diego Creek at Culver Drive.

Table 5-14
Summary of Nutrient TMDLs for Upper Newport Bay and San Diego Creek

TMDL	Dec 31, 2002	Dec 31, 2007	Dec 31, 2012
Newport Bay Watershed, TN – Summer load (4/1 to 9/30)	200,097 lbs	153,861 lbs	
Newport Bay Watershed, TN – Winter load (10/1 to 3/31; non-storm)			144,364 lbs
Newport Bay Watershed, Total Phosphorus – Annual Load	86,912 lbs	62,080 lbs	
San Diego Creek, Reach 2, daily load			14 lbs/day
Urban Runoff Allocation for the Newport Bay Watershed Summer load Winter load	 22,963	 11,481	 38,283

***Study Data Comparison with Nitrogen Water Quality Objective* –** The Basin Plan water quality objectives are expressed in terms of TIN, which is comprised of nitrate/nitrite nitrogen and ammonia. By far the majority of the TIN in San Diego Creek is comprised of nitrate/nitrite nitrogen, as measured ammonia concentrations were typically quite low with a majority below the detection limit. For this reason, only the nitrate/nitrate concentration data is compared to the Basin Plan objectives in this report.

Table 5-15 shows the mean and median nitrate/nitrite concentrations measured in the five study sites. The mean and median nitrate/nitrite concentration of all sites except 1004 was below the Reach 2 Basin Plan objective of 5 mg/L TIN. As discussed previously, Site 1004 may not be a representative control site because the underlying distribution of pre-intervention nitrogen data appears to be different from the other sites. Similar arguments may also be true for Site 1003. With the exception of Site 1004, mean nitrate/nitrite concentrations suggest that, <u>on average</u>, residential runoff from these sites does not contribute to the exceedance of Basin Plan standards for TIN in receiving waters in San Diego Creek, Reach 1 and 2. The Reach 2 water quality objective was occasionally exceeded in all sites, except for the post intervention conditions in 1001 and 1002.

Table 5-15
Mean and Median Nitrate/Nitrite Concentration (mg/l) by Site (all data).

	1001		1002		1003		1004		1005	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
n	23	25	23	25	24	25	23	25	24	25
Mean	2.56	1.47	2.57	1.07	2.13	1.71	36.50	6.61	2.61	4.13
Median	2.32	1.38	1.56	0.93	1.68	0.94	16.88	2.29	2.45	1.48
n>5 mg/L	1	0	4	0	1	2	18	8	2	1
n>13 mgL	0	0	0	0	0	0	12	4	0	1

The mean and median nitrate/nitrate concentrations in Sites 1004 and 1005 exhibit exceedances of the 5 mg/L standard during pre- and/or post intervention conditions. Site 1004, in particular, had high levels of measured nitrate/nitrite concentrations, especially during the pre-intervention period. A number of these high readings exceed the Reach 1 water quality objective of 13 mg/L TIN. The results from Site 1004 are not consistent with those from the other four study sites, and the source of the high readings is unknown. Localized conditions involving excessive fertilizer usage by a few users could possibly be a factor in these elevated readings. In particular, the R3 Study mentions an unknown connection to a neighboring watershed, which could explain the source of elevated nutrient levels.

The Mann-Whitney (rank-sum) test was performed to compare the statistical difference between median concentrations during pre- and post-intervention periods. The median nitrate/nitrite in the post-intervention period was lower at all sites, and the difference was statistically significant at the 0.05 confidence level. As the control stations exhibited this trend, the data (i.e. entire data sets with unequal seasonal coverage) cannot be used to ascertain if the structural and educational BMPs were effective in reducing the runoff concentrations of nitrate/nitrite.

Clearly another factor is contributing to reduced concentrations in the post-intervention period. One possibility that was investigated is differences in seasons, year-to-year variability, and sampling times of the pre- and post-intervention data. Table 5-16 presents mean and median concentrations for comparable seasons and sampling times. The table shows that there are still noticeable reductions in all of the median concentrations, except Site 1005. Applying the Mann-Whitney (rank-sum) test to the data, it was found that statistically significant differences between median nitrate/nitrite concentrations in the pre- and post-intervention periods occurred only at Sites 1001 and 1004, as compared to all sites when all data is considered. These results indicate that seasonal effects are present in the data and should be considered in the study evaluation. It may be inferred from these results that there were significant reductions in the nitrate/nitrite concentration in the intervention site during the wet season that may, in part, be attributable to the structural BMPs. It is unknown whether similar reductions would occur in dry weather runoff during the dry season because such data was not collected during the pre-intervention period.

Table 5-16
Mean and Median Nitrate/Nitrite Concentration (mg/l) by Site for Comparable Seasons and Sampling Times[1]

	1001		**1002**		**1003**		**1004**		**1005**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
n	18	14	18	14	19	14	18	14	19	14
Mean	2.38	1.43	1.95	0.95	2.17	1.66	26.24	6.57	2.24	6.27
Median	2.22	1.48	1.16	0.96	1.50	1.02	8.94	2.06	2.03	1.96
n>5 mg/L	0	0	2	0	1	1	13	4	1	1
n>13 mg/L	0	0	0	0	0	0	7	3	0	1

1 – evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.

Study Data Comparison with Nitrogen TMDLs **-** The nitrogen TMDL is expressed in terms of total nitrogen TN loads. TN concentrations were calculated from the monitoring data as the sum of the nitrate/nitrite nitrogen and total Kjeldahl nitrogen (TKN) nitrogen. Table 5-17 shows the mean and median TN concentrations measured in the five study sites. The mean and median TN concentration in dry weather runoff are generally in the range of 2 to 5 mg/L, with the exception of Site 1004 where substantially higher concentrations were measured. The rank sum tests indicated that median TN concentrations were significantly lower (in a statistical sense) in the post-intervention period in Site 1001 (structural BMPs, see Table 5-8), and at Site 1002 (control, see Table 5-9). Based on the probability plots in Appendix E2, Site 1004 is expected to as well. However, Sites 1003 and 1005 did not show statistically significant reductions. These results did not change when only subsets of the data were used to consider possible effects stemming from the sampling time and sampling months.

Table 5-17
Mean and Median TN Concentration (mg/l) by Site

	1001		**1002**		**1003**		**1004**		**1005**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
All Data										
n	23	25	23	25	23	25	23	25	23	25
Mean	4.24	3.09	5.31	3.44	3.66	4.42	48.00	10.18	6.89	7.74
Median	3.84	2.27	3.95	2.55	2.66	2.50	19.01	5.57	5.06	4.36
Subsets[1]										
n	18	14	18	14	18	14	18	14	18	14
Mean	4.18	2.78	4.51	2.63	3.71	3.71	33.99	8.91	6.98	9.91
Median	3.62	2.02	3.22	2.21	2.51	2.47	12.14	3.74	4.17	3.96

1 – Data subsets with comparable sampling time and seasons. Evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.

TN flux estimates were calculated for Sites 1001 and 1005 (Table 5-18). The flow measurements at Sites 1002 to1004 are not reliable. Therefore, flux estimates were not calculated for these sites. Flux estimates were calculated as the product of the constituent concentration and the average daily flow occurring on the day of the sample collection. The flux estimates were found to be quite variable as they depend on both flow and concentration measurements. Table 5-18 shows that median TN flux estimates decreased from the pre- to post-intervention periods for both sites. Mann-Whitney (rank sum) tests show the reductions to be statistically significant (Table 5-11). Because comparable data is not available for the control sites, it is not possible to infer whether these reductions are influenced by the ET controllers in the intervention site (1001). Also, as previously discussed, the reduction in TN flux may be attributable to a reduction in flow, a reduction in concentration, seasonal factors, or a combination of these.

Table 5-18
Mean and Median TN Flux (mg-N/acre/day) by Site

	1001		**1005**	
	Pre	**Post**	**Pre**	**Post**
All data				
n	14	22	10	21
Mean	1476	1667	2104	6537
Median	1164	530	1568	1177
Subset[1]				
n	12	14	10*	8
Mean	1384	587	2104	1716
Median	902	497	1568	960

1 – Data subsets with comparable sampling time and seasons. Evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.
* – Same as the all data case

Although the flux estimates in Table 5-18 are limited in number, duration, and location, they can be used to speculate about the magnitude of the urban area contribution of TN loads to Newport Bay and the potential reduction in loads from structural and nonstructural BMPs. Based on the limited flux data, the annual TN load to Newport Bay in dry weather runoff from urban areas in the San Diego Creek Watershed is estimated to range between 37,000 to 50,000 lbs per year under existing land-use conditions (see Table 5-19). This is for the most part below the 2012 urban runoff allocation of 49,764 lbs. The annual TN load is estimated to increase to 50,000-67,000 lbs per year under build-out conditions.

According to the 2001 report on the nutrient TMDL (OCPFRD, 2001), the average daily TN load in San Diego Creek at Campus Drive was 540 lbs/day between July 2000 and June 2001. This converts to an annual load of about 197,000 lbs, which is below the 2007 TMDL (note: San Diego Creek is the majority but not sole contributor of TN loads to Newport Bay). Estimates in Table 5-19 suggest that dry weather runoff from urban areas account for about 20 to 25 percent of the annual TN in the San Diego Creek Watershed. If it is assumed that flux reductions observed in the post intervention period are attributable to the structural and nonstructural BMPs, and if similar interventions could hypothetically be implemented on a watershed-wide basis, then the potential reduction in annual dry weather TN loads is estimated to range between 12,500-20,000 lbs. This would represent a reduction of about 6-10 percent of the current TN loads and about 30-40 percent of the estimated current dry weather urban loads. These estimates are based on few data collected in a limited area and should therefore be considered preliminary in nature.

Table 5-19
Estimated Annual TN Loads in Dry Weather Runoff from Urban Areas in the San Diego Creek Watershed

	TN flux (mg-N/acre/d)	Annual TN Load to Newport Bay (lbs) Existing land-use[1]	Annual TN Load to Newport Bay (lbs) Built-out land-use[2]
Pre-intervention conditions	1160 – 1560	37,300 – 50,500	50,000 – 67,000
Post-intervention conditions	530 – 1180	17,000 – 38,000	23,000 – 51,000
Potential reduction		~12,500 – 20,000	~16,000 – 27,000

1 –Used 40000 acres or about 53% of the San Diego Creek Watershed area (IRWD, 2003). For comparison, urban land use in 1999 use was estimated at 35,500 acres of the watershed area at Campus Drive (Tetra-Tech, 2000).
2 – Used 53500 acres or about 71% of the San Diego Creek Watershed area (IRWD, 2003).

The following conclusion can be made based on the analyses above:

- Average and median nitrate/nitrite concentrations in dry weather runoff are below the Reach 2 water quality objective (5 mg/L), for most but not all study sites.
- Occasional exceedance of the Reach 2 water quality objective occurred in all study sites.
- The majority of measured nitrate/nitrite concentrations at Site 1004 during the pre-intervention period were greater than the Reach 2 water quality objective of 5 mg/L. The data is not consistent with those from the other sites. The cause is unknown, but could possibly be related to the unknown connection to the neighboring nursery discussed in the R3 report.
- Sampling periods (months) and sampling time (morning versus evening) were found to affect the statistical significance of differences between pre- and post- intervention median nitrate/nitrate concentration in some of the sites. The sampling period and sampling time did not affect the statistical significance of differences between pre- and post-intervention median TN concentrations.
- Median TN fluxes at Sites 1001 and 1005 were statistically smaller in the post-intervention period. The extent to which the structural and nonstructural BMPs contributed to these reductions cannot be determined due to the lack of reliable flow data in the control sites.
- Preliminary estimates of annual TN loads to Newport Bay in dry weather runoff from urban sources range between 37,000 to 50,000 lbs per year, or about 20 to 25 percent of the current TN loads.
- The potential reductions in annual dry weather TN loads due to implementation of BMPs on a watershed basis is estimated to range between 12,500-20,000 pounds per year. This would represent a reduction of about 6-10 percent of the current TN loads and 30-40 percent of the urban loads.

5.4.4.3 Phosphorus

The majority of the annual TP load in the San Diego Creek Watershed occurs in the wet season, and has been correlated with sediment loads generated by storm events (USEPA, 1998b). This correlation suggests that a majority of phosphorus occurs in particulate form attached to sediments. The main sources of the TP are in Peters Canyon Wash and San Diego Creek above Culver Drive (USEPA, 1998b).

Phosphorus TMDL **–** There is no numeric objective for phosphorus for San Diego Creek in the Basin Plan. Because measured TP and sediment loads are correlated, it was determined in the TMDL that a 50 percent reduction in TP loads would be achieved through compliance with the sediment TMDL (USEPA, 1998a). Accordingly, the TMDL for TP was based on a 50 percent reduction of average annual load estimated at 124,160 lbs (USEPA, 1998b). The TMDLs are applicable for all flow conditions. The target compliance date was set for December 31, 2007.

The annual TP load allocation for urban areas is 4102 lbs by 2002, reducing to 2960 lbs by 2007. According to the USEPA (1998b), the TP is allocated in the same proportion as sediments. The annual urban area (stabilized vs. construction) sediment allocation for the Newport Bay Watershed is 50 tons distributed over 95.3 square miles (see Table 5 in USEPA, 1998a). This is a very small allocation over a large area. By contrast, the annual construction allocation is 6500 tons distributed over the assumed 3.0 square miles under construction in any one year. Using the same proportions of sediment load allocations, the TP load rate based on the 2007 urban allocation is 2960 lbs/95.3 square miles = 0.0485 lbs/acre/yr. If the construction and urban allocations are combined, the TP load rate based on the combined 2007 urban and construction allocations is (2960+12810) lbs/(95.3+3.0) square miles = 0.251 lbs/acre/yr.

Study Data Comparison with TMDLs **–** Similar to the nitrogen TMDL, the phosphorus TMDL is expressed in terms of total annual TP loads. Table 5-20 shows the mean and median TP concentrations measured in the five study sites. The mean and median TP concentrations in dry weather runoff are below 1.2 mg/L in all sites, with the exception of Site 1004, where substantially higher concentrations were measured. Comparison of the pre- and post-intervention median TP concentrations in all data (Table 5-20) reveals an increase in the median TP concentration during the post-intervention period for all sites except the intervention Site 1001 and Site 1004. In contrast, when subsets of the data with similar seasons and sampling times are considered (Table 5-20), there is a decrease in the median TP concentration at all sites except 1005. This indicates that there are seasonal influences in the data, which presumably are related to rainfall. Unfortunately, no data is available to permit comparison of pre- and post-intervention concentrations for dry weather flows during the dry season.

Table 5-20 Mean and Median TP Concentration (mg/l) by Site

	1001		**1002**		**1003**		**1004**		**1005**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
All Data										
n	23	25	23	25	24	25	23	24	24	25
Mean	0.73	0.60	0.92	0.84	0.98	1.21	3.33	1.50	1.01	1.19
Median	0.60	0.51	0.77	0.82	0.62	0.67	2.54	1.05	0.73	0.85
Subsets[1]										
n	18	14	18	14	19	14	18	13	19	14
Mean	0.78	0.47	0.91	0.67	1.13	0.57	2.62	1.33	0.93	1.24
Median	0.61	0.41	0.73	0.56	0.75	0.58	1.82	1.07	0.75	0.83

1 – Data subsets with comparable sampling time and seasons. Evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.

TP flux estimates were calculated for Sites 1001 and 1005 using the approach discussed in the nitrogen section above. Table 5-21 shows that median TP flux estimates decrease from the pre- to post-intervention periods at the intervention site (1001), but not in the education only site (1005). Mean fluxes increased at both sites. However, as discussed earlier, the mean values are strongly influenced by outliers and do not provide a good measure of central tendency for the data. Application of the Mann-Whitney (rank sum) test shows the reduction in median TP flux at Site 1001 is statistically significant. This suggests that the structural BMPs had a positive influence in reducing the TP fluxes. However, because comparable data is not available for the control sites, it is not possible to ascertain the extent to which the ET controllers contributed to these reductions. Also, as discussed previously, reductions in flux could be influenced by several factors: reduction in concentration, reduction in flow, and/or seasonal variability.

Table 5-21
Mean and Median TP Flux (mg-P/acre/day) by Site (all data)

	1001		**1005**	
	Pre	**Post**	**Pre**	**Post**
All data				
n	14	22	10	21
Mean	265	370	473	1327
Median	164	109	219	219

Similar to the previous analyses of TN loads, the TP flux estimates in Table 5-21 can be used to speculate about the magnitude of the urban area contribution of TP loads to Newport Bay and the potential reduction in loads from structural BMPs. Based on the limited flux data, the annual TP load to Newport Bay in dry weather runoff from urban areas in the Newport Bay Watershed is estimated to range between about 5,000 to 11,000 lbs per year (see Table 5-22), assuming a total urban area of 95.3 square miles obtained from Table 5 of the sediment TMDL (USEPA, 1998a). These estimated annual TP loads are greater than the urban allocation (for both dry and wet weather) and are less than the combined urban and construction allocations (Table 5-22). However, these estimates are based on dry weather data only, and it is expected that a major portion of the TP loads will occur in runoff from winter storms. Therefore, actual annual TP loads would be expected to be greater. If it is hypothesized that flux reductions observed at the intervention site (1001) could be realized over the entire watershed, then the potential reduction in annual dry weather TP loads from urban areas is estimated at 2700 lbs. As stated previously, these estimates are based on few data collected in a limited area and should therefore be considered preliminary in nature.

Table 5-22
Estimated Annual TP Loads in Dry Weather Runoff from Urban Areas in the San Diego Creek Watershed

	TP flux (mg-P/acre/d)	Annual TP Load Rate to Newport Bay (lbs/acre/year)[1]	Annual TP Load to Newport Bay (lbs/year)
2007 Urban Area Allocation for Newport Bay		0.0485	2960
2007 Combined Urban and Construction Area Allocation for Newport Bay		0.251	15770
Pre-intervention conditions (median fluxes)	164 – 219	0.132 – 0.176	8049 – 10748
Post-intervention conditions (median fluxes)	109 – 219	0.088 – 0.176	5350 – 10748
Potential reduction			2700

1 - urban area is 95.3 square miles and the construction area is 3.0 square miles based on Table 5 in USEPA,1998a

5.4.4.4 Metals

Metals TMDLs **–** The USEPA (June 2002) determined that TMDLs are required for dissolved copper, lead, and zinc in San Diego Creek, Upper Newport Bay, and Lower Newport Bay, and that TMDLs are required for cadmium in San Diego Creek and the Upper Newport Bay. The TMDLs for San Diego Creek are expressed as concentration limits, based on the California Toxic Rule (CTR) criteria at various hardness values that are associated with different flow regimes (Table 5-23). The flow regimes are based on 19 years of flow measurements in San Diego Creek at Campus Drive. The concentration-based TMDLs apply to all freshwater discharges to San Diego Creek, including discharges from agricultural, urban, and residential lands, and storm flow discharges. The applicable flow regime at any location in the entire watershed is determined on the basis of discharge at Campus Drive.

Table 5-23
Summary of Dissolved Metal TMDLs for San Diego Creek

Dissolved Metal (?g/l)	Base flow (0–20 cfs) hardness @ 400 mg/L		Small flows (21-181 cfs) hardness @ 322 mg/L		Medium flows (182-814 cfs) hardness @ 236 mg/L		Large flows (>814 cfs) hardness @ 197 mg/L
	Acute	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**
Cadmium	19.1	6.2	15.1	5.3	10.8	4.2	8.9
Copper	50	29.3	40	24.3	30.2	18.7	25.5
Lead	281	10.9	224	8.8	162	6.3	134
Zinc	379	382	316	318	243	244	208

Metals Sources **–** The USEPA (June 2002) conducted a source analysis as part of the TMDL preparation. Surface runoff is the largest contributor of metals loads in the San Diego Creek watershed, which includes natural and man made sources (USEPA, June 2002). Much of the metals loads are from natural sources. The estimated anthropogenic contributions are metal specific and range from about 33 percent for zinc to 63 percent for cadmium (USEPA, June 2002). A primary anthropogenic source of heavy metals is runoff from urban roads, which contributes to sources of cadmium (tire wear), copper (brakes, tires), lead (brakes, tires, fuels and oils), and zinc (tires, brakes, galvanized metals). Use of copper sulfate by nurseries may also be a minor source of copper loads. Other copper and zinc uses in building materials (roofing and roof drains) may be another source.

The USEPA found that metal inputs were heavily influenced by rainfall and stream flow rates. Monitoring results were reported to be highly variable due to different rainfall amounts and flows during each water year. The USEPA estimated that base flows account for 25 percent of the total metal loadings, with the remainder from low, medium and large flows caused by storms.

The USEPA's preliminary analyses suggest that: 1) a primary source of metals in dry weather runoff in the study watershed is from roads (i.e. wash off of metals in driveways, parking lots, streets, gutters, etc.); 2) the runoff concentrations will be influenced by rainfall which result in wash off of accumulated metals; and 3) the concentrations can be variable depending on the amount of rainfall.

Study Data Comparison with Base Flow TMDLs **–** The metals TMDLs for base flow conditions are based on meeting the CTR criteria at a total hardness of 400 mg/L. The CTR criteria express maximum allowable concentrations in receiving waters for acute (short term) and chronic (4-day) exposure periods. The acute and chronic criteria are expressed as values that cannot be exceeded more that once in three years. Although the criteria are applicable in the receiving waters and not in the urban runoff per se (i.e. the measured dry weather discharge), exceedance of the CTR in the urban discharge would suggest a potential for the discharge to contribute to an exceedance in the receiving waters.

Table 5-24 shows the mean and median heavy metal concentrations in the five study sites. With the exception of mean copper concentrations in some of the sites, all mean and median concentrations were below the chronic and acute CTR criteria. Copper, lead, and zinc concentrations occasionally exceeded the chronic CTR criteria, and copper and zinc concentrations occasionally exceeded the acute criteria. These exceedances suggest that the dry weather runoff can potentially contribute to an exceedance in the receiving waters. However, if intervention is determined to be effective in reducing runoff flows, then the BMPs would help to reduce impacts of these potential exceedances by allowing for greater dilution with the in-stream flows.

Table 5-24
Mean and Median Metal Concentrations (mg/L) by Site (all data)

	1001		1002		1003		1004		1005	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Cadmium										
n	23	25	23	25	24	25	23	25	24	25
Mean	0.26	0.14	0.47	0.44	0.27	0.17	0.64	0.22	0.21	0.29
Median	0.27	0.10	0.24	0.10	0.10	0.10	0.36	0.10	0.10	0.10
n>6.2 ? g/l	0	0	0	0	0	0	0	0	0	0
n>19.1 ? g/l	0	0	0	0	0	0	0	0	0	0
Copper										
n	23	25	23	25	24	25	23	25	24	25
Mean	13.5	16.9	27.3	30.3	11.5	26.6	21.8	17.7	32.1	30.8
Median	11.5	11.4	10.9	14.0	11.1	14.3	12.7	11.4	12.3	20.4
n>29.3 ? g/l	2	2	3	7	0	2	5	4	3	5
n>50 ? g/l	0	1	3	3	0	2	2	3	3	2
Lead										
n	23	25	23	25	24	25	23	25	24	25
Mean	0.8	1.6	5.9	4.7	0.8	1.6	3.5	1.5	1.0	3.2
Median	0.6	0.6	0.9	1.2	0.6	0.8	0.7	0.7	0.7	1.3
n>10.9 ? g/l	2	1	2	3	0	0	2	0	0	1
n>281 ? g/l	0	0	0	0	0	0	0	0	0	0
Zinc										
n	23	25	23	25	24	25	23	25	24	25
Mean	58.7	37.2	115.2	86.3	56.3	56.8	83.6	40.9	74.0	75.0
Median	56.0	50.2	53.4	57.2	50.7	53.9	50.8	43.8	52.4	54.5
n>382 ? g/l	0	0	1	2	0	0	1	0	0	0
n>379 ? g/l	0	0	1	2	0	0	1	0	0	0

Dry weather metals monitoring information in the Central Irvine Channel, the immediate receiving water of the study watersheds, was unavailable. OCPFRD dry weather monitoring data is available in San Diego Creek at Campus Drive, which is quite a way downstream from the study sites. Data collected between December 2001 and June 2002 (Table 5-25) shows that average dry weather concentrations at Campus Drive are well below mean and median concentrations measured in dry weather runoff from the study watershed. Similar comparisons cannot be made for lead and cadmium because the method detection limits in the OCPFRD data are greater than those in the R3 data. None of the OCPFRD dry weather data exceeded the chronic or acute criteria.

Table 5-25
Summary of OCPFRD Dry Weather Monitoring Data of San Diego Creek at Campus Drive (12/01 to 6/02)

	Cadmium	Copper	Lead	Zinc
Sample number	24	24	24	24
Range	All < 1 ?g/l	<2 – 16 ?g/l	<2-2.4 ?g/l	<10-16
Mean		7.4 ?g/l	most <2 ?g/l	most <10
Median-		6.8?g/l		

These comparisons suggest that metal loads in dry weather runoff from the study (urban) watersheds could be a contributing factor to dry weather copper and zinc loads measured at Campus Drive. These dry weather discharges do not result in non-compliance of the base flow metal TMDL at Campus (based on the reviewed data only). It is unknown if the elevated concentrations measured in the dry weather urban runoff result in exceedance of the CTR criteria in the immediate receiving waters. If flow reductions observed in the intervention watershed are attributable to the ET controllers, then these controllers would help to reduce impacts from any potential exceedances of the TMDL because the discharges would be subject to greater dilution by the in-stream flows.

5.4.4.5 Pathogens

Pathogens are agents or organisms that can cause diseases or illnesses, such as bacteria and viruses. Fecal coliform bacteria are typically used as an indicator organism because direct monitoring of human pathogens is generally not practical. Fecal coliform are a group of bacteria that are present in large numbers in the feces and intestinal tracts of humans and animals, and can enter water bodies from human and animal waste. The presence of fecal coliform bacteria implies the water body is potentially contaminated with human and/or animal waste, suggesting the potential presence of associated pathogenic organisms.

Fecal Coliform TMDL **–** The RWQCB has adopted phased TMDL criteria for pathogens, with the initial focus on additional monitoring and assessment to address areas of uncertainty. The goal of the Newport Bay TMDL is compliance with water contact recreational standards by 2014:

- Fecal coliform concentration of not less than five samples per 30 days shall have a geometric mean less than 200 MPN/100 ml, and not more than 10 percent of the samples shall exceed 400 MPN/100ml for any 30-day period.

A second goal is to achieve the shellfish harvesting standards by 2020:

- The monthly median fecal coliform concentration shall be less than 14 MPN/100 ml, and not more than 10 percent of the samples shall exceed 43 MPN/100 ml.

The TMDLs are applicable for all flow regimes.

Study Data Comparison with Fecal Coliform TMDLs **–** Table 5-26 shows the mean and median fecal coliform concentrations measured in the five study watersheds. From 70 percent to 100 percent of all fecal coliform measurements were greater than 400 MPN/ml in all study watersheds. This level of exceedance is substantially greater than the allowable 10 percent. The mean and median fecal coliform concentrations also exceed the 400 MPN/100ml criterion in all study watersheds. There was insufficient data to calculate the 30-day geometric mean (a minimum of 5 samples per 30 days needed). However, the TMDL criterion (30-day geometric < 200 MPN/100 ml) would likely be exceeded, assuming that any additional data would be of the same magnitude as those collected. Exceedance of the TMDL criteria in all study watersheds suggests that urban dry weather runoff is likely a contributing factor to any dry weather exceedance of the TMDL in the receiving waters.

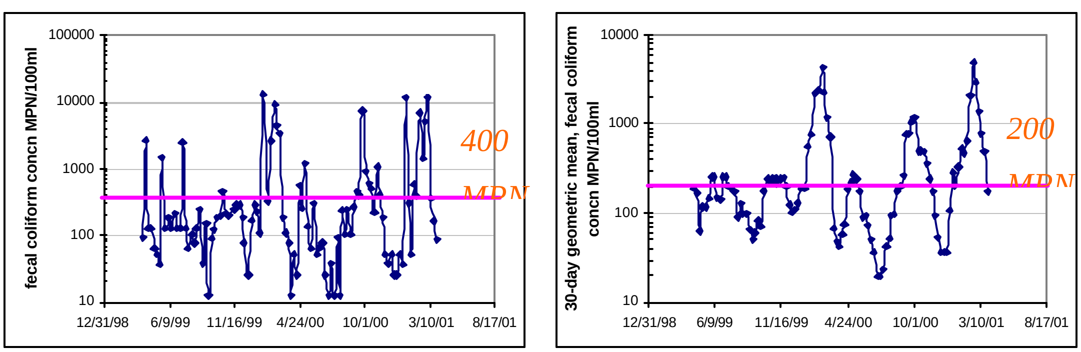
Table 5-26
Mean and Median Fecal Coliform Concentration (MPN/100ml) by Site

	1001		1002		1003		1004		1005	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
All Data										
n	22	24	21	24	23	24	21	24	23	24
Mean	4921	3003	5582	128193	34526	28980	28205	34185	17976	10326
Median	2300	1400	1700	3000	13000	4000	13000	13000	8000	8000
% > 400 MPN/100ml	82%	67%	86%	79%	100%	88%	95%	83%	92%	93%
Subsets[1]										
n	17	14	17	14	18	14	17	14	18	14
Mean	2545	3054	3090	5074	13783	37479	23312	20166	8524	6109
Median	2200	950	1400	1400	8000	2650	8000	6500	4000	2900
% > 400 MPN/100ml	100%	71%	82%	79%	100%	86%	94%	79%	100%	93%

1 – Data subsets with comparable sampling time and seasons. Evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.

Dry weather coliform monitoring information in the Central Irvine Channel was not available. Therefore, it is unknown if elevated fecal coliform concentrations measured in the study watershed contribute to an exceedance of the TMDL in the immediate receiving waters. The OCPFRD has collected dry and wet weather *E. coli* monitoring information in San Diego Creek at Campus Drive (OCPFRD, September 2001), which is considerably downstream from the study watersheds. A plot of the equivalent fecal coliform concentration (assuming an 80 percent *E. coli* content) shows exceedance of the TMDL occurs primarily during the wet season, although dry season exceedances are also evident (see Figure 5-9). This suggests that dry weather urban runoff is potentially a contributing factor to exceedance of the TMDL in dry weather flows at Campus Drive. The ET controllers would reduce the impacts from these potential exceedances if they were determined to be effective in reducing the dry weather runoff volumes.

Figure 5-9
Time Series of Fecal Coliform Levels of San Diego Creek at Campus Drive (converted from measured E. *coli* concentrations)



Median fecal coliform concentrations presented in Table 5-26 may be used to evaluate the influence of the structural and non-structural BMPs. When all monitoring data sets are considered, the median fecal coliform concentrations are equivalent or increase from pre- to post- intervention conditions in all sites except the 1001 (intervention site) and 1003 (a control site). Based on the Mann-Whitney (rank-sum) test, the reduction in median concentrations at Site 1001 and 1003 is significant at the 95 percent confidence level. Thus the site with the irrigation controllers corresponded to a significant reduction in median fecal coliform concentrations, in comparison to two of the three control sites, while the education only watershed exhibited no discernable reduction in median concentrations.

When subsets of the data with similar seasons and sampling times are considered (Table 5-26), there is a decrease in the median fecal coliform concentration at all sites except 1002. However, because of the smaller sample sizes, the decrease is median concentration is statistically significant only at Site 1003. This suggests that there could be seasonal influences in the monitoring data, but the data is not sufficient to determine if there are statistically significant differences in the median concentrations.

5.5 Conclusions

The initial review of water quality data from the study found virtually no difference in concentrations or pollutant flux over time. The technological and education treatments provided essentially no detectable increase or decrease in water quality following the intervention.

The follow-up review utilizing more robust statistical methods on a sample of study data suggests that the interventions did result in changes in water quality. TN levels in the retrofit neighborhood following intervention were found to be significantly lower than levels before intervention, whereas no detectable differences were noted before and after intervention in the education neighborhood. Relatively large observed reductions in TN flux in the retrofit neighborhood could be influenced by seasonal factors, and the extent to which the ET controller contributed to the reduction is unknown. Similarly, although reductions in TP flux were observed in the retrofit neighborhood, the effect of the ET controllers cannot be determined.

Chapter 6: Public Education

6.1 Overview

This chapter discusses issues pertaining to public acceptance of water conservation and runoff reduction measures. Specific information is provided on:

- Evaluation approach, including development of ET controller + education and education-only BMPs
- Customer interaction
- Evaluation results, as measured through responses to pre- and post-intervention customer surveys

More detailed information is provided in Appendix F.

6.2 Evaluation Approach

The public acceptance evaluation was conducted to compare the effectiveness of proposed BMPs for ET controller technology + education and education only. There were three groups of R3 Study participants: 1) participants who had their home irrigation controllers replaced with an ET controller and who received educational materials, 2) participants who received educational materials only, and 3) control groups, who received no interventions. The retrofit participants were selected through random "cold knocking" and through letter solicitations that explained the study. The education group was self and randomly selected. Some of the education group participants voluntarily chose to participate in the study by replying to a letter. However, the majority was randomly selected through a door-to-door campaign.

6.2.1 ET Technology + Education (Retrofit Group)

For the R3 Study, existing sprinkler timers that are set manually by the homeowner were replaced with the radio controlled ET controller systems. Trained technicians were used to ensure successful installation because ET controllers require programming for each valve including area (size of yard or planter per valve), soil type (clay, sand, etc.), and landscape type (turfgrass, shrubbery, etc.). The remaining irrigation system was unchanged, including piping and sprinkler head configuration.

The participating ET technology retrofit group homes received a site evaluation and installation of an ET controller to manage the irrigation system. Additionally, the residents of these homes received information regarding environmentally sensitive landscape practices. The controllers were installed in 112 residential homes, two condominium associations' landscapes, two HOA landscapes, one pool/park setting, and 12 city street landscapes.

Public education materials were also provided, as described in Section 6.2.2.

6.2.2 Education Only

Educational materials were provided to both the retrofit and education-only groups. Public education consisted of an initial informational packet containing three items. The first item was an introductory letter that described the purpose of the packet. The second item was a booklet with irrigation, fertilization, and weed and pest control information. The centerfold of the booklet was a month-by-month guide to irrigating, fertilizing, and pesticide application suitable for posting near the sprinkler timer. Third, each homeowner was supplied a soil probe for measuring the water content of the landscaped soils. In addition to the initial packet, monthly reminders were mailed to each homeowner including landscape maintenance tips about irrigation system, watering schedule, fertilizing, and weed and insect control. Suggested sprinkler run times (for the non-ET sprinkler neighborhood) and fertilizer or pesticide application usage, including non-toxic alternatives, were also provided in the monthly newsletter. A representative collection of the public information tools used for the R3 Study is provided in Exhibits A through D at the end of this section.

6.2.3 Customer Interaction

Home residents were advised that if they had any problems with the controller or if the controller required any adjustments, they should call the water district for assistance. IRWD's customer service department telephone number was left on a sticker on the ET controller. All calls related to the ET controller were logged in separately and routed to the appropriate staff member for assistance. Table 6-1 shows the number of calls that were received from residential residents during the R3 study period.

Table 6-1
Calls from Residential Customers in R3 Study

April 2001	1	August 2001	13	December 2001	1	April 2002	2
May 2001	12	September 2001	4	January 2002	4	May 2002	3
June 2001	7	October 2001	5	February 2002	9	June 2002	6
July 2001	13	November 2001	3	March 2002	4	July 2002	2

Generally, there were four common types of calls: 1) customer misunderstanding the way the ET controllers were supposed to operate, 2) installation-related issues, 3) maintenance or system design issues, and 4) ET controller malfunctioning. These issues were addressed and resolved. (See Appendix F.)

.

6.3 Customer Surveys

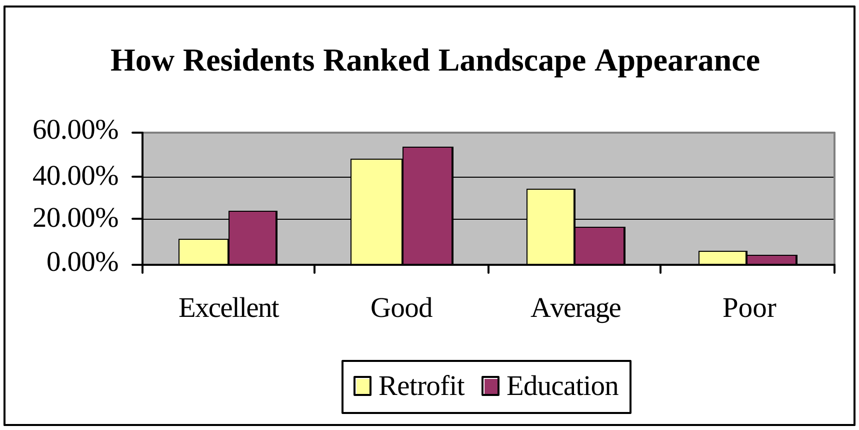
This section describes pre-and post-intervention surveys developed to measure public acceptance.

6.3.1 Pre-survey

The purpose of the pre-survey was to determine if the retrofit group and the education group had similar irrigation practices and attitudes. The pre-survey was distributed to the retrofit group while installation of the controller was taking place. Retrofit study participants were asked to fill out the survey while staff was installing the controller. The education group received their survey as part of the initial educational packet that was randomly distributed to residents. Education group participants were provided a stamped addressed envelope to return their survey to the IRWD. Ninety-seven percent (109/112) of those that received a survey from the retrofit group mailed the survey back. Twenty-four percent (53/225) of residents in the education group mailed back a survey. Pre-survey results are tabulated in Appendix F and summarized below.

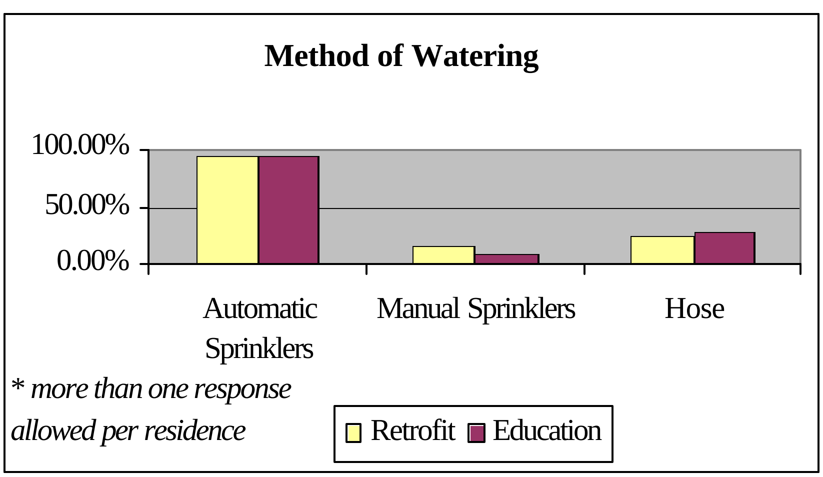
Figure 6-1 shows the responses of both of the groups. Similar responses were given. A majority of the residents in both groups believed that the appearance of the yard is average to good. It should be noted that the "excellent" response was selected by more of the education group than the retrofit group. One possible explanation for this response is that the staff was on-site while people were filling out their survey in the retrofit group.

Figure 6-1



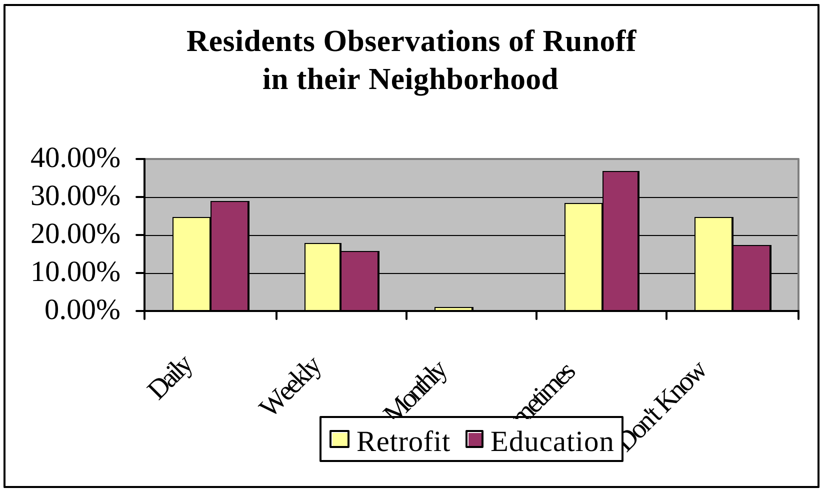
When residents were asked how they watered their lawn, the responses across groups were very similar. The percentage of people in the retrofit and education group that use automatic sprinklers, manual sprinklers, or a hose are similar. The survey shows that the retrofit and education groups have similar watering behaviors. As shown on Figure 6-2, the majority of the participants used automatic sprinklers. This is important because the R3 Study focuses on retrofitting the automatic irrigation controllers as a water management tool.

Figure 6-2



Residents were asked how often they observed runoff in their neighborhood. As presented on Figure 6-3, the data shows that residents in both groups have similar attitudes and views of urban runoff.

Figure 6-3



Residents were asked if they used fertilizers in their landscape, and chemicals to control pests or weeds. As shown on Figure 6-4, fertilizer use in both groups is almost the same. Results for chemical use were also similar for both groups. (See Figure 6-5.)

Figure 6-4

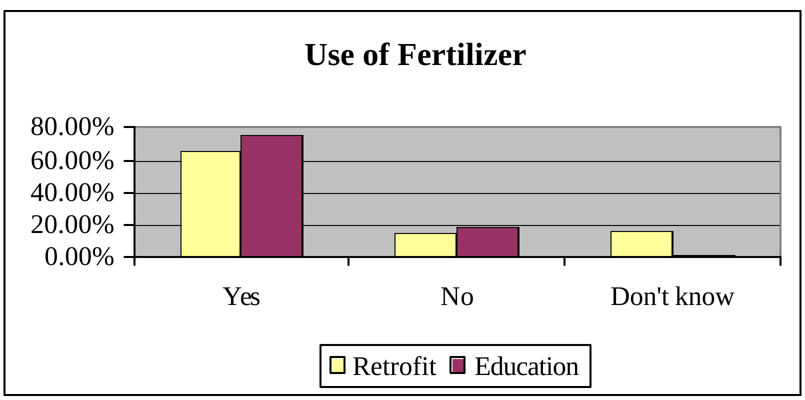
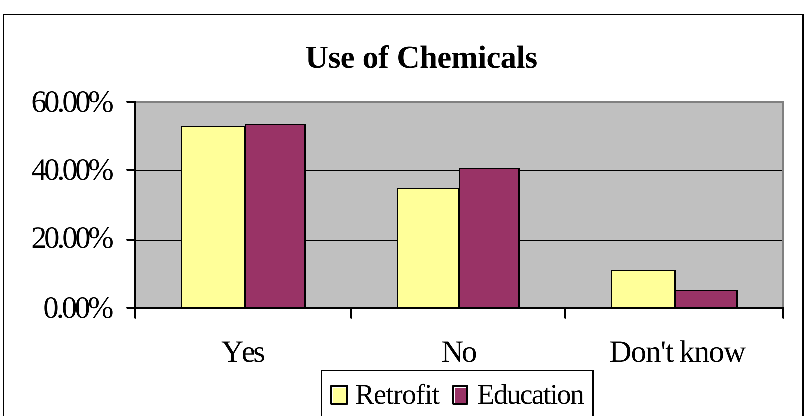


Figure 6-5



The purpose of the post-survey was to determine the attitudes of the study participants towards the ET controller and to determine if the education material had an impact on modifying behavior of the recipients. The post-survey was distributed to both of the groups through the mail. Twenty-three percent (52/225) of the education group participants responded to the survey, and forty-five percent (50/112) of the retrofit group participants responded. Post survey results are tabulated in Appendix F and summarized in the tables and text below.

6.3.2 Post-survey

Table 6-1 summarizes responses of the retrofit group compared to responses from the education group. The majority of the retrofit households acknowledged their satisfaction with the ET controller's performance and agreed that they would recommend the ET controller to their friends. It appears that the residents liked the controller and did not mind having someone else manage their irrigation-watering schedule. Data shows that households accepted the controller as a method of saving water, reducing runoff, and watering their landscapes. The survey shows that twice the number of retrofit households observed a decrease in their water bill than the education households did. A majority of the education households did not observe a change in their water bills. Data appears to show that the appearances of the retrofit landscapes were ranked equally with those landscapes that were part of the education group. It can therefore be concluded that the survey showed that the lower use of water did not create landscapes that were inferior to the education group. The customer's perception of a lower bill is important for the success of any long-term conservation program.

The retrofit and education group were asked if they were willing to pay for an ET controller signal. A majority of the households in both of the groups would not be willing to pay for an ET signal. The ET controller costs approximately $150.00 and the signal fee is $48 per year. The ET controller would be able to save less than 2 ccfs per month, which is a savings of about $14 per year. It appears that the savings in water use per year is not large enough for the water customer to pay for an ET signal.

Table 6-2
ET Controller Selected Responses

Responses to select survey questions	Retrofit group	Education group
Were satisfied with the ET controller	72 percent	n/a
Would recommend use of the ET controller to others	70 percent	n/a
Ranked the appearance of their yard as good to excellent	70 percent	69 percent
Not willing to pay for an ET signal	58 percent	69 percent
Saw decrease in water bills	44 percent	23 percent
Saw water bills unchanged	38 percent	63 percent

6.3.3 Education Only and Retrofit Group Responses

Table 6-3 summarizes the responses to the educational material by the retrofit group compared to the responses by the education group. Samples of these educational materials provided for participants in the R3 Study are presented on the following pages as Exhibit A through Exhibit D. Only half of the education households acknowledged that they sometimes or most of the time would change the settings on their controller according to ET via the monthly letter's (Exhibits A and B) suggested schedule. Monthly mailings also provided monthly landscape maintenance tips (Exhibits C and D). Here, the majority of the households in both of the groups liked the tips on the irrigation checks and fertilization sections. Although most people read these sections, a vast majority (80 percent) of households in both of the groups did not change their use of pesticides, herbicides, or fertilizers.

In addition to the education materials, a soil probe was given to both groups at the beginning of the study. A soil probe is a tool that takes a soil sample and enables the user to see the amount of moisture available to the plants and its depth. This allows the user of the soil probe to determine if the plants require more or less irrigation. More than half of the households in both groups only used the soil probe once or not at all. The majority of the people never used the soil probe at all. From a program point of view, people enjoy the education materials, but they appear to have little effect on modifying behavior.

Table 6-3
Education Material Selected Responses

Responses to select survey questions	Retrofit group	Education group
Have not changed their use of pesticides and herbicides	82 percent	81 percent
Have not changed their use of fertilizers	80 percent	73 percent
Did not use the soil probe or used it only once	76 percent	62 percent
Believed fertilization checks (part of monthly tips) were helpful	58 percent	44 percent
Believed irrigation checks (part of monthly tips) were helpful	42 percent	58 percent

6.4 Conclusions

While there were some customer service-related issues, the response to the ET controller was generally positive with 72 percent of participants indicating that they liked the controllers. This group also found that the controller irrigation either maintained or improved the appearance of their landscape. This is a classic win-win situation. The water district customers receive a desired benefit of a healthy landscape, and the community receives several important environmental benefits from the conservation of valuable and limited water resources and the reduction in dry season urban runoff.

Exhibit A
Monthly Landscape Maintenance Tips Letter Sent to "retrofit" customers in group 1001

May Landscape Maintenance Tips

The weather is getting warmer, the days are longer, and most of your plants are well into their growth stage. This is also the season for weeds and garden pests.

Irrigation System

- Watch for grass or plant growth that blocks sprinkler heads.
- Look for overspray onto streets and sidewalks and realign the sprinkler head.
- Look for dry spots and find the sprinkler problem to fix, such as a clogged head.
- Look for wet spots and potential sprinkler problems, such as a broken head.

Watering Schedule

- The Run-off Study Controller will adjust watering times as the weather changes.

Fertilizing

- Time to apply a slow release Nitrogen fertilizer to turf (apply only as directed on the bag or container).
- Keep fertilizer off of sidewalks, patio and streets.
- Do not wash fertilizer into drains or gutters.

Weed and Insect Control

- Watch for aphids and whiteflies. Wash insects off of leaves with a hard spray of water or spray with diluted soap solution.
- Apply mulch to control weeds, improve moisture retention and restore nutrients to the soil.
- Pick weeds now while they're still small.
- Use weed and insect chemicals only as directed on the containers.

This is a guide only. This guide does not hold public agencies responsible for the health and appearance of your home landscape.

Exhibit B
Monthly Landscape Maintenance Tips Letter (Sent to "education only" customers in group 1005)

May Landscape Maintenance Tips

The weather is getting warmer, the days are longer, and most of your plants are well into their growth stage. This is also the season for weeds and garden pests.

Irrigation System

- Watch for grass or plant growth that blocks sprinkler heads.
- Look for overspray onto streets and sidewalks and realign the sprinkler head.
- Look for dry spots and find the sprinkler problem to fix, such as a clogged head.
- Look for wet spots and potential sprinkler problems, such as a broken head.

Watering Schedule

- Start with this suggested schedule:
  Turf: 3 days per week, 3 cycles* of 3 minutes
  Shrubs and groundcover: 2 days per week, 3 cycles* of 3 minutes
- Reduce this amount in shaded areas.
- Use the soil probe to check the level of moisture beneath the surface before you water. If the soil is still moist 2 or more inches below the surface, wait another day to water.

Fertilizing

- Time to apply a slow release Nitrogen fertilizer to turf (apply only as directed on the bag or container).
- Keep fertilizer off of sidewalks, patio and streets.
- Do not wash fertilizer into drains or gutters.

Weed and Insect Control

- Watch for aphids and whiteflies. Wash insects off of leaves with a hard spray of water or spray with diluted soap solution.
- Apply mulch to control weeds, improve moisture retention and restore nutrients to the soil.
- Pick weeds now while they're still small.
- Use weed and insect chemicals only as directed on the containers.

This is a guide only. This guide does not hold public agencies responsible for the health and appearance of your home landscape.

*By "cycling" your irrigation timer to turn on for the suggested number of minutes about an hour apart, you reduce runoff and gain deeper watering and healthier root growth.

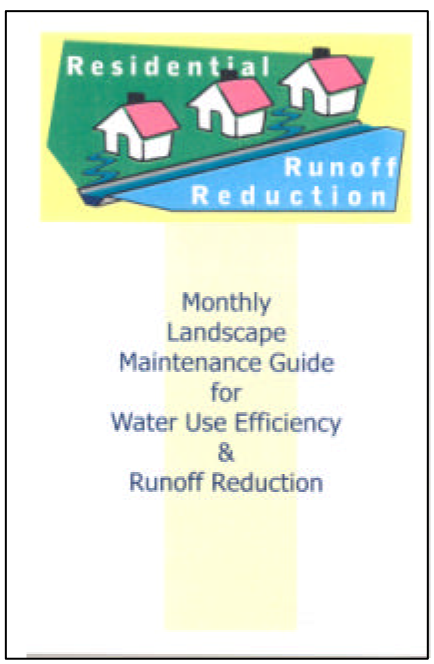
Exhibit C
Monthly Landscape Maintenance Calendar (Provided for "retrofit" and "education only" customers)
(Actual size: 8.5 in. x 11in.)

Residential Runoff Reduction

Monthly Landscape Maintenance Guide for Water Use Efficiency & Runoff Reduction

Seasons	Fall		Winter			Early Spring		Late Spring		Summer		
Month	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**
Irrigation System												
Check for: Runoff, from broken, blocked, clogged heads or overspray	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Check for Misting	✓				✓		✓		✓		✓	
Check for Dry Spots	✓							✓	✓	✓	✓	✓
Watering Schedule If two numbers are shown (i.e. 3 ▶ 2) adjust the number of days as indicated sometime during the month.												
Turf (grass) or Annuals Days to water per week	3 ▶ 2	2 ▶ 1	1	1	1 ▶ 2	2 ▶ 3	3	3	4	4 ▶ 5	4	4 ▶ 3
Trees, Shrubs Groundcovers	2 ▶ 1	1	1	1	1	1 ▶ 2	2	2	2	2	2	2
Deep Watering (trees) ●									●	●	●	●
Root zone watering: Use the soil probe any time you think there is too much or too little water in the yard. If soil is moist in the plant root zone, irrigation level is OK. If the soil is very wet, reduce your watering.												
Rain potential: Turn controllers to "rain pause" or off. Use a soil probe to determine when to turn controllers back on.	✓	✓	✓	✓	✓	✓	✓					
Fertilizing (specialty plants like roses or annuals may have different fertilizer requirements)												
Turf	Balanced ✓ slow release					Nitrogen slow ✓ release		Nitrogen slow ✓ Release			Nitrogen slow ✓ release	
Groundcovers	Balanced ✓ slow release					Balanced ✓ slow release			Balanced ✓ slow release			
Shrubs							Balanced ✓ slow release					Balanced ✓ slow release
Trees						Balanced ✓ slow release						Balanced ✓ slow release
Weed/Insect Control												
Mulch	✓							✓				
Pesticides (insects)						✓	✓		✓			✓
Herbicides (weeds)					✓		✓				✓ Optional	

Exhibit D
Monthly Landscape Maintenance Guide
Provided for "retrofit" and
"education only" customers
(Actual size 5.5 in. x 8.5 in)



Chapter 7: Findings, Conclusions, and Recommendations

7.1 Overview

The previous chapters of this report evaluate changes in water usage, dry weather runoff, water quality, and customer attitudes and awareness related to irrigation practices associated with the R3 Study. The intent of this chapter is to "integrate" these findings and outline their context as they relate to the interests and goals of the study participants and provide guidance for future efforts to improve water quality in the San Diego Creek watershed and in other areas of the county and state. Information is provided on:

- Findings and conclusions related to study methods for the water conservation, runoff reduction, water quality, and customer acceptance evaluations
- Findings and conclusions related to key results from the four study evaluations
- Recommendations related to future planning and policy

7.2 Study Methods

As noted in Chapters 3 through 6 of this report, study assumptions and methods demonstrated varying degrees of success. This section presents findings and conclusions regarding the degree of reliability of certain evaluation approaches and provides a foundation for future studies to build upon.

7.2.1 Water Conservation

Findings and conclusions regarding the study method for the water conservation evaluation portion of the R3 Study focused on three major areas.

First, the empirical effort used in the study quantified the change in mean water consumption and the shift in seasonal consumption. The models were not extended to document how water savings vary across households, for example, how savings are decreased/increased among lower/higher water use households. Such information could be useful in future studies.

Second, the study evaluated only about one year of post installation data. Thus, the statistical models can say little about the persistence of water savings. Additional follow-up quantification of water savings in subsequent years would be desirable.

Third, the modeling effort did not estimate the effect of self-selection by the participants in the education-only group. Thus, no attempt was made to extend the inference from the existing sample of participants to: 1) the rest of the service area; or 2) other service areas. The error component of the estimated models could be improved by specifying a function form to explain the variance. This should only be attempted after all major data issues have been resolved**.**

7.2.2 Runoff Reduction

As discussed in Chapters 2 and 4, significant measurement and data quality issues were associated with the enacted real-time measurement of urban runoff. The technology employed involved custom configurations and numerous needed calibration adjustments. Debris build-up was an early, ongoing, and possibly unavoidable issue that interfered with the calibration of the flow meters. Some of the original locations selected were more prone to this type of problem, and the flow meters were necessarily relocated. Although flow-monitoring problems required data from two of the three control sites to be discarded, the data from the other three sites (two treatments and one control) was sufficiently accurate to allow for the determination of meaningful statistical results.

To minimize the data collection issues experienced during the R3 Study, it would be helpful to install a V-notch weir in the storm drain. (See figure 7-1.) This would enable low flows to be captured and measured more precisely. It should be noted, however, that installation in an underground drain (as opposed to the surface drain shown on the figure) would require protective gear to be worn by the data collectors. Full gear (breathing apparatus) could become cost prohibitive for an aggressive (bi-weekly) monitoring program.

Figure 7-1
Detail of Diversion V-notch Design of Weir Installed in Large Drainage Pipe
(Note: Black sonic sensor hanging directly over V-notch to measure water flow levels.)

7.2.3 Water Quality

As discussed in Chapter 5, two independent reviews of water quality measurements were conducted as part of the R3 Study. Because of the variability of the data and limitations in sample quantities, the first review, which used parametric statistical techniques, provided less definitive results that the second review, which used more robust data analysis techniques. For some of the parameters reviewed, the robust analytical techniques were able to identify and measure differences in water quality across time and between study treatments.

7.2.4 Public Acceptance

As discussed in Chapter 6, pre- and post- intervention surveys were given to both the retrofit group and the education group. The pre-intervention survey was given to assess and document the prevailing landscape maintenance attitudes and behaviors of both participating groups. The post- intervention survey was given to determine 1) whether or not there was an acceptance of the ET controller as a way of managing landscape irrigation and 2) if exposure to the educational materials and monthly landscape maintenance tips had led to a change in irrigation practices and landscape management behaviors in either study group.

The survey responses indicate that, while 82 to 90 percent of the retrofit and education-only group reported to have read the educational materials, reading these materials did not cause their landscape maintenance habits to change. These responses suggest that future surveys should be designed to capture a measurement of the changes in the study subjects' consumer attitudes and behaviors in greater detail.

Future projects could benefit from using a marketing research firm specializing in the use of polls and surveys to measure residential consumers' attitudes and behaviors. The wording of each pre- and post- intervention survey question can be very carefully crafted in order to target, capture, and quantify each specific pre- and post- intervention behavioral change that is being measured. Identical or one-to-one correspondence between the pre- and post- survey questions is another effective marketing research technique. By documenting customers' changing responses, over time, to identical questions, behavioral shifts can be tracked and quantified.

7.3 Study Results

Key results of the four R3 Study evaluations are summarized below. Because the water conservation and runoff reduction evaluations were interrelated, the results from these evaluations are discussed together below.

7.3.1 Water Conservation and Runoff Reduction

As discussed in Chapter 3, water consumption by residential customers in the retrofit group was reduced by 41.2 gallons per day per household, with a reduction for the education group of 25.6 gallons per day per household. In contrast, whereas the runoff flows for the retrofit group were reduced during the study, flows in the education group increased (Chapter 4). There are three related explanations for this dichotomy: 1) the inclusion of small to medium size "common area" landscapes in the retrofit group and the exclusion of this group from the education group; 2) differences in irrigation scheduling between the residential homes in the two groups; and 3) proximity and relative flow volumes of the landscapes to the storm drain system.

7.3.1.1 Dedicated Landscapes

The retrofit group common areas averaged 0.8 acres in size and encompassed 15 sites/irrigation controllers including city landscape medians, HOA greenbelts, and a park. It is estimated that these sites account for more than 75 percent of the total area under treatment in the Site 1001 area. More specifically, these 15 sites totaled about 12 acres. The remaining 112 irrigation controllers installed on single-family residential lots are estimated to encompass 3.5 to 4 acres. The proportion of residences receiving educational materials including irrigation scheduling information was chosen to match the number receiving retrofit treatment. However, the total treated acres for the two groups varied considerably.

As was the protocol for all retrofit sites, irrigation schedules for these sites were established based on valve-by-valve evaluations of plant, soil, and irrigation system parameters. These schedules resulted in significantly more start times and shorter run times than that observed in these areas prior to the study.

More specifically, prior to installation of the retrofit treatment, each valve was turned on for two minutes to determine the flow. In this brief period, runoff was observed for many of the valves. This relates to the predominant clay soils, where runoff can exceed 90 percent of applied water after short periods due to the low infiltration rates. It is believed that the more frequent, short duration irrigation schedules developed by the treatment irrigation technology is the primary mechanism to reduce runoff from irrigation sites. In addition, these sites were closely monitored and incorporated suggested BMPs such as weekly meter readings. These sites were also used to develop the protocol for the midweek scheduling changes for all of the retrofit area and when to terminate a rain pause for the region.

In contrast to the retrofit group, the controllers on comparable common area landscapes in the education group are assumed to have continued with typical irrigation schedules that likely result in higher levels of runoff. If this is the case, and the common areas account for a similar percentage of irrigated area, this could explain the observed differences in runoff between the retrofit and education groups.

7.3.1.2 Differences in Irrigation Schedules

In addition to the runoff differences likely stemming from the inclusion of the nonresidential landscapes in the retrofit group, irrigation scheduling differences also existed for the residential homes between the retrofit and education groups. The education group households received a suggested irrigation schedule that provided the number of days per week to run the irrigation system, the number of minutes per cycle (start time), and a maximum of three start times. As noted above, short run times and multiple start times are believed to be the key element in reducing irrigation runoff.

Although the post-study survey indicated that about 60 percent of those in the education group changed their controller's irrigation schedule at least "sometimes," it is not clear how closely they followed the suggested schedule, including the recommendation on start times. Inasmuch as programming many controllers for multiple start times can be challenging, it is possible these instructions were generally overlooked. In contrast, the weather-based irrigation controller used on the retrofit homes automatically reduced the run time for slope, soil, and sprinkler precipitation rate. This will likely reduce runoff even in the absence of direct water savings. This difference may also be a consideration in the dissimilar runoff results in the two treatment sites.

7.3.1.3 Proximity to Storm Drains and Flow Volumes

The final consideration is the location and relative flow volumes of the common area landscapes relative to location and flow volumes of the residences. The common area landscapes were typically located closer to storm drain catch basins (and the study flow monitors) than most residential lots and also had much higher flow volumes on the individual irrigation valves. Runoff from most residential lots had to travel a signficant distance through surface street gutters before reaching catch basins and were subject to both evaporation and seepage in route. In addition, the limited drainage associated with many residential back yards could have further reduced the quantity of water reaching the storm drain from these areas in both the retrofit and education groups. Consequently, the reduction in runoff from treated retrofit common area landscapes and the presumed lack of similar reductions for the education group common areas, combined with the high valve flow volumes, likely explain the differences in observed runoff for the two treatment groups.

7.3.2 Water Quality

As described in Chapter 5, water quality samples were taken twice per month, resulting in a total of 39 samples over an 18-month period. One of the simplest and most straightforward methods to review these samples is to compare them to established water quality objectives for the San Diego Creek watershed. The subsections below address water quality and flow, and runoff water quality.

7.3.2.1 Water Quality and Flow

Chapter 5 of this report also describes issues with the reliability of study flow data during certain study periods and with certain monitoring locations. Because of the temporal relationship of these issues, integrating the water quality and flow data to determine changes in the mass loading of water quality constituents is difficult from a statistical standpoint. However, certainly, the water quality and flow data from the study provide some useful qualitative insight into the impacts of the interventions and may be instructive for future water quality improvement efforts.

7.3.2.2 Runoff Water Quality

Analyses utilizing ore robust statistical methods suggest that the intervention did result in changes in water quality. TN levels in the retrofit neighborhood following intervention were found to be significantly lower than levels before intervention, whereas no detectable differences were noted before and after intervention in the education neighborhood. Relatively large observed reduction in TN flux in the retrofit neighborhood could be influenced by seasonal factors, and the extent to which the ET controller contributed to the reduction is unknown.

7.3.3 Public Education

Data issues discussed previously make it difficult to quantify the impact of public education on reduced water usage and reduced dry season runoff. However, pre- and post-surveys of the retrofit + education and education only groups showed a positive response to the concepts of the irrigation tips. More than 70 percent of the retrofit group participants indicated that they liked the ET controllers, and the group also found that controller irrigation either maintained or improved the landscape. However, it appears that the savings in water use per year is not large enough for the water customers to be willing to pay for an ET signal.

7.4 Recommendations

The application of data from this study will influence future programs and efforts to improve water quality. The application of the irrigation management program focusing on using automatic real-time weather-based irrigation scheduling not only resulted in reductions in onsite/customer water use, but also reduced runoff. With the quality of runoff essentially unchanged, this reduction in runoff should result in a decrease in the total mass of non-point source pollutant loading to the watershed. The relative cost-effectiveness of this program should be evaluated in comparison to other existing or proposed BMPs to improve watershed water quality.

Although not directly determined from the study, the results suggest that the common area landscape sites will provide the most cost-effective application of the water management program. Additional empirical verification of this relative cost-effectiveness supposition is likely warranted.

An additional issue related to the water management program is the availability and viability of the irrigation controllers tested as a part of the study. Although the tested controllers operated reasonably well, occasionally glitches occurred, which necessitated either telephone or onsite intervention by study personnel. For the number of controllers installed for the study, these maintenance issues were manageable. However, the wide-scale use of these controllers would require a significant commitment from the water purveyor or the controller manufacturer to address maintenance issues. At this time, it is not believed that the controller manufacturer has established infrastructure to support a large number of controllers. In addition, the viability of the tested water management program is completely dependent on the regular transmission of data signals from the controller manufacturer to adjust irrigation schedules. Assurances on the long-term viability of signal transmission are imperative to the expansion of the tested program.

In contrast to the water management program, the educational program implemented as a part of the R3 Study reduced customer water use, but did not reduce measured runoff from the study area. Consequently, again assuming no change in runoff quality, this treatment would not appear to provide pollutant mass loading benefits to the watershed. However, the relationship between the observed water savings for the treated portion of the study area and increased runoff for the entire study area is unclear. Because of the clear relative cost advantages of educational programs, additional and more focused studies should be conducted to more fully understand this relationship and determine the viability of educational programs in reducing non-point source pollution.

Appendix A: References

The Residential Runoff Reduction Study

Appendix A: References

Ackerman and Schiff. in press. Modeling stormwater emissions to the Southern California Bight. Journal of Environmental Engineering (ASCE).

APHA. 2001. Standard methods for the examination of water and wastewater. American Public Health Association. Philadelphia, PA.

AWWARF. 1999. Residential End Uses of Water.

Bay, S., D. Greenstein, S. Lau, M. Stenstrom, and C. Kelley. 1996. Toxicity of dry weather flow from the Santa Monica Bay Watershed. Southern California Academy of Sciences 95: 33-45.

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, and D.R.G. Farrow. 1999. National estuarine eutrophication assessment: Effects of nutrient enrichment in the nation's estuaries. NOAA, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science. Washington, DC.

DeVlaming, V.; Connor, V.; DiGiorgio, C.; Bailey, H.; Deanovic, L.; Hinton, D. 2000. Application of whole effluent toxicity test procedures to ambient water quality assessment. Environmental Toxicology and Chemistry 19: 42-62.

IRWD. 2003. Irvine Ranch Water District San Diego Creek Watershed Natural Treatment System (NTS) Draft Master Plan.

IRWD, MWDOC, and MWD. 2001. Residential weather-based irrigation scheduling: Evidence from the Irvine “ET Controller” Study.

Noble, R.T., J.H. Dorsey, M. Leecaster, V. Orozco-Borbon, D. Reid, K. Schiff, and S.B. Weisberg. 2000. A regional survey of the microbiological water quality along the shoreline of the southern California Bight. Environmental Monitoring and Assessment 64: 435-447.

OCPFRD. 2002. Orange County Stormwater Program 2000-2001 Annual Status Report. County of Orange Public Facilities and Resources Department. Anaheim, CA.

OCPFRD. 2001. National Pollution Discharge Elimination Annual Progress Report. County of Orange Public Facilities and Resources Department.

OCPFRD. September 2001. Newport Bay Fecal Coliform TMDL Annual Data Report.

RWQCB. 1995. Water Quality Control Plan, Santa Ana River Basin (8).

Smullen, J., S. A. and C. K. 1999. Updating the US nationwide urban runoff quality database. Water Science and Technology 39: 9-16.

SCCWRP. 2003. Contributions of organophosphorus pesticides from residential land uses during dry and wet weather. Technical Report 406. Westminster, CA.

Tetra Tech, Inc. July 2000c. Newport Bay Watershed Urban Nutrient TMDL Compliance Evaluation.

USEPA. June 2002. Total maximum daily loads for toxic pollutants. San Diego Creek and Newport Bay, CA.

USEPA. 2000. Water quality inventory 1998 Report to Congress. U.S. Environmental Protection Agency, Office of Water. Washington, DC EPA841-R-00-001.

USEPA. 1998a. Total maximum daily loads for sediment and monitoring and implementation recommendations. San Diego Creek and Newport Bay, CA.

USEPA. 1998b. Total maximum daily loads for nutrients. San Diego Creek and Newport Bay, CA.

USEPA. 1995. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to west coast marine and estuarine organisms. First Edition. U.S. Environmental Protection Agency, National Exposure Research Laboratory. Cincinnati, OH. EPA/600/R-95/136.

USEPA. 1993. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fourth Edition. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory. Cincinnati, OH. EPA/600/4-90/027F.

USEPA. 1987. Results of the Nationwide Urban Runoff Study. PB84-185545. U. S. Environmental Protection Agency, Water Planning Division. Washington, D.C.

USEPA. 1983. Chemical methods for the examination of water and wastes. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory. Cincinnati, OH. EPA-600/4-79-020.

Wong, K. M., E. W. Strecker and M. K. Stenstrom. 1997. GIS to estimate storm-water pollutant mass loadings. Journal of Environmental Engineering (ASCE) 123: 737 – 745.

Appendix B: Study Design

The Residential Runoff Reduction Study

Appendix B: Study Design

Introduction

In 1999, the Municipal Water District of Orange County (MWDOC) and Irvine Ranch Water District (IRWD), in partnership with other national, state, and local agencies and organizations began developing a project to accomplish two goals:

1) Measure changes in the dry weather volume and pollutant content of residential runoff associated with improved irrigation management practices.
2) Confirm residential irrigation water savings identified in a previous study evaluating an automated residential irrigation controller system (the "Westpark Study").

This Appendix presents detailed information on the general study design framework described in Chapter 2. Subjects discussed include watershed selection, flow monitoring, water quality sampling, ET controller operation and selection process, and controller installation and operation.

Watershed Selection

Five watersheds were selected for the study area, based on five criteria: 1) Isolation from other watersheds, 2) climate, 3) land use, 4) development age, 5) irrigation water management techniques.

Isolation from Other Watersheds:

A watershed consists of a region of land, which drains through a single point. The five study watersheds were located in the Northwood Village subdivision in the IRWD service area. Each watershed drains through a single point and is isolated from other sources of runoff. This enabled the runoff flow and water quality to be free of interference from other sources.

Climate

While most of Southern California and Northwood Village have a similar climate, the five watersheds share the same ET zone. They are located within 5 miles of CIMIS station #75, which provides local ET_o information. The ET_o (reference evapotranspiration, the amount of water utilized by plants and lost to evaporation) is the same throughout the Northwood region and most of the central section of the IRWD service area. The plant water requirements of ET_g, which is the standard of turfgrass for cool season turfgrass and is often referred to as simply ET, are the same for all five watersheds.

Due to the close proximity of the all the homes and the lack of any physical or geographical separation of the five watersheds, the study team relied on the CIMIS station #75 for ET_o data.

Land Use

The Northwood section of IRWD's service area was selected because the predominant land use is single-family residence. There are also local parks, common city streetscapes, two condominium associations and one homeowners association (HOA). Several of the watersheds contained townhouses, apartments or condominiums. However, these types of multi-family units were limited in each of the watersheds; no single watershed had a large number of multi-family units.

Development Age

Northwood's neighborhoods were created during two distinct periods of home development. The first phase of development began in the late 1970s and finished in the early 1980s. The second phase started in 2000 and continues to the present. The study excluded the newer section of Northwood for two reasons. First, the newer homes and their HOA are not typical of Southern California. Second, IRWD has monthly water bill information dating back to the late 1980s on homes in the older section of Northwood.

Irrigation Water Management Factors

In addition to ET_o, other basic factors of irrigation water management are precipitation rate, soil type, and plant type. This study implemented real time ET scheduling through a commercially-available signal and distributed educational material to improve water management. Other water management factors are described below.

Precipitation rates vary from irrigation valve to irrigation valve, and most of the homes applied the water with spray heads operating off the pressure provided by IRWD. The individual homeowners installed most of the irrigation systems after the purchase of their houses. The technology used in these irrigation systems was of the same approximate age and featured similar types of equipment. The irrigation systems installed in the study area were also representative of a common irrigation set-up presently in use in Southern California. .

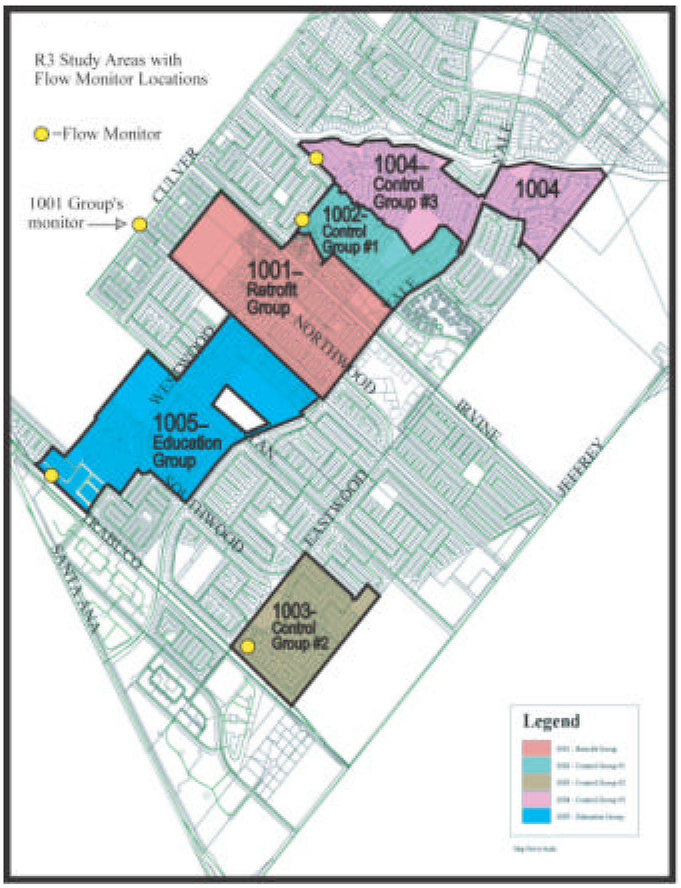
The soil type in the study area is not typical of Southern California and consists of heavy clay. Clay has the lowest infiltration rate and requires the highest level of water management.

The landscapes have sufficiently similar plant material. Although there was no data available to perform a numerical comparison, the study team field surveyed each of the potential watersheds. The majority of landscaping of all homes in the study area consisted of turfgrass. To varying extent, the outside edges, fence, building and walkways areas were lined with shrubs and plant materials other than turfgrass. The best estimate of the ratio of turfgrass to other landscaping is approximately 70 percent. While some of the homes in each of the watersheds may not have followed this construct, the vast majority of landscapes were laid out in this fashion, which allowed the study team to determine which plant materials were mostly consistently found throughout the five watersheds.

Results

After determining that large sections of Northwood were similar and after locating safe monitoring sites, the study team traced the storm drains. The selection of the monitoring site determined the shape and contents of the watershed. The study was able to isolate five watersheds with similar characteristics. The areas of the five watersheds are outlined and labeled in Figure B-1 below.

Figure B-1
Five watershed areas and their corresponding Control groups



Flow Monitoring

The two main criteria for the study's flow monitoring equipment were: 1) the monitor could not alter the pipe or channel and 2) the monitoring must be able to distinguish the seasonal flow changes and any flow change that resulted from the three different treatments (i.e., retrofit group treatment, education-only group treatment, and control group treatment).

Two technologies were suitable for this application: Manning's equation plus a level sensor, or velocity sensor and level monitor (area-velocity). The area-velocity method was chosen due to lack of slope information for the storm drain system. The selected equipment was a Sigma 950, manufactured by Hach. The equipment was battery operated, could record data every minute, and included an ultrasonic transmitter and a velocity sensor located in the storm drain. The ultrasonic transmitter established the water surface level and area, while the velocity sensor determined the velocity of the water in the pipe.

Flow was calculated by the equation: Flow = Area x Velocity. Because four of the five monitoring locations (see Figure B-1 above) were located in pipes, several variations on the ultrasonic transmitter / velocity sensor were tested before the combination of sonic and velocity wafer were selected.

Water Quality Sampling

The water quality sampling program quantified constituents found in residential runoff flows. Because a typical residential neighbor includes more than single-family lots, the concept of water management through an ET signal technology expanded to include common area landscapes.

The water quality sampling program consisted of two phases: 1) pre-study and 2) dry weather sampling.

Pre-study

Based on water level elevation provided by the flow monitors, the study team developed a plan for sampling water quality during dry weather runoff periods. In the early evening (7 to 10 pm) and again in the early morning (3 to 6 am), the water level would rise, indicating an increase in runoff flow. While the amount of change varied by location and date, the pattern was common to all of the watersheds.

The study team performed a weeklong test to determine the most representative sampling time. The team sampled all five study areas every day at 4 am and 7 pm. The constituents sampled were fecal coliform, nutrients, and trace metals.

The test results showed neither differences nor patterns in concentrations between sites, days, and sample times.

Dry Weather Sampling Duration

The final sampling program consisted of bi-weekly sampling of all five sites. During sampling weeks, all five sites were sampled for all analyses listed in Table B-1 on Tuesday, and three sites were sampled for pesticides two additional days. Toxicity samples were collected once per month at all five sites.

Table B-1
Routine Water Quality Analysis Responsibilities

Responsible Lab	Water Quality Parameter	Bottle Type
IRWD	NO_2, NO_3, NH_3, T-PO_4, TKN, O-PO_4, EC, pH, Trace Metals, Total / Fecal Coliform	(2) 1-L Cubitainer (1) 250 ml Sterile
SCCWRP	Toxicity (Sea Urchin Fertilization)	
SCCWRP	Pesticides	
MWL	MS-2 Phage	(1) 1-L (from MWL)
MWL	Enterococcus	(1) 250 mL (from MWL)

The study team collected the biweekly Tuesday samples beginning in January of 2001 and continuing through the next 18 months. The first months of sampling occurred before or during the installation of the ET controllers in the residences and the common landscape. The last 12 months, starting in July 2001 and finishing in June 2002, became the post retrofit samplings. The pesticide sampling continued for an additional six months through December 2002. Table B-2 provides outlines the water quality and data collection schedule for each group in the study.

Table B-2. Water Quality and Data Collection Schedule					
Sample Site	**Site ID**	**Cross Streets**	**Atlas Page**	**Parameter**	**Frequency**
Group A Education Site Control Site	1005 1003	Shadwell/Westmoreland Carver/Carver	84w – C1 105w – A1	Flow WQ	Weekly Bi-weekly
Group B Control Site Control Site Retrofit Site	1004 1002 1001	Hicks Canyon/Park Place La Paloma/Park Place Culver/Florence	83w – D2 83w - D1 84n – A3	Flow WQ	Weekly Bi-weekly

ET Irrigation Controller Operation and Selection Process

To meet the R3 Study objectives, it was necessary to install as many ET controllers as possible in the retrofit group. Providing the fullest coverage of the watershed with proper irrigation water management generated the best chance of changing the runoff flows. Since residential areas include landscapes other than those of the homeowners, these landscape areas were included in the water management component of the R3 Study. This represents a 3 to 1 ratio of medium-size landscapes to residential landscapes. A description of the installation process for both residential and medium-size landscapes follows:

Residential Landscapes

The IRWD staff attempted to reach as many of the 334 residences in the retrofit watershed as possible. These targeted residents received three letters which informed them of the following:

1) If selected to participate in the study, they would receive a free controller that would automatically adjust the landscape watering.
2) Their participation would be part of an environmental study aimed at preventing runoff from reaching the ocean.
3) They would be saving water without having to program an irrigation controller.
4) They were provided instructions for participating in the study along with a phone number to call to sign-up, as well as a form with a stamped and addressed envelope (for returning the form).

Additionally, IRWD staff hosted a function for the HOA in which staff demonstrated the ET controller to the residents and helped them to complete the sign-up form. Lastly, IRWD staff walked the Northwood neighborhood and hung flyers on the study candidates' front doors. These flyers contained statements from the homeowners in Westpark that had participated in the original ET Controller study. The flyers also described the ET controllers' overall customer satisfaction and ease with which the irrigation system worked.

In all, 137 residents responded to the various communication efforts by agreeing to participate in the study and installing the ET controller on their property. Of the 137 positive responses, 112 homes were equipped with proper automatic valves.

The installation of controllers began in April 2001 and continued through June 2001. A full team of IRWD staff worked weekdays, Saturdays and evenings to complete the installations. Additionally, educational materials were distributed to the retrofit group during installations.

Medium-size Landscapes

In addition to the single-family residences, the retrofit watershed contains 2 condominium complexes, and one HOA with three distinct land use types. The area also contained 12 city streetscapes. The City of Irvine agreed to change out the existing manual controllers with the ET controllers. All of the HOAs agreed to change out their controllers for the ET controllers.

The only major landscape not replacing its existing controller with an ET controller was the park-playground area of the school. The school landscape area consisted of a single meter with two separate controllers and more than 50 valves. This would require at least six ET controllers. Given the limitation in the controller and the high number of cycles that would be required to correctly irrigate the school site, IRWD was not confident that the ET controllers could be programmed in a manner that would avoid conflicting runtimes.

Controller Installation and Operation

The study evaluated the performance of the engineering of irrigation management techniques to reduce the consumption and residential runoff while maintaining the quality of the landscape. A typical irrigation controller is difficult to program and limited in the scope of the scheduling ability. Proper scheduling requires calculations based on real time ET data, landscape topography, and plant type, which are beyond the capabilities of typical controllers. The landscaper in the field is left to guess or rely on past experience as to the correct amount of water, the correct runtime to prevent runoff, and the correct days of the week to water.

The operation of the ET controller in this study was optimized by: 1) weekly maintenance, and 2) proper irrigation scheduling. IRWD staff programmed the controllers, which were operated by a combination of IRWD staff and HydroPoint consultants. (HydroPoint Data Systems, also known as HydroPoint, developed and supplied the ET controllers used in the R3 Study.)

During the prior study in Westpark, the programming was calculated based on a design precipitation rate suggested for spray heads. That study received numerous complaints that too much water was being applied and an effort was undertaken to conduct an area/flow measurement to determine the actual precipitation rate. These measurements indicated an average precipitation rate of 3.98 inches per hour while the design precipitation rate for the spray heads was 1.80 inches per hour. The measured rates varied from as low as 1.4 inches per hour to as high as 9 inches per hour. This suggested that standard settings in which a homeowner would program the controller are unlikely to efficiently run the irrigation. Because of this and other important factors, trained staff preformed the installations

Appendix C: Statistical Analysis of Water Savings

The Residential Runoff Reduction Study

Appendix C - Statistical Analysis of Water Savings

Prepared for
Municipal Water District of Orange County and
The Irvine Ranch Water District

Prepared by

Thomas W. Chesnutt. Ph.D.
Sanjay Gaur, M.S.

A & N Technical Services, Inc.
839 Second Street, Suite 5
Encinitas CA 92024-4452
760.942.5149 voice, 760.942.6853 fax

February 2002

DRAFT FINAL

Table of Contents

Summary

Findings

$ **Single Family Residences:** Households receiving an evapotranspiration (ET) controller and education were found to save approximately 41.2 gallons per day on average (33.2 gpd – 49.2 gpd is the 95 percent confidence level). Households receiving the education treatment alone were found to save approximately 25.6 gallons per day on average (20.1 gpd – 31.1 gpd is the 95 percent confidence level). This sample compared 93 ET controller/education participants and 192 education-only participants to 1236 nonparticipating single family customers.

A secondary finding in this sample related to seasonal shape in this average savings effect. For the one year of post-intervention consumption data within our sample, the water savings was not constant. The ET controller/education intervention, in particular, saved more water in the autumn and less in the spring growing season.

$ **Landscape-Only Accounts:** Among a smaller sample of 21 landscape-only accounts, significant water savings (16 percent) were obtained from the use of ET controllers. A sample of 76 matched sites (similar in landscaped area and type of use) also showed the effects of City water efficiency improvements. Since both of these samples contain a large number of medians and streetscapes, it is possible that each gallon saved from irrigation-only sites contributes more to runoff reduction than a gallon saved at a single family site. Since the runoff reduction was not measured by customer account, this study will not be able to confirm or deny this hypothesis.

Introduction

The purpose of this work is a statistical analysis of water savings among customers who installed evapotranspiration (ET) controllers and customers given irrigation education in the Irvine Ranch Water District. This report documents a careful statistical analysis of historical water consumption data to derive estimates of the net water savings from these interventions.

Approach

Historical water consumption records (July 1997 to August 2002) for a sample of participants and for a sample of nonparticipating customers were examined statistically. The hypothesis was that installation of new irrigation technology or better management of existing equipment would reduce the observed water consumption of customers participating in this program. This study empirically estimates the water savings that resulted from both types of interventions—(1) customers receiving both ET controllers and follow-up education and (2) customers receiving an education-only intervention.

Since installation of ET controllers required the voluntary agreement of the customer to participate, this sample of customers can be termed "self-selected." Customers were randomly chosen to receive the education-only treatment. While this analysis does quantitatively estimate the reduction of participant's water consumption, one may not directly extrapolate this finding to nonparticipants. This is because self-selected participant can differ from customers that decided not to participate.

The explanatory variables in these models include

- Deterministic functions of calendar time, including
  - The seasonal shape of demand
- Weather conditions
  - measures of air temperature
  - measures of precipitation, contemporaneous and lagged
- Customer-specific mean water consumption
- “Intervention” measures of the date of participation and the type of intervention

Data and Methods

Consumption records were compiled from the IRWD customer billing system for customers in the study areas. Billing histories were obtained from meter reads between July 1997 and August 2002. It is important to note that a meter read on August 1 will largely represent water consumption in July. Since the ET controllers were installed in May and June of 2001, the derived sample will only contain slightly more than one year of data for each participant. Table 1 presents descriptive statistics on the sample.

Table 1: Single Family Residential Sample Descriptive Statistics

	Site 1001		Site 1004	Site 1005	
	ET Controller Participant	Non-Participant	Control	Education Participant	Non-Participant
Number of Usable Accounts	97	213	264	196	346
Pre-period: July 1997-May 2001					
Mean Use (gpd)	375	371	405	390	418
No. of observations	4,504	9,860	12,452	9,251	16,364
Post-period: June 2001-August2002					
Mean Use (gpd)	366	379	427	395	421
No. of observations	1,358	2,982	3,694	2,744	4,856

The landscape-only customers (21 accounts) were handled separately. Two control groups were developed for these irrigation accounts: A matched control group was selected by IRWD staff by visual inspection, finding 3-5 similar control sites for each participating site. Similarity was judged by irrigated area and type of use (Home Owner Association, Median, Park, or Streetscape). Since the City of Irvine was improving irrigation efficiency on the City-owned sites during the post-intervention period, this matched control group also had potential water savings. A second control group was developed where the selection was done solely located by geographic area. In this way, the statistical models can separately estimate the water savings effects for each group.

Table 2: Landscape Accounts
Descriptive Statistics

	Participant	**Matched Control**	**Unmatched Control**
Number of Usable Accounts	21	76	895
Acres per Account	0.93	0.92	0.96
Type of Account (if known)			
HOA	3	13	
Median	3	11	
Park	1	6	
Streetscape	14	47	
Pre-period: July 1997-June 2001			
Mean Use (gpd)	2,948	2,768	3,042
Mean Use per Acre (inches/day)	0.11702	0.11823	0.12893
No. of observations	967	3,503	39,352
Post-period: July 2001-August2002			
Mean Use (gpd)	2,845	2,990	3,271
Mean Use per Acre (inches/day)	0.10813	0.12012	0.13013
No. of observations	293	1,052	12,121

The first major issue with using meter-read consumption data is the level and magnitude of noise in the data. The second major issue is that records of metered water consumption can also embed non-ignorable meter mis-measurement. To keep either type of data inconsistencies from corrupting statistical estimates of model parameters, this modeling effort employed a sophisticated range of outlier-detection methods and models. These are described in the next section.

Daily weather measurements—daily precipitation, maximum air temperature, and evapotranspiration—were collected from the CIMIS weather station located in Irvine. The daily weather histories were collected as far back as were available (January 1, 1948) to provide the best possible estimates for "normal" weather through the year. Thus we have at least 54 observations upon which to judge what "normal" rainfall and temperature for January 1rst of any given year.

Robust regression techniques were used to detect which observations are potentially data quality errors. This methodology determines the relative level of inconsistency of each observation with a given model form. A measure is constructed to depict the level of inconsistency between zero and one; this measure is then used as a weight in subsequent regressions. Less consistent observations are down-weighted. Other model-based outlier diagnostics were also employed to screen the data for any egregious data quality issues.

Specification

A Model of Water Demand

The model for customer water demand seeks to separate several important driving forces. In the short run, changes in weather can make demand increase or decrease in a given year. These models are estimated at a household level and, as such, should be interpreted as a condensation of many types of relationships—meteorological, physical, behavioral, managerial, legal, and chronological. Nonetheless, these models depict key short-run and long-run relationships and should serve as a solid point of departure for improved quantification of these linkages.

Systematic Effects

This section specifies a water demand function that has several unique features. First, it models seasonal and climatic effects as continuous (as opposed to discrete monthly, semi-annual, or annual) function of time. Thus, the seasonal component in the water demand model can be specified on a continuous basis, then aggregated to a level comparable to measured water use (e.g. monthly). Second, the climatic component is specified in different form as a similar continuous function of time. The weather measures are thereby made independent of the seasonal component. Third, the model permits interactions of the seasonal component and the climatic component. Thus, the season-specific response of water demand can be specific to the season of the year.

The general form of the model is:

Equation 1

$$Use = \mu_i + S_t + W_t + E_{i,t}$$

where ***Use*** is the quantity of water demand within time *t*, the parameter $\boldsymbol{\mu_i}$ represents mean water consumption per meter *i*, $\boldsymbol{S_t}$ is a seasonal component, $\boldsymbol{W_t}$ is the weather component, $\boldsymbol{E_{i,t}}$ is the effect the landscape interventions for meter *i* at time period *t*. Each of these components is described below.

Seasonal Component : A monthly seasonal component can be formed using monthly dummy variables to represent a seasonal step function. Equivalently, one may form a combination of sine and cosine terms in a Fourier series to define the seasonal component as a continuous function of time.[1] The following harmonics are defined for a given day *T*, ignoring the slight complication of leap years:

Equation 2

$$S_t \equiv \sum_{1}^{6}\left[\beta_{i,j} \cdot \sin\left(\frac{2\pi \cdot jT}{365}\right) + \beta_{i,j} \cdot \cos\left(\frac{2\pi \cdot jT}{365}\right)\right] = Z \cdot \beta_S$$

[1] The use of a harmonic representation for a seasonal component in a regression context dates back to *Hannan* [1960]. *Jorgenson* [1964] extended these results to include least squares estimation of both trend and seasonal components.

where T = (1,...365) and j represents the frequency of each harmonic.[2] Because the lower frequencies tend to explain most of the seasonal fluctuation, the higher frequencies can often be omitted with little predictive loss.

To compute the seasonal component one simply sums the multiplication of the seasonal coefficient with its respective value. This number will explain how demand changes due to seasonal fluctuation.

Weather Component: The model incorporates two types of weather measures into the weather component–maximum daily air temperature and rainfall.[3] The measures of temperature and rainfall are then logarithmically transformed to yield:

Equation 3

$$R_t \equiv \ln\left[1+\sum_{t=T}^{T_d} Rain_t\right], A_t \equiv \ln\left[\sum_{t=T}^{T_d} \frac{AirTemp_t}{d}\right]$$

where d is the number of days in the time period. For monthly aggregations, d takes on the values 31, 30, or 28, ignoring leap years; for daily models, d takes on the value of one. Because weather exhibits strong seasonal patterns, climatic measures are strongly correlated with the seasonal measures. In addition, the occurrence of rainfall can reduce expected air temperatures. To obtain valid estimates of a constant seasonal effect, the seasonal component is removed from the weather measures by construction.

[2] If measures of water demand are available on a daily basis, the harmonics defined by Equation 2 can be directly applied. When measures of water demand are only observed on a monthly basis, two steps must be taken to ensure comparability. First, water demand should be divided by the number of days in the month to give a measure of average daily use. Otherwise, the estimated seasonal component will be distorted by the differing number of days in a month. The comparable measures of the seasonal component are given by averaging each harmonic measure for the number of days in a given time period.

[3] Specifically it uses the maximum daily air temperature and the total daily precipitation at the Irvine weather station. This station was selected due to its proximity to the study area.

Specifically, the weather measures are constructed as a departure from their "normal" or expected value at a given time of the year. The expected value for rainfall during the year, for example, is derived from regression against the seasonal harmonics. The expected value of the weather measures ($\hat{\boldsymbol{A}}=\boldsymbol{Z}\bullet$) is subtracted from the original weather measures:

Equation 4

$$W_t \equiv (R_t - \widehat{R}_t) \cdot b_R + (A_t - \widehat{A}_t) \cdot b_A$$

The weather measures in this deviation-from-mean form are thereby separated from the constant seasonal effect. Thus, the seasonal component of the model captures all constant seasonal effects, as it should, even if these constant effects are due to normal weather conditions. The remaining weather measures capture the effect of weather departing from its normal pattern.

The model can also specify a richer texture in the temporal effect of weather than the usual fixed contemporaneous effect. Seasonally-varying weather effects can be created by interacting the weather measures with the harmonic terms. In addition, the measures can be constructed to detect lagged effects of weather, such as the effect of rainfall one month ago on this month's water demand.

Effect of Landscape Interventions: Information was compiled on the timing and location of each ET controller installation and education-only customer participation. The account numbers from these data were matched to meter consumption histories going back to 1997. All raw meter reads were converted to average daily consumption by dividing by the number of days in the read cycle. Using these data, relatively simple "intervention analysis" models[4] were statistically estimated where, in this case, the intervention is ET controller installation and/or participation in the landscape education program. The form of the intervention is:

Equation 5

$$E_{i,t} \equiv I_{ET} \cdot b_{ET} + I_{Ed} \cdot b_{Ed}$$

The indicator variable I_{ET} takes on the value one to indicate the presence of a working ET controller and is zero otherwise. The indicator variable I_{Ed} takes on the value one if a household agreed to participate in the education program and is zero otherwise.

The parameter $\hat{b}_{ET}$ represents the mean effect of installing an ET controller and is expected to be negative (installing an ET controller reduces water consumption.) The parameter $\hat{b}_{Ed}$ has a similar interpretation for the education-only participants.

This formulation also permits formal testing of the hypothesis that landscape interventions can affect the seasonal shape of water consumption within the year. Since numerous studies have identified a tendency of customers to irrigate more than ET requirements in the fall and somewhat less in the spring, it will be informative to examine the effect of ET controllers designed to irrigate in accord with ET requirements. The formal test is enacted by interacting the participation indicators with the sine and cosine harmonics.

[4] See Box and Tiao, "Intervention Analysis with Applications to Economic and Environmental Problems" *Journal of the American Statistical Association*, Vol 70,No. 349, March 1975, pp. 70-70.

Stochastic Effects

To complete the model, we must account for the fact that not every data point will lie on the plane defined by **Equation 1**. This fundamental characteristic of all systematic models can impose large inferential costs if ignored. Misspecification of this “error component” can lead to inefficient estimation of the coefficients defining the systematic forces, incorrect estimates of coefficient standard errors, and an invalid basis for inference about forecast uncertainty. The specification of the error component involves defining what departures from pure randomness are allowed. What is the functional form of model error? Just as the model of systematic forces can be thought of as an estimate of a function for the “mean” or expected value, so too can a model be developed to explain departures from the mean—i.e., a “variance function” If the vertical distance from any observation to the plane defined by **Equation 1** is the quantity **e**, then the error component is added to **Equation 1**:

Equation 6

$$Use = \mathbf{f}\left(\mathbf{S}_t, \mathbf{C}_t, \mathbf{T}_t\right) + e$$

The error structure is assumed to be of the form:

Equation 7

$$\begin{aligned} &e_{it} = m_i + x_{it} \\ &where \\ &m_i \sim N(0, s_m^2) \\ &x_{it} \sim N(0, s_x^2) \end{aligned}$$

The *X* and *?* are assumed to be independent of each other and of *μ*. The individual component *μ* represents the effects of unmeasured household characteristics on household water use. An example of such an unmeasured characteristic might be the water use behavior of household members. This effect is assumed to persist over the estimation period. The second component *?* represents random error. Because *μ* and *?* are independent, the error variance can be decomposed into two components:

Equation 8

$$s_e^2 = T \cdot s_m^2 + s_x^2$$

This model specification is accordingly called an error components or variance components model. The model was estimated using maximum likelihood methods.

Estimation Results

Estimated Landscape Customer Water Demand Model

Table 3 presents the estimation results for the model of landscape (irrigation-only) customer water demand in the R3 study sites. This sample represents water consumption among 992 accounts between June 1997 and August 2002. This sample contains 21 ET controller accounts, 76 matched control accounts, and 895 unmatched control accounts.

The constant term (1) describes the intercept for this equation. The independent variables 2 to 9—made up of the sines and cosines of the Fourier series described in Equation 2—are used to depict the seasonal shape of water demand. The estimated weather effect is specified in "departure-from-normal" form. Variable 10 is the departure of monthly temperature from the average temperature for that month in the season. (Average seasonal temperature is derived from a regression of daily temperature on the seasonal harmonics.) Rainfall is treated similarly (Variable 11). One month lagged rainfall deviation is also included in the model (Variables 12). The next variable accounts for the amount of irrigated acreage on the site. (Note that while measured acreage is available for all irrigation-only accounts, this is not true for single family accounts.)

The effect of the landscape conservation program interventions is captured in the following rows. The parameter on the indicator for ET controllers (15) suggests that the mean change in water consumption is 472 gallons per day, approximately 16 percent of the pre-intervention water use. The matched control group (17) did experience water savings, approximately 241 gallons per day or 8.7 percent of their pre-intervention water use. The variables testing for differences in pre-intervention use cannot distinguish any differences between the different types of accounts.

Table 3: Landscape Customer Water Demand Model **Dependent Variable: Average Daily Metered Water Consumption (in gallons per day)**		
Independent Variable	**Coefficient**	**Std. Error**
1. Constant (Mean intercept)	2619.0670	234.8112
2. First Sine harmonic, 12 month (annual) frequency	-811.6864	26.3271
3. First Cosine harmonic, 12 month (annual) frequency	-1984.6310	25.9776
4. Second Sine harmonic, 6 month (semi-annual) frequency	104.1141	26.5769
5. Second Cosine harmonic, 6 month (semi-annual) frequency	-18.5088	26.9614
6. Third Sine harmonic, 4 month frequency	-124.1069	28.1396
7. Third Cosine harmonic, 4 month frequency	107.1129	28.4812
8. Fourth Sine harmonic, 3 month (quarterly) frequency	39.5420	30.5372
9. Fourth Cosine harmonic, 3 month (quarterly) frequency	-62.1012	30.7453
10. Deviation from logarithm of 31 or 61 day moving average of maximum daily air temperature	6306.4130	562.5547
11. Deviation from logarithm of 31 or 61 day moving sum of rainfall	-747.0860	51.9108
12. Monthly lag from rain deviation	-209.8997	46.2994
13. Irrigated Acreage (in acres)	490.5891	139.6673
14. ET controller sites, test for difference in pre-intervention use	-46.2624	1278.0470
15. Average Effect of ET controller (21 accounts)	-472.1763	279.4630
16. Matched accounts, test for difference in pre-intervention use	-166.3042	691.8883
17. Average Effect of city efficiency improvements (76 accounts)	-240.9208	148.0551
Number of observations		57017
Number of customer accounts		983
Standard Error of Individual Constant Terms		5749.64
Standard Error of White Noise Error		4179.81
Time period of Consumption	June 1997 - July 2002	

Estimated Single Family Residential Water Demand Model

Table 4 presents the estimation results for the model of single family water demand in the R3 study sites. This sample represents water consumption among 1,525 single family households between June 1997 and July 2002. This sample contains 97 ET controller/education participants (in Site 1001) and 192 education-only participants (in Site 1005).

The constant term (1) describes the mean intercept for this equation. (A separate intercept is estimated for each of the 1,525 households but these are not displayed in Table 4 for reasons of brevity.) The independent variables 2 to 8—made up of the sines and cosines of the Fourier series described in Equation 2—are used to depict the seasonal shape of water demand. The predicted seasonal effect (that is, $Z \cdot \hat{b}_S$) is the shape of demand in a normal weather year. This seasonal shape is important in that it represents the point of departure for the estimated weather effects (expressed as departure from normal). We will also test to see if the landscape interventions have any effect on this seasonal shape.

The estimated weather effect is specified in "departure-from-normal" form. Variable 11 is the departure of monthly temperature from the average temperature for that month in the season. (Average seasonal temperature is derived from a regression of daily temperature on the seasonal harmonics.) Rainfall is treated in an analogous fashion (Variable 14). One month lagged rainfall deviation is also included in the model (Variables 15). The reader should also note that the contemporaneous weather effect is interacted with the harmonics to capture any seasonal shape to both the rainfall (Variables 12 and 13) and the temperature (Variables 9 and 10) elasticities. Thus, departures of temperature from normal produce the largest percentage effect in the spring growing season. Similarly, an inch of rainfall produces a larger effect upon demand in the summer than in the winter.

The effect of the landscape conservation program interventions is captured in the following rows. The parameter on the indicator for ET controllers/education (16) suggests that the mean change in water consumption is 41.2 gallons per day while the education only participants (19) saved approximately 25.6 gallons per day. The model cannot say whether education-only participants saved this water through improved irrigation management or by also reducing indoor water consumption. Since the sample includes only one year of post-intervention date, the model cannot say how persistent either effect will be in future years.

Table 4: Single Family Residential Water Demand Model **Dependent Variable: Average Daily Metered Water Consumption (in gallons per day)**		
Independent Variable	**Coefficient**	**Std. Error**
1. Constant (Mean intercept)	405.6593	3.1660
2. First Sine harmonic, 12 month (annual) frequency	-45.4215	0.9636
3. First Cosine harmonic, 12 month (annual) frequency	-89.1494	0.9629
4. Second Sine harmonic, 6 month (semi-annual) frequency	3.6549	0.6798
5. Second Cosine harmonic, 6 month (semi-annual) frequency	1.0709	0.6733
6. Third Cosine harmonic, 4 month frequency	1.7312	0.7151
7. Fourth Sine harmonic, 3 month (quarterly) frequency	4.4016	0.7403
8. Fourth Cosine harmonic, 3 month (quarterly) frequency	3.3491	0.7865
9. Interaction of contemporaneous temperature with annual sine harmonic	48.7897	17.1559
10. Interaction of contemporaneous temperature with annual cosine harmonic	-72.4672	22.3626
11. Deviation from logarithm of 31 or 61 day moving average of maximum daily air temperature	284.7163	13.542
12. Interaction of contemporaneous rain with annual sine harmonic	10.1102	1.8546
13. Interaction of contemporaneous rain with annual cosine harmonic	5.9969	2.6904
14. Deviation from logarithm of 31 or 61 day moving sum of rainfall	-34.0117	1.8931
15. Monthly lag from rain deviation	-13.3173	1.0549
16. Average Effect of ET controller/Education (97 participants)	-41.2266	4.0772
17. Interaction of ET intervention with annual sine harmonic	38.9989	5.3327
18. Interaction of ET intervention with annual cosine harmonic	-6.3723	4.8980
19. Average Effect of Education-only intervention (192 participants)	-25.5878	2.8081
20. Interaction of Ed.-only intervention with annual sine harmonic	6.0357	3.5870
21. Interaction of Ed.-only intervention with annual cosine harmonic	-3.0703	3.3826
Number of observations	94,655	
Number of customer accounts	1,525	
Standard Error of Individual Constant Terms		120.85
Standard Error of White Noise Error		129.81
Time period of Consumption	June 1997- July 2002	

How ET Controllers Affect Peak Demand

The question of how these programs affected the seasonal shape of water demand can be interpreted from the remaining interactive effects—the indicators interacted with the first sine and cosine harmonics. For example, the seasonal shape of demand can be derived before and after ET controller/education participation:

$$\text{Pre\_Intervention}: S_t = Z \cdot \hat{b}_S \approx -45.4 \cdot \sin_1 - 89.1 \cdot \cos_1 + 3.6 \cdot \sin_2 + 1.1 \cdot \cos_2 + \ldots + 3.4 \cos_4$$

$$\text{Post\_ETIntervention}: S_t' \approx Z \cdot \hat{b}_S + 39 \cdot I_{ET} \cdot \sin_1 - 6.4 \cdot I_{ET} \cdot \cos_1$$

When the pre/post seasonal patterns are combined with their pre/post mean water consumption, the following before and after picture can be seen throughout the year.

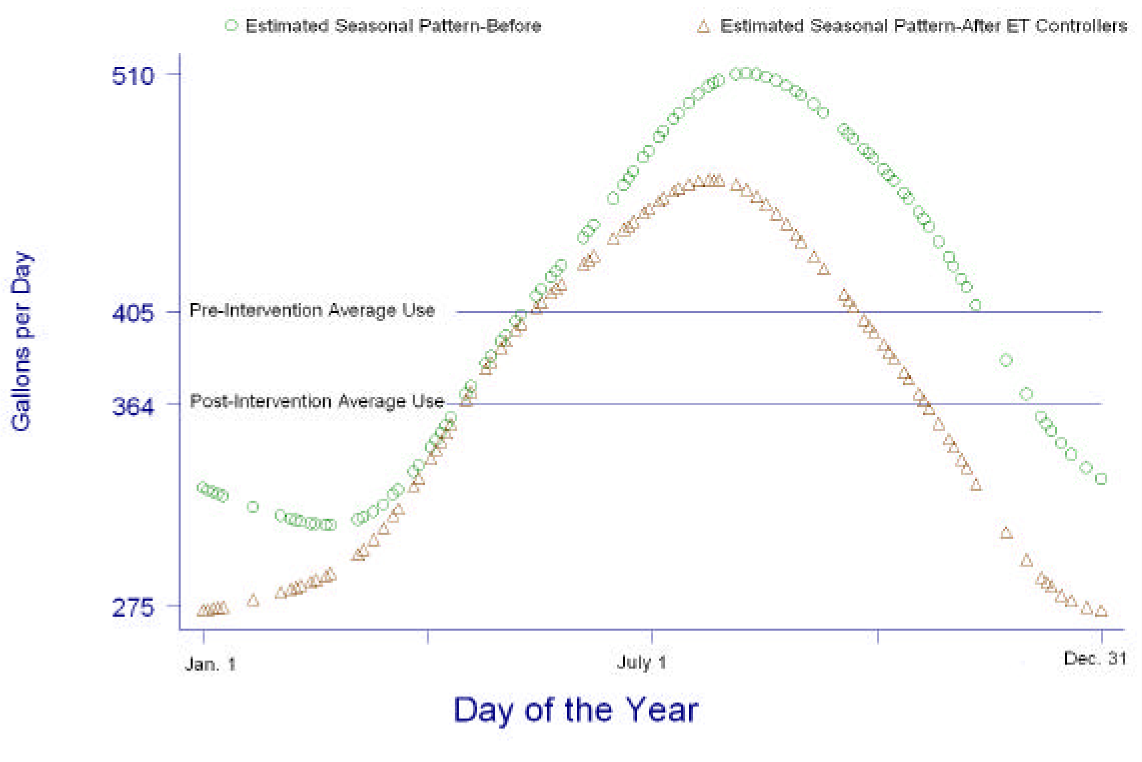


Figure 1-Effect of ET intervention on Water Demand

In Figure 1, several observations should be made. First, the difference between the two horizontal lines corresponds to the estimated mean reduction of approximately 41 gallons per day. Second, the assumption of a constant 41 gallon per day effect does not hold true throughout the year. The reduction is barely noticeable in the spring growing season and is much larger in the fall.

The reduction in peak demand—though dependent upon how the seasonal peak is defined[5]—is greater than the average reduction. The estimated peak day demand, occurring on August 8, is reduced by approximately 51 gallons. This “load-shaping” effect of the ET controller intervention can translate into an additional benefit to water agencies. The benefits from peak reduction derive from the avoided costs of those water system costs driven by peak load and not average load—the costs for new treatment, conveyance, and distribution all contain cost components driven by peak capacity requirements.

Figure 2 plots the corresponding estimates for the Education-only intervention. The reduction in average demand is less—approximately 25 gallons per day. The effect upon the estimated seasonal shape of demand is much more muted. In fact, the change to the estimated seasonal shape of demand induced by the education-only intervention is not significantly different from zero at classical levels of significance.

[5] This is the issues of “coincident” versus “noncoincident” peak demand: the extent to which the peak load of a customer coincides with the system peak. Water systems by their nature have a strong and predictable tendency to peak seasonally—for Southern California, this occurs in the summer. Given the predictability of system peaks, and the attendant costs, the empirical case for the contribution of ET controller load shaping to the reduction of systems cost is relatively straightforward. The additional value of peak reduction--over and beyond reductions in average consumption--require careful specification of the additional incremental costs necessitated by peak flow requirements.

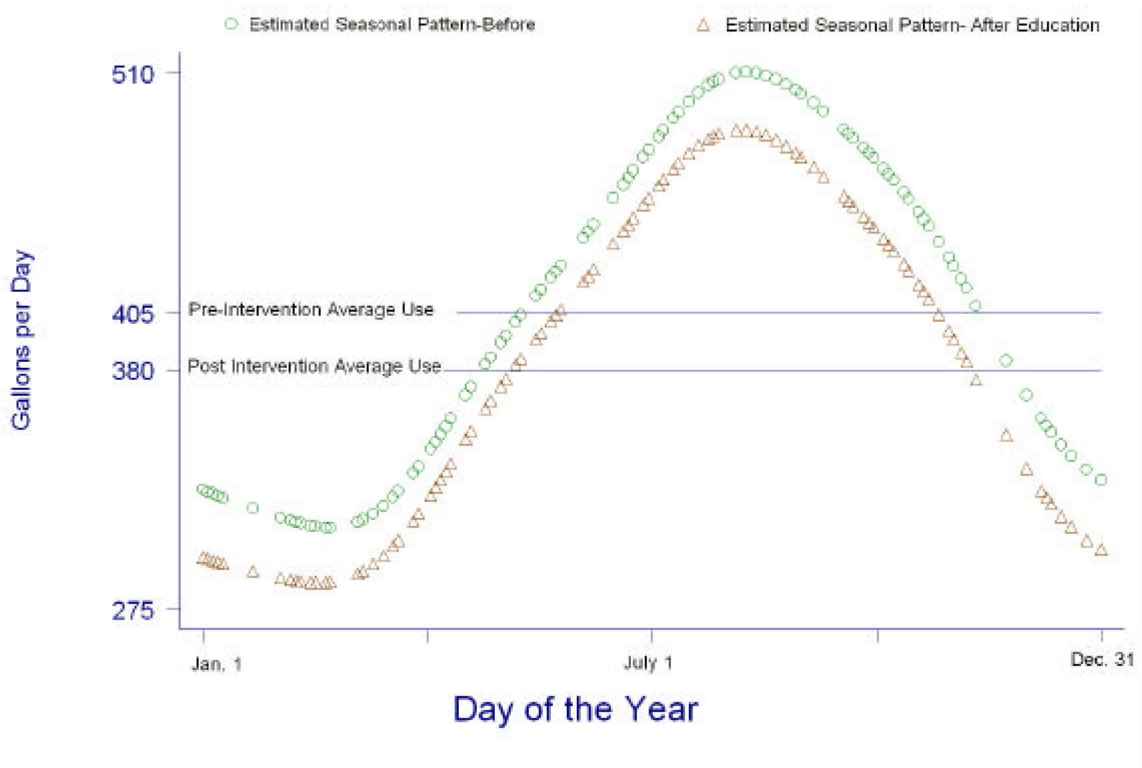


Figure 2-Estimated Effect of Education-only on Water Demand

Caveats and Additional Work

This modeling effort focused on developing the best depiction of net changes in water consumption due to the landscape interventions of ET controllers and/or education. Much of the modeling effort was expended on data cleaning, diagnosis, and validation. We believe that the most serious data issues were identified and appropriately handled. To the extent that future data quality can be improved, future work could provide several statistical refinements in model specification:

- The empirical effort has quantified the change in mean water consumption and the shift in seasonal consumption. The models have not been extended to document how water savings vary across households—how are savings decreased/increased among lower/higher water use households?
- Since the sample only contains about one year of post installation data, the statistical models can say little about the persistence of water savings. Additional follow-up quantification of water savings in subsequent years is required.
- The modeling effort to date has *not* attempted to estimate the effect of self-selection. Thus, we make no attempt to extend the inference from the existing sample of participants to (1) the rest of the service area or (2) to other service areas.
- The error component of the estimated models could be improved by specifying a function form to explain the variance. This should only be attempted after all major data issues have been resolved.

Conclusion

This report documents the shape of water savings achieved by the landscape interventions of ET controllers and/or education. Households participating in these programs saved significant amounts of water. The education-only program showed less water savings than the ET controller/education program, but were still significant. The ET controller/education program changed both the level and shape of water demand.

Appendix D1: Statistical Analysis of Urban Runoff Reduction

The Residential Runoff Reduction Study

Appendix D1 - Statistical Analysis of Urban Runoff Reduction

Prepared for
Municipal Water District of Orange County and
The Irvine Ranch Water District

Prepared by

Thomas W. Chesnutt. Ph.D.
Sanjay Gaur, M.S.

A & N Technical Services, Inc.
839 Second Street, Suite 5
Encinitas CA 92024-4452
760.942.5149 voice, 760.942.6853 fax

February 2002

DRAFT FINAL

Table of Contents

Summary

$ **Data Reliability and Validity:** There were significant measurement and data quality issues with the enacted real-time measurement of urban runoff. The technology employed involved custom configurations and numerous needed calibration adjustments. Debris build-up was an early, ongoing, and possibly unavoidable issue that interfered with the calibration of the flow meters. Some of the original locations selected were more prone to this type of problem and the flow meters were necessarily relocated. Careful attention was paid to documenting data quality issues in ways that did allow for quantitative evaluation of runoff. Nonetheless, the intrinsic data reliability constrains the inference that can be drawn.

$ **Control Study Sites 1002 and 1003:** The measured runoff for the study sites 1002 and 1003—potential control sites—had recurring measurement issues that produced generally unreliable runoff data. We were unable to use the runoff data from either of these sites to serve as a match to either of the sites receiving landscape interventions (ET controllers and/or education).

$ **Control Site (1004):** The unadjusted runoff flow at Site 1004 contained some elevated and likely invalid flow recordings in the pre-intervention period; that is prior to May 2001. Using robust statistical modeling methods, the spurious flow observations were identified and "quarantined." It is possible that these high flow measures were completely accurate measures of real runoff within Site 1004; perhaps one or more customers experienced undetected leaks. If this is the case, then Site 1004 could not serve as a good "matched" control site. The runoff in the post-intervention period for the Control Site 1004 increased 63 percent from the pre-intervention period.

$ **Effect of Education-only Intervention (Site 1005):** Study site 1005 contained approximately 565 single-family residences. Of these, 225 residential customers agreed to participate in the irrigation education program. Study site 1005 was found to have post-intervention runoff (after May 2001) that was 36 percent higher than pre-intervention runoff (May 2001 and before). The question of how much higher runoff might have been without the education intervention necessitates comparisons to comparable sites that did not receive any intervention.

Comparison across sites can, in theory, control for time-varying covariance in runoff. That is, measured runoff from a matched control group could be used to estimate how runoff increases in the summer period. Comparing across sites, however, will also require standardizing for the different areas across sites and testing for how well matched the sites are in the pre-intervention period. These results are presented in the body of this chapter. If one is willing to accept the Control Site as a matched control, Site 1005's post-intervention runoff is 21 percent less than expected.

$ **Effect of Evapotranspiration Controller/Education Intervention:** Study site 1001 contained 565 single-family residences. Of these, 114 agreed to participate in the evapotranspiration (ET) controller/education program. In addition, approximately 26 landscape sites (HOA, City median, parks, and school sites) also received ET controllers.

Study site 1001 was found to have post-intervention runoff (after May 2001) that was approximately 49 percent less than pre-intervention runoff (May 2001 and before). These two time periods are not equivalent as valid pre-intervention measures include less than four months of data. Since urban runoff derives from outdoor water use, it generally increases in the spring and summer and declines in the autumn and winter. Hence, the 49 percent runoff reduction is likely to be an underestimate of the level of runoff reduction that would be estimated on comparable time periods.

Using either Site 1005 or 1004 as matched controls implies that the observed post-intervention runoff was 64 to 71 percent less than expected.

Introduction

The purpose of this work is a statistical analysis of the reduction of runoff induced by Evapotranspiration (ET) controllers and irrigation education in the Irvine Ranch Water District. This report documents a careful statistical analysis of measured runoff in residential areas to derive estimates of the runoff reduction from these interventions.

Methods

Robust regressions techniques were used to detect which observations are potentially data quality errors. This methodology determines the relative level of inconsistency of each observation with a given model form. A measure is constructed to depict the level of inconsistency between zero and one; this measure is then used as a weight in subsequent regressions. Less consistent observations are down-weighted. Other model-based outlier diagnostics (Cook's distance, DFBETA statistics, and residual diagnostics) were also employed to screen the data for any egregious data quality issues.

Results

Descriptive Statistics

Raw flow rates

After screening for the known data quality problems, using the "rank" indicator, all raw meter reads were first converted to average hourly values. These were then aggregated by date to convert to daily runoff—the runoff measures are available in both mean hourly flow and total daily volume. Precipitation taken from the Irvine weather station was matched to the daily data and used to separate wet from dry days. Wet weather storm flow can be a more complicated phenomenon to predict, as it depends on the timing and magnitude of the rainfall event, the moisture deficit of soils, and other factors. The relative lack of large storm events in the post-intervention period precluded examination of these more complicated forces and the effect that the landscape interventions might have on wet day runoff.

Standardizing for area

Area-standardized measures of site runoff were also created for dry/wet days, where total daily volume was divided by the estimated permeable/total area. Estimates of area for the study sites were derived from the IRWD GIS system. The GIS system was queried to produce estimates of the number of lots and total area for the different land use classifications (single family residence, condo, HOA, school, landscape, street, and unknown). The GIS system also provided an estimate of the number of buildings, and building area. The area taken up by buildings is treated as impermeable. The remaining area was separated into permeable and impermeable area using a land use classification-specific assumption of impermeability. Table 1 provides the raw data used to construct the estimated site area. (Due to lack of usable flow measures, Sites 1002 and 1003 are not separately reported.) Table 2 aggregates these data by site.

Table 1: Estimated Area of Study Sites by Land Use

R3 GROUP	#Lots	Classification	Total Area	Building Area	Assumed Impermeable Coefficient	Estimated Impermeable Area	Estimated Permeable Area
1001	64	?	499885		0	0	499885
1001	565	SFR	2911227	976574	0.5	1943900	967326
1001	109	Condo	447096	189721	0.9	421358	25738
1001	4	HOA	255208		0.75	191406	63802
1001	2	School	198676		0.9	178808	19868
1001	10	Landscape	845529		0	0	845529
1001	97	Street	2163105		1	2163104	0
1004	61	?	307556		0.0	0	307556
1004	417	SFR	2081636	719485	0.5	1400560	681076
1004	1	HOA	40165		0.8	30123	10041
1004	1	School	348739		0.9	313865	34874
1004	2	Landscape	1136		0.0	0	1136
1004	42	Street	1089143		1.0	1089143	0
1005	8	?	118370		0.0	0	118370
1005	559	SFR	2957363	1033197	0.5	1995280	962083
1005	1	HOA	66421		0.8	49816	16605
1005	1	School	264236		0.9	237812	26424
1005	1	School	261089		0.9	234980	26109
1005	2	Landscape	773206		0.0	0	773206
1005	45	Street	1736098		1.0	1736098	0

Table 2: Estimated Area of Study Sites (in sq. ft.)

R3 Group	Estimated Impermeable Area	Estimated Permeable Area	Total Area
1001	4,898,578	4,246,905	7,320,726
1004	2,833,692	572,686	3,868,375
1005	4,253,986	1,194,553	6,176,782

Robust Analysis of Runoff

Form of the Model

Using the runoff flow data, regression models were used to estimate mean runoff by site. A regression framework allows for (1) hypothesis testing within or across sites and (2) use of robust modeling techniques to identify and minimize the influence of spurious or outlying observations. Sites 1002 and 1003 contained too few valid observations to be included in this analysis. The form of the model is specified to have a single pre-intervention mean (μ_1) and to allow for tests of changes in this mean over time and across sites:

Equation 1

$$\frac{RunoffVolume_{i,t}}{SiteArea_i} \equiv m_1 + I_{4,\mathrm{Pre}} \cdot d_{4,\mathrm{Pre}} + I_{5,\mathrm{Pre}} \cdot d_{5,\mathrm{Pre}} + I_{1,Post} \cdot d_{1,Post} + I_{4,Post} \cdot d_{4,Post} + I_{5,Post} \cdot d_{5,Post}$$

The indicator variable $I_{i,\,t}$ takes on the value one to indicate that an observation comes from site *i* and the time period *t* (pre/post). Thus, the indicator variable $I_{4,Pre}$ takes on the value one for Site 1004 in the pre-period (Feb.2001-May 2001) and is zero otherwise. The parameter $d_{4,\mathrm{Pre}}$ is the estimate of how runoff in Site 1004 differs from the common mean μ_1 in the pre-period. The parameter $d_{5,\mathrm{Pre}}$ has a similar interpretation for Site 1005. The common intercept will, by construction, pick up the estimate of Site 1001 pre-period mean runoff, since the parameters $d_{4,\mathrm{Pre}}$ and $d_{5,\mathrm{Pre}}$ absorb any differences in the other sites.[1] The indicator variable $I_{,1Post}$ takes on the value one for Site 1001 in the post-period (June 2001 -June 2002); its parameter is interpreted as the estimated change to the pre-period mean runoff. The parameters $d_{4,Post}$ and $d_{5,Post}$ have similar interpretations for Site 1004 and Site 1005.

Table 3: Robust Regression Estimates of Mean Dry Day Runoff

Dependent Variable: Dry Day Runoff Height (in inches per unit area) (Height=Runoff Volume/Site Area)

Variable	Coefficient	Std. Error	t	Prob.>|t|
Mean Runoff: Feb-May 2001				
1. Intercept (1001 mean runoff)	0.898563	0.120838	7.44	0
2. Difference of Site1004 in pre-period	0.143721	0.157245	0.91	0.361
3. Difference of Site1005 in pre-period	-0.092260	0.151479	-0.61	0.543
Change in Runoff: June 2001-June2002				
4. Change of Site 1001 in post-period	-0.445390	0.134540	-3.31	0.001
5. Change of Site 1004 in post period	0.878089	0.113737	7.72	0
6. Change of Site 1005 in post period	0.202553	0.106973	1.89	0.059
Number of observations	950			
F (5, 944)	74.92			
Prob. > F	0			
Quasi-R-Squared	0.35			

Robust Regression Results

Table 2 presents the robust regression estimation results for the model of dry day runoff in R3 study Site 1001 (containing some customers receiving the ET controller/education intervention), Site 1004 (whose customers received no treatment), and Site 1005 (containing some customers receiving the education-only treatment). This sample represents metered dry day runoff, standardized by estimated site permeable area, between Feb. 2001 and June 2002.

[1] The choice of Site 1001 as the reference site—implied by excluding a Site 1001 change indicator—is not required. Choosing another site would generate an essentially equivalent model that is one that generates identical predictions, but would change the interpretation of the coefficients.

Differences among Sites in the Pre-Intervention Period. The constant term (1) defines the intercept for this equation and can be interpreted as the mean daily runoff in Site 1001—about 0.898 hundredths of an inch per permeable acre. The following two variables (2) and (3), the indicators for Sites 1004 and 1005 in the pre-period, suggest that estimated difference in mean runoff is not statistically distinguishable from zero; The standard errors of the estimated coefficients are larger than the estimated coefficients. The estimated pre-period site mean runoff for these sites can also be inferred from these coefficients: $m_{4,\mathrm{Pre}} \equiv m_1 + d_{4,\mathrm{Pre}} \approx 0.89 + 0.14 = 1.03$ hundredths of an inch and

$m_{5,\mathrm{Pre}} \equiv m_1 + d_{5,\mathrm{Pre}} \approx 0.89 - 0.09 = 0.80$.

Change in Runoff in the Post-Intervention Period: The formal test for the change in runoff in the post-intervention period (June 2001-June 2002) can be found in the following three site-specific terms: variables 4, 5 and 6 as shown in Table 3. The estimated change in dry day runoff for Site 1001 (4) is -0.44 hundredths of an inch. In relative terms, this works out to approximately a 49 percent reduction. The implied mean post-intervention dry day runoff for Site 1001 is 0.89-0.44˜0.45 hundredths of an inch. This reduction in runoff is statistically distinguishable from zero at classical levels of confidence.

The reader should be careful in interpreting this result as the pre- and post- periods are not comparable. The post-intervention period, June 2001 to June 2002, includes 13 months but would be fairly close to an annual average. The period of time covered by the pre-intervention period for all sites, February to May 2001, includes at most 4 months. For Site 1001, the pre-intervention period only includes the months of April and May in 2001, because the flow meter produced enough invalid reads in February and March to necessitate its relocation to a new site in April. Since these are not the highest months for urban runoff, it would be reasonable to expect runoff in the post-intervention period to increase. For this reason, the reduction of 49 percent from the pre-intervention period would be a lower bound on the true estimate of runoff reduction. We can examine the other two valid sites for insight into how much runoff would have increased in the post-intervention period.

The estimated change in dry day runoff for Site 1004 (5) is +0.88 hundredths of an inch. This increase in runoff is statistically distinguishable from zero at classical levels of confidence. The implied mean post-intervention dry day runoff for Site 1004, is (0.89+0.88˜) 1.77 hundredths of an inch. In relative terms, this works out to a fairly large (1-{1.77-1.03}/1.03=) 72 percent increase in the post-intervention period.

The estimated change in dry day runoff for Site 1005 (6) is +0.20 hundredths of an inch. This increase in runoff is statistically distinguishable from zero at close to classical levels of confidence. The implied mean post-intervention dry day runoff for Site 1005, is (0.89+0.20˜) 1.09 hundredths of an inch. In relative terms, this works out to a more modest (1-{1.09-0.80}/0.80=) 36 percent increase in the post-intervention period.

Comparing Post-Intervention Change in Runoff across Sites. The last and potentially most vulnerable inference compares the time change in runoff across sites. If Site 1001 had experienced the same change in runoff as its neighbor sites 1005 or 1004, then dry day runoff would have increased from 36 to 72 percent in the post-intervention period. In absolute terms, this would imply a prediction of non-intervention runoff of 1.24 to 1.53 inches per acre. Compared to the realized 0.45 inches of runoff in the post-intervention period, this reduction would translate to 64 to 71 percent reduction in runoff.

A similar counterfactual exercise for Site 1005 would require assuming that Site 1004 is a good matched control site. Then dry weather runoff in Site 1005 would have increased by 72 percent in the post-intervention period, a level of 1.38 inches per acre. Compared to the realized 01.09 inches of runoff in the post-intervention period, the reduction would translate into a modest but non-ignorable 21 percent decrease in runoff.

Both of these exercises require use of Site 1004 as a control site. While the unadjusted flow measures for Sites 1001 and 1005 are fairly close in the pre-intervention period, the same cannot be said for the flow measures from Site 1004. Perhaps the question would be best put, "Given the three estimates of reduction runoff for Site 1001, which should be used?" The direct within-site estimate of a 49 percent runoff reduction is likely biased low; runoff in the post-intervention period should have increased. The estimate of 64 percent, based on Site 1005 as a control site, may also be biased on the low side. Though Site 1005 did have pre-intervention runoff that reasonably matched Site 1001, Site 1005 also contained more than 200 homes that participated in the education-only intervention with monthly follow-up. These homes did have quantified water savings, some of which is likely to have resulted from reduced runoff. Site 1004 did not receive any treatment but did have measurement issues. Thus the estimate of a 71 percent reduction, using Site 1004 as a control site, has an unknown bias.

The bigger inferential uncertainties lie in how these conservation interventions will work as they are scaled in a larger program or in how other implementations of these programs would work in other areas.

Caveats and Additional Work

- The difficulties encountered in calibrating custom configured equipment to measure runoff limited the amount of pre-intervention data. This in turn precluded simple before and after comparisons of mean runoff flow. Nonetheless, a sufficient length of baseline data was collected to allow quantitative estimates of runoff reduction. If additional flow data can be collected, additional analysis would be possible: (1) the runoff reduction under wet conditions could be examined and (2) an estimate of the seasonal shape of runoff could be included in the models to improve the precision of the estimated runoff reduction.

- Because the runoff measurement is not at a customer level, we cannot distinguish the relative contribution of different customers to urban runoff reduction. Thus, for Site 1001, we cannot state how much the single family ET controller/education contributed relative to the ET controller intervention with landscape customers.

Appendix D2: Residential Runoff Reduction Study Update – 2003 Runoff Data

The Residential Runoff Reduction Study

Memorandum

To: Dick Diamond, IRWD

From: Thomas W. Chesnutt, Ph.D.

Date: August 31, 2004

Re: Residential Runoff Reduction Study Update – 2003 Runoff Data

---

Finding

The 2003 measures of runoff from the Residential Runoff Reduction Sites 1001, 1004, 1005 support the findings of the earlier data: Site 1001 has a consistently lower mean level of urban runoff *and* a smaller variation in runoff.

Approach

A & N Technical Services performed data manipulation, collation, and validation on 2003 flow data collected in the R3 Study. The raw flow measures were provided in spreadsheet form. First, the spreadsheets of flow data from three study sites were incorporated into database form. This entailed the writing of a program for each site to convert the spreadsheets that also accounted for variations of form. Second, we performed validation checks on the estimated flow rates to check for consistency problems. Where correctable, revisions will be performed to the flow estimates. Last, these raw data exhibit an inconsistent time step, varying from 5-30 minutes. The raw data for each site was converted into their consistent daily basis—mean flow and total daily volume. The consistent time series version of flow data in the three study sites was then combined into a single consistent database with a consistent time series across sites. A consistent time-step, in term, allows valid comparisons across sites.

An attached spreadsheet contains the raw estimated daily runoff data–mean daily flow, total daily volume, and an indicator measure of data quality. As was experienced with the earlier data, there were considerable measurement issues that the IRWD team had to overcome to obtain consistent measures of flow. The project team coded a data quality indicator ("rank") for each subcomponent of the flow measure—instantaneous velocity and flow height. A combined indicator was also developed. The data quality indictor was set to 2 for measures that were known to be bad (rank=2). The data quality indictor was set to 1 for measures of questionable data quality (rank=1). Thus, the data quality indicator rank would take on the value 222 if all three measures (velocity, height, and estimated flow) were known to be bad and would take on the value 111 if all three were of questionable data quality. A value of zero was assigned to measures having no known or suspected data quality issues.

The data are summarized in two ways. First, the descriptive statistics of the mean daily flow volume (adjusted by site area) at each of the three sites in this post-installation period are examined. The estimated mean daily runoff flow is expressed in inches per acre. Second, a graph of 2003 runoff data is developed for each site that displays the raw data and a lowess-smoothed line of central tendency. (Lowess smoothers are a robust data analytic technique that can convey a sense of the level of runoff.)

Table 1 provides the descriptive statistics of mean dry day runoff height at the three sites. (Note that the number of observations per site are reduced due to the exclusion of flow measures on wet days and exclusion of flow measures due to data quality concerns.) The 2003 flow data were also graphed for the three sites. These figures follow. Site 1001 that received the ET controller and education intervention consistently displays both lower levels of runoff and lower variability in runoff. Site 1004 displays very large variability in runoff; this level of variability is the norm rather than the exception. The months of May and June in 2003 did experience wetter than normal (May) and cooler than normal (June) weather patterns.

Table 1: Estimated Mean Dry Day Runoff Height

January 2003 – August 2003

(in inches per unit area)

(Height=Runoff Volume/Site Permeable Area)

Site	Obs	Mean	Std. Dev.	Min	Max
Site 1001 (ET controllers +ed.) Runoff Height	136	1.03	0.72	0	3.90
Site 1005 (Education only) Runoff Height	160	1.79	2.75	0	27.29
Site 1004 (“Control”) Runoff Height	136	2.29	2.83	0	14.25

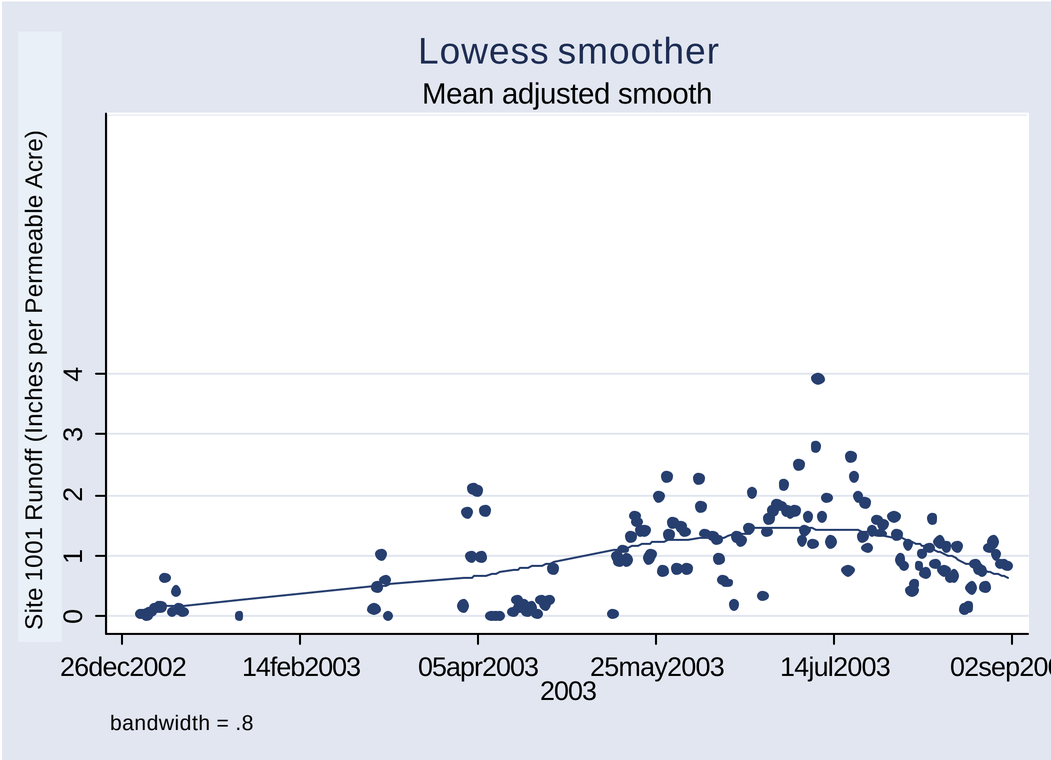


Figure 1: Site 1001 ET Control and Education Intervention

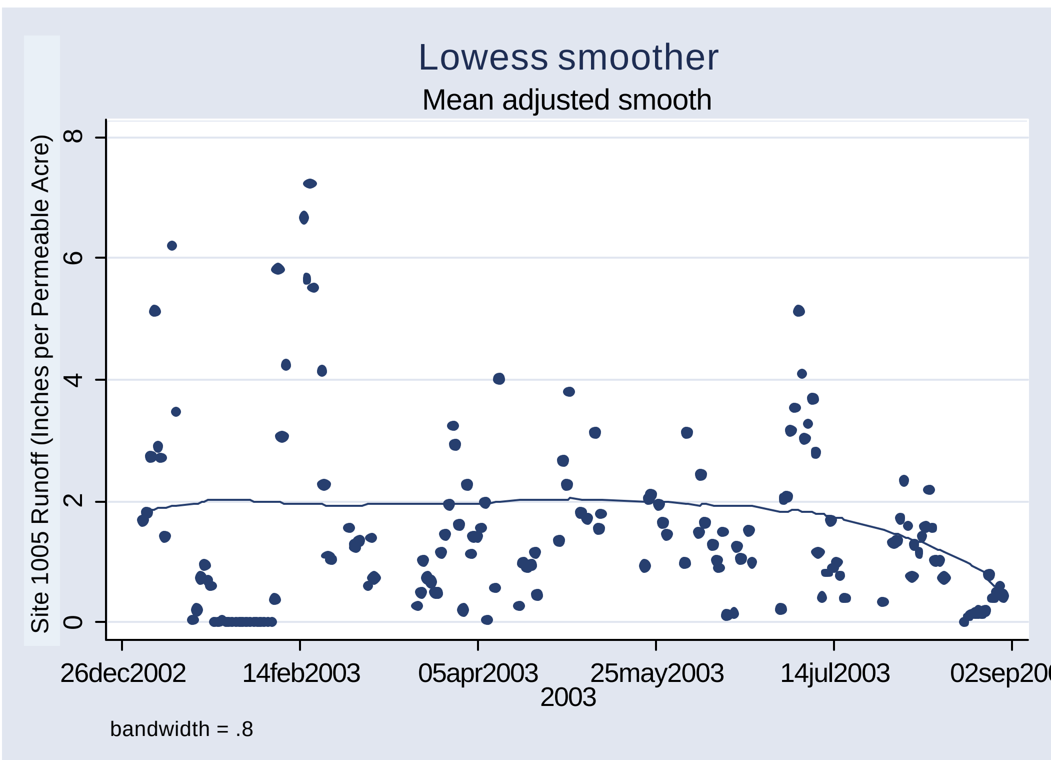


Figure 2: Site 1005 Education Only Site

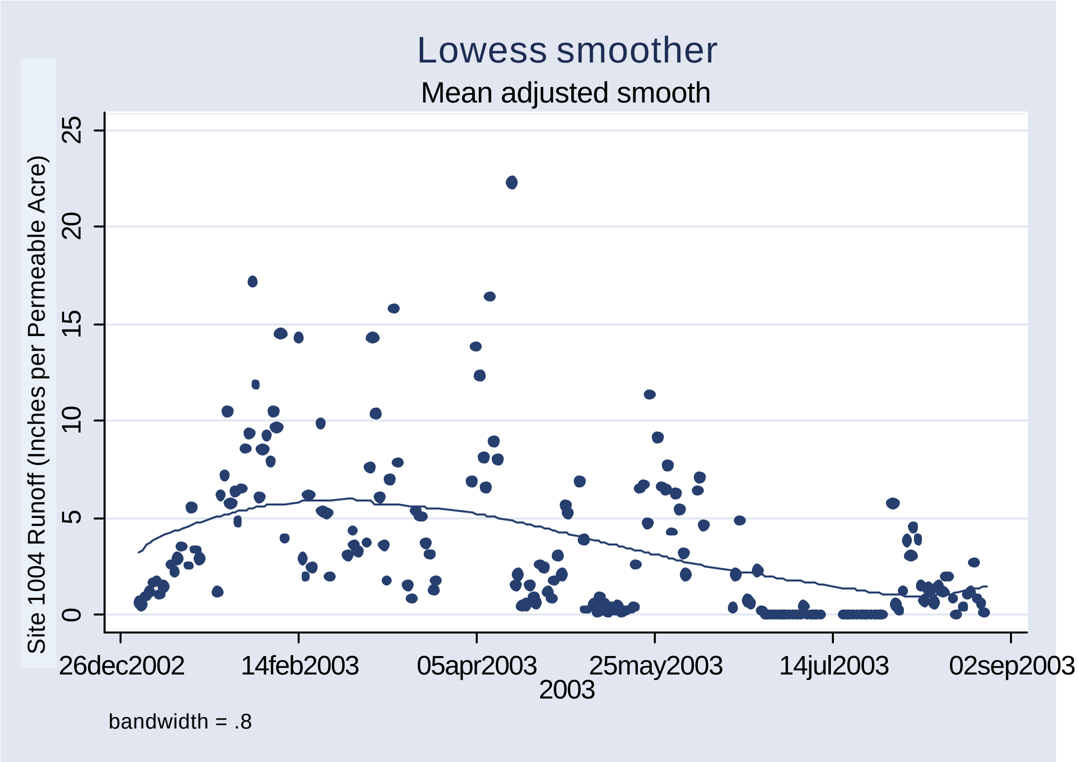


Figure 3: Site 1004 "Control" site

Appendix E1: The Effect of Technology and Public Education on the Water Quality of Dry Weather Runoff from Residential Neighborhoods

The Residential Runoff Reduction Study

Appendix E1

The Effect of Technology and Public Education on the Water Quality of Dry Weather Runoff from Residential Neighborhoods

Prepared by Kenneth C. Schiff,
Southern California Coastal Water Research Project

May 2003

ABSTRACT

Urban runoff is one of the largest contributors of pollutants to impaired surface waters in the United States, however little is known about effectiveness of potential best management actions (BMPs) to improve water quality. The goal of this study was to quantify the effectiveness of a technological BMP compared to public education as a BMP. The technological BMP consisted of a new evapotranspiration (ET) sprinkler controller that automatically changes sprinkler timing based on weather conditions using remotely controlled radio signals at a nearby weather station. Water quality (nutrients, trace metals, bacteria, pesticides, toxicity) was measured every two weeks for six months at five similar residential neighborhoods, then the technology plus education or education only treatments were applied to one neighborhood each, and measurements continued for another year. At the end of one year post intervention, there was virtually no difference in concentrations or pollutant flux over time. The technological and education treatments provided essentially no detectable increase or decrease in water quality following the intervention. The lack of detectable differences in water quality was a result of a combination of factors including large variability among measurements within a neighborhood and insufficient sample sizes to detect small changes in concentration or pollutant flux.

INTRODUCTION

Urban runoff has been identified as a major contributor to water quality problems throughout the United States (EPA 2000). Runoff from urban areas contains numerous potential pollutants including nutrients, trace metals, pesticides, and/or bacteria (US EPA 1987, Wong et al 1997, Smullen et al 1999, Ackerman and Schiff in press). These discharges have resulted in water quality impairments such as excessive blooms of algae (Bricker et al 1999), toxicity to aquatic organisms (deVlaming et al 2000, Bay et al 1996, closures of recreational shoreline for protection of human health (Noble et al 2000).

As managers become aware of the environmental concerns resulting from discharges of urban runoff, they are seeking methods and technologies for reducing or eliminating these discharges. Best management practices (BMPs) come in a variety of forms, including structural and non-structural control measures. Structural BMPs typically include technologically driven management actions that either reduce or eliminate runoff volume and/or attempt treatment of runoff prior to discharge. Non-structural BMPs typically are aimed at changing peoples attitudes or behavior that reduce the use of potential pollutants or limit their entry into the storm drainage systems. The most commonly cited form of non-structural BMPs is public education, which often consists of advertising campaigns, mailers, and other widely distributed educational materials.

The problem with both structural and nonstructural BMPs is that the efficiency and effectiveness of these BMPs are largely unknown. There is no uniform manner or standard method for independently testing these BMPs. Manufacturer information is occasionally available for some structural BMPs, but these data are looked upon suspiciously by most urban runoff managers as a result of their potential conflict of interest. Nonstructural BMPs, such as public education, are almost entirely without rigorous evaluation of their effectiveness. Hence, managers struggle with which BMPs to select, and in which environmental application, to achieve the greatest reduction in pollutant concentrations or mass emissions. At the same time, regulatory mechanisms like National Pollutant Discharge Elimination System (NPDES) Permits for municipal separate storm sewer systems or total maximum daily loads (TMDLs) continue to push the regulatory obligation of urban runoff managers to reduce concentrations and mass emissions of many potential pollutants.

The goal of this study is to compare the effectiveness of technological BMPs versus public education for reducing concentrations or mass emissions of potential pollutants in dry weather discharges. The technological BMP consisted of evapotranspiration (ET) controllers that communicate with landscape irrigation systems of individual households. This technology is designed to optimize watering times for landscaped areas, hence reducing overwatering and resultant runoff. The public education campaign focused on not just appropriate watering times, but also minimization of pesticide, herbicide, and fertilizer usage. These two types of BMPs were tested in residential neighborhoods, typically the most common land use in urban watersheds (Wong et al. 1997). Our goal was to determine if technology or education provides more pollutant reduction so that urban runoff managers can select optimal runoff pollutant minimization strategies.

METHODS

We used a before-after, control-impact (BACI) design for evaluating the effectiveness of both the sprinkler technology and public education. Each neighborhood was sampled every other week between December 2000 and June 2001. In June 2001, homes in one of the neighborhoods were outfitted with the ET sprinkler controllers. Since homeowners with the retrofitted sprinkler controllers were simultaneously being educated, a well-defined public education campaign was also begun with these homeowners. To ascertain the difference between education and ET sprinkler technology, homeowners in a second neighborhood were targeted with an identical public education campaign, but without effect of the ET sprinkler retrofit technology. There was no education or technology intervention in the remaining three neighborhoods, which served as control neighborhoods to document the effect of no treatment. Sampling at the five neighborhoods continued every other week from June 2001 to June 2002.

ET Sprinkler Controller and Public Education

The ET controller is described in detail elsewhere (*see Chapter 2 – Study Methods*). It is similar to any automatic sprinkler timer available at most home improvement stores and nurseries, but with the capacity to receive radio signals that will alter sprinkler timing based on current weather conditions. If weather is hot and dry, the radio signals call for longer or more frequent irrigation. If the weather is cool and moist, such as recent precipitation, the radio signals call for shorter or less frequent irrigation. For this study, the existing sprinkler timers that are set manually by the homeowner were replaced with the radio controlled ET controller systems. Trained technicians were used to ensure successful installation; ET controller requires programming for each valve including area (size of yard or planter per valve), soil type (clay, sand, etc.), and landscape type (turfgrass, shrubbery, etc.). The remaining irrigation system was unchanged, including piping and sprinkler head configuration.

Public education consisted of an initial informational packet containing three items. The first item was an introductory letter that described the purpose of the packet. The second item was a booklet with irrigation, fertilization and weed and pest control information. The centerfold of the booklet was a month-by-month guide to irrigating, fertilizing and pesticide application suitable for posting near their sprinkler timer. Third, each homeowner was supplied a soil probe for measuring the water content of their landscaped soils. In addition to the initial packet, monthly reminders were mailed to each homeowner including landscape maintenance tips such as irrigation system, water schedule, fertilizing, and weed and insect control. Suggested sprinkler run times (for the non-ET sprinkler neighborhood) and fertilizer or pesticide application usage, including non-toxic alternatives, were also provided in the monthly newsletter.

Treatment Neighborhoods

The five neighborhoods were located within a three mile radius in Irvine, CA. The selection criteria for the neighborhoods included similarity in: 1) age of neighborhood (approximately 20 years old); 2) primary land use (single family residential); 3) irrigation management factors (precipitation rate, soil type, plant type, slope and sun exposure); 4) proximity to radio signal for ET controller (all neighborhoods used the same signal). The five neighborhoods were designated 1001 (sprinkler retrofit + education), 1002 (control), 1003 (control), 1004 (control), and 1005 (education only). Although each of the five neighborhoods met the selection criteria, there were some differences worth noting (Table WQ1). First, the two treatment neighborhoods were larger, up to twice as large as the control neighborhoods. Second, the two treatment neighborhoods were more impervious, up to two twice as much impervious area, as the control neighborhoods. Third, the two treatment neighborhoods had greater proportions of landscaped common areas than any of the control neighborhoods.

The treatments were not uniformly applied to all homeowners in either the 1001 or 1005 neighborhoods. In the case of sprinkler + retrofit neighborhood (1001), roughly one third of the pervious area actually retrofit their sprinkler systems. These homeowners, condominium complexes, school and city landscaped areas were recruited by trained personnel. In order to keep the relative percentages approximately the same between treatment neighborhoods, homeowners representing roughly 30% of the pervious area were selected to receive the education materials in the education only neighborhood (1005). These homeowners were selected at random.

Sampling and Laboratory Analysis

Each of the five neighborhoods were hydrologically self-contained and drained to a single underground pipe unique to each neighborhood. At each of these five locations, samples were collected for flow and water quality. Stage (water depth) and velocity were recorded at 5 min intervals using an ultrasonic height sensor mounted at the pipe invert and a velocity sensor mounted on the floor of the pipe. Flow was calculated as the product of velocity and wetted cross-sectional area as defined by the stage and pipe circumference. Despite the relatively continuous measurement of flow, many of the flow measurements were excluded due to faulty readings. Synoptic flow and water quality measurements were only available for two sites over the course of the entire study (i.e. before and after intervention), including the sprinkler + education and education only sites. Flow measurements at the time of water quality sampling for the three control sites were considered faulty and discarded.

Grab samples for water quality, collected just downstream of the flow sensors in the early morning, were collected using peristaltic pumps and pre-cleaned Teflon tubing. Samples were placed in individual pre-cleaned jars, placed on ice, and transported to the laboratory within one hour. Each sample was analyzed for 19 target analytes, five microbiological parameters, and four toxicity endpoints (Table WQ2). Target analytes included trace metals, nutrients, and organophosphorus (OP) pesticides. Microbiological parameters included fecal indicator bacteria and bacteriophage. Toxicity was evaluated using two marine species, the purple sea urchin *Strongylocentrotus purpuratus* and the mysid *Americamysis bahia*. Toxicity endpoints included the median effects concentration that estimates the concentration at which 50% of the sample population is affected (EC50) and the no effect concentration that estimates the highest concentration at which no effect is observed (NOEC). All of the laboratory methodologies followed standard protocols developed by the US EPA (1995, 1993, 1983) or Standard Methods (APHA 2001).

Data Analysis

Data analysis consisted of five steps. These steps included: 1) comparison of water quality among the five neighborhoods prior to intervention; 2) comparison of water quality concentrations over time by neighborhood; 3) comparison of water quality concentrations before and after intervention by treatment type; 4) comparison of pollutant flux before and after intervention by treatment type; and 5) correlation of toxicity measures with potential toxicants in dry weather runoff.

Comparison of water quality concentrations among the five neighborhoods prior to intervention was conducted to assess if there were inherent differences among treatment sites for each constituent. This analysis was conducted using an analysis of variance (ANOVA) using Tukey's post hoc test for identifying the significantly different neighborhoods. All data were tested for normality and homogeneous variance prior to testing. Only the microbiological data were determined to be non-normally distributed, so these results were log transformed prior to data analysis

Comparison of water quality concentrations over time was accomplished by creating temporal plots of monthly mean concentration. Comparisons of water quality concentration before and after intervention by treatment type were accomplished using a standard t-test of the mean concentration before versus mean concentration after intervention. The mean concentrations for sprinkler+education, education only, and sprinkler+education – education only for each sampling event were normalized by the grand mean of the control sites for the same sampling event.

Pollutant flux estimates were calculated by the product of the concentration and volume at the time of sampling and then normalized to the area of the sampled neighborhood. Pollutant flux before and after treatment was compared somewhat differently since the lack of flow data at the control sites did not permit an estimate of flux for these neighborhoods. Mean pollutant flux before and after intervention was compared using standard t-tests at the sprinkler+education and education only neighborhoods without normalization to control values.

Correlation of toxicity with toxicant concentrations was accomplished using a Pearson product moment correlation. These correlations are inferential only and do not presume resulting correlations automatically identify the responsible toxicants. In order to help identify potential causative toxic agents, concentrations of the correlated constituents were compared to concentrations known to induce toxicity in the respective test organisms.

RESULTS

There were significant differences in water quality among sites prior to intervention (Table WQ3). Site 1004, the control site, had the greatest mean concentrations for 15 of the 24 constituents evaluated prior to the sprinkler intervention. Mean concentrations for seven of the 15 constituents were significantly greater at site 1004 than mean concentrations at least one other site (ANOVA, $p<0.05$). In particular, all of the mean nutrient concentrations were greater at site 1004 than the other sites. Mean ammonia, nitrate/nitrite, and TKN were a factor of 13, 11, and 2.5-fold greater at site 1004 than the mean concentrations at the next greatest site, respectively. On the other hand, sites 1001 and 1002 generally had the lowest average concentrations prior to the sprinkler intervention. Cumulatively, these sites had the lowest mean concentrations for 17 of the 24 constituents evaluated. Site 1002 also had the least toxicity, on average, of all five sites. Finally, site 1003 had an intermediate status. Mean concentrations of enterococcus and fecal coliforms at this site were greater than any other site (fecal coliforms significantly greater than sites 1001 and 1002), but the mean concentrations of five trace metals (chromium, copper, cobalt, nickel, selenium) were lowest at this site.

Water quality concentrations and toxicity were highly variable over time during the study period (Figure WQ1). Temporal plots of concentrations and toxicity for each site demonstrated that there was no seasonal trend and no overall trend with time. There were, however, occasional spikes in concentrations for many constituents that appeared to fall into one of two categories. The first category was recurring spikes in concentration that were unpredictable in timing and location. For example, both fecal coliform and enterococcus consistently varied by more than an order of magnitude from month to month during the study period and there was no similarity in pattern between the sites. The second category of concentration spike was single or infrequent peaks. Occasionally these spikes would occur across multiple sites, such as the peak in both lead and zinc at all three control sites (1002, 1003, and 1004) in October 2001, without commensurate changes in concentration at the treatment sites (1001 or 1005). More often, infrequent spikes were isolated to a single site. For example, concentrations of chlorpyrifos climbed to over 10,000 ng/L in July 2001, but averaged near 50 ng/L the remainder of the year at site 1005. Similarly, concentrations of ammonia and total phosphorus spiked 10 and 25-fold prior to June 2001 at the control site (1004) with less variability and overall lower concentrations the remainder of the study.

There were few significant differences that resulted from the intervention of education, sprinkler retrofit and education, or sprinkler retrofit minus education, relative to control sites (Table WQ4). Only six of the 24 constituents evaluated showed a significant difference between pre and post-intervention concentrations after normalizing to mean control values. These significant differences were a net increase in concentrations of ammonia, nitrate/nitrite, total phosphorus, chlorpyrifos, diazinon, and fecal coliforms. These statistical analyses were the result of one of two circumstances. In the first circumstance, there were individual large spikes in concentration at treatment sites, but not at control sites following intervention (i.e. chlorpyrifos and diazinon at sites 1001 and 1005). Therefore, the net difference in concentrations between controls and treatments increased following the intervention. In these cases, removal of the outlier samples resulted in no significant difference among treatment effects relative to controls before intervention compared to after intervention. In the second circumstance, there were large spikes in concentrations at control site(s) prior to the intervention (i.e. ammonia, nitrate/nitrite, and total phosphorus at site 1004) that later subsided while treatment site concentrations and variability remained steady. Therefore, the difference between treatments and controls changed following interventions, although it was not a result of the education or technology.

Although there were no significant differences in pollutant flux as a result of the intervention, there were significant differences in pollutant flux among sites prior to intervention (Table W5). Mean flux did not change at either site from before to after the installation of technology or initiation of education. Site 1001 however, the sprinkler+education site, had the greatest mean flux for 22 of the 24 constituents evaluated prior to the sprinkler intervention. The mean flux for 20 of these 22 constituents was significantly greater at site 1001 than the mean flux at site 1005 (t-test, $p<0.05$). Site 1005 had greater mean fluxes only for MS2 phage and ammonia. The differences among the fluxes prior to (and after) intervention was the result of two factors; greater flow and, at times, greater concentrations at site 1001 compared to site 1005. Mean dry weather flow at the time of water quality sampling was nearly three times greater at site 1001 than 1005.

Toxicity was inconsistently found at all five of the sampling sites (Table WQ3, Figure WQ4) and there was no change in toxicity as a result of the intervention (Table WQ4). The two species tested did not respond similarly either among sites, among treatments, or over time. Correlation of toxicity with constituent concentrations yielded few significant relationships for either species (Table WQ6). Mysid toxicity was correlated with diazinon and several trace metals, but the strongest relationship was with diazinon concentration. Moreover, the concentrations of diazinon were well above the levels known to cause adverse effects in this species while trace metals were not (Table WQ7). Sea urchin fertilization toxicity was only correlated with concentrations of zinc. The concentrations of zinc were well above the level known to induce adverse effects in this species (Table WQ7).

DISCUSSION

This study was unable to find large, significant reductions in concentration or pollutant flux as a result of education and/or sprinkler retrofit technology. This may indicate that the technology and/or education are inefficient for improvements in water quality. Equally as important, however, was the absence of meaningful increases in concentrations. Of the small number of concentrations that showed significant increases, most could be explained by highly variable spikes in concentrations reminiscent of isolated entries to the storm drain system as opposed to ongoing chronic inputs or the effects of best management practices evaluated in this study.

If significant changes did occur, our study design may not have detected these changes due to two factors. First, the variability in concentrations within and between sites are naturally high and our study simply collected too few samples. After taking into account the variability and relative differences in mean concentrations, we used zinc as an example constituent to determine what sample sizes would be required to detect meaningful differences. Assuming that our sampling yielded the true mean and variance structure that actually existed at the five sites, power analysis indicated that a minimum sample size of no less than five-fold would have been required to detect the differences we observed in zinc concentrations during this study.

The second factor that could have hindered our ability to detect meaningful differences in water quality is that the technology and education treatments were applied at the spatial scale of individual homes, while our study design sampled at the neighborhood scale. This problem was exacerbated in this study because only a fraction (approximately one-third) of the homes within the neighborhoods we sampled had the technological or educational treatments. Therefore, the treatments were effectively diluted, decreasing our ability to detect differences in water quality.

It appears that residential dry weather flows measured in our study may contribute significant proportions of some constituents to overall watershed discharges. Our study sites were located within the San Diego Creek watershed, the largest tributary to Newport Bay. San Diego Creek is routinely monitored to provide environmental managers the information they need to properly manage the Bay (OCPFRD 2002). We compiled the dry weather monitoring data at the mouth of San Diego Creek from OCPFRD during 2001-2002 and compared the concentrations to our results from residential neighborhoods (Table wq5). Mean concentrations of chlorpyrifos, diazinon, copper and zinc were much higher in upstream residential neighborhoods, than concentrations measured at the mouth of San Diego Creek. These residential dry weather contributions are amplified by the fact that the San Diego Creek watershed is primarily composed of residential land uses. In contrast, concentrations of selenium, arsenic, and total phosphorus in the residential dry weather discharges were much lower than the cumulative dry weather discharges from San Diego Creek, indicating that residential areas may not be the primary source of these constituents.

REFERENCES

Ackerman and Schiff. *in press.*. Modeling stormwater emissions to the Southern California Bight. *Journal of Environmental Engineering (ASCE)*

APHA. 2001. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Philadelphia, PA.

Bay, S., D. Greenstein, S. Lau, M. Stenstrom, and C. Kelley. 1996. Toxicity of dry weather flow from the Santa Monica Bay watershed. *Southern California Academy of Sciences* 95:33-45.

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, and D.R.G. Farrow, 1999. National estuarine eutrophication assessment: Effects of nutrient enrichment in the nation's estuaries. NOAA, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science. Washington, DC

DeVlaming, V.; Connor, V.; DiGiorgio, C.; Bailey, H.; Deanovic, L.; Hinton, D. 2000. Application of whole effluent toxicity test procedures to ambient water quality assessment. *Environmental Toxicology and Chemistry* 19:42-62

Noble, R.T., J.H. Dorsey, M. Leecaster, V. Orozco-Borbon, D. Reid, K. Schiff, and S.B. Weisberg. 2000. A regional survey of the microbiological water quality along the shoreline of the southern California Bight. *Environmental Monitoring and Assessment* 64:435-447

OCPFRD. 2002. Orange County Stormwater Program 2000-2001 Annual Status Report. Orange County Public Facilities and Resources Department. Anaheim, CA.

Smullen, J., S. A. and C. K. 1999. Updating the US nationwide urban runoff quality database. *Water Science and Technology* 39: 9-16.

US EPA. 2000. Water quality inventory 1998 Report to Congress. U.S. Environmental Protection Agency, Office of Water. Washington, DC EPA841-R-00-001

U.S. EPA. 1995. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to west coast marine and estuarine organisms. First Edition. U.S. Environmental Protection Agency, National Exposure Research Laboratory, Cincinnati, OH. EPA/600/R-95/136..

U.S. EPA. 1993. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fourth Edition. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, OH. EPA/600/4-90/027F..

USEPA. 1987. Results of the Nationwide Urban Runoff Study. PB84-185545. U. S. Environmental Protection Agency, Water Planning Division. Washington, D.C.

U.S. EPA. 1983. Chemical methods for the examination of water and wastes. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, OH. EPA-600/4-79-020.

Wong, K. M., E. W. Strecker and M. K. Stenstrom. 1997. GIS to estimate storm-water pollutant mass loadings. *Journal of Environmental Engineering (ASCE)* 123: 737 - 745

Table WQ1. Characteristics of the five treatment[a] study neighborhoods.

	Neighborhood				
	1001	1002	1003	1004	1005
Total Area (ft^2)	5,174,861	2,145,864	2,426,731	3,868,375	6,176,782
Impervious Area (%)	64.3	30.3	33.6	54.8	82.2
Land Use (%)					
Single Family Res	34.4	52.8	65.4	53.8	47.9
Condo	7.7	2.2	0.0	0.0	1.1
Homeowners Assoc	1.6	8.1	0.0	1.0	4.3
School	3.8	0.0	0.0	9.0	4.2
Landscape	16.3	0.1	6.6	0.0	12.5
Street	29.2	30.4	28.1	28.2	28.1
Unknown	7.0	6.5	0.0	8.0	1.9

[a] 1002, 1003, 1004=control, 1005=education, 1001=education + sprinkler retrofit

Table WQ2. Reporting level and method for target analytes.

	Reporting Level	Method
Metals (ug/L)		
Antimony	0.2	EPA 200.8
Arsenic	1.5	EPA 200.8
Barium	0.2	EPA 200.8
Cadmium	0.2	EPA 200.8
Chromium	0.3	EPA 200.8
Cobalt	0.1	EPA 200.8
Copper	1.5	EPA 200.8
Lead	0.3	EPA 200.8
Nickel	0.2	EPA 200.8
Selenium	5.0	EPA 200.8
Silver	0.4	EPA 200.8
Zinc	5.0	EPA 200.8
Microbiology		
Enterococcus (MPN/100 mL)	2	SM9230B
Fecal Coliform (MPN/100 mL)	2	SM9221B
Total Coliform (MPN/100 mL)	2	SM9221B
MS2 Phage (PFU/100 mL)	2	EPA 1602
Somatic Phage (PFU/100 mL)	2	EPA 1602
Nutrients (mg/L)		
Ammonia as N	5.0	EPA 350.1
Nitrate/Nitrite as N	5.0	EPA 353.2
Total Kjeldahl Nitrogen	10.0	EPA 351.2
Ortho-Phosphate as P	0.5	EPA 365.1
Total Phosphorus	1.0	EPA 365.4
OP Pesticides (ng/L)		
Chlorpyrifos	20.0	IonTrap GCMS
Diazinon	20.0	IonTrap GCMS
Toxicity (% effluent)		
Sea Urchin Fertilization EC50	NA	EPA 1995
Sea Urchin Fertilization NOEC	NA	EPA 1995
Mysid EC50	NA	EPA 1993
Mysid NOEC	NA	EPA 1993

Table WQ3. Mean concentration (and 95% confidence interval) of constituents in dry weather discharges collected before and after intervention[a] at five residential neighborhoods in Orange County, CA.

Parameter	Site 1001				Site 1002				Site 1003				Site 1004				Site 1005			
	Pre-Intervention		Post-Intervention		Pre-Intervention		Post-Intervention		Pre-Intervention		Post-Intervention		Pre-Intervention		Post-Inter vention		Pre-Intervention		Post-Intervention	
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Metals (ug/L)																				
Antimony	3.28	0.52	3.09	0.51	2.90	0.29	3.49	0.73	3.33	0.60	3.71	0.72	2.98	0.33	3.46	0.51	2.66	0.30	3.11	0.58
Arsenic	2.19	0.64	2.61	0.95	1.99	0.41	2.87	1.25	1.58	0.35	2.38	0.94	4.06	0.85	3.07	0.95	2.44	0.60	3.02	0.97
Barium	80.91	11.61	93.04	10.97	87.39	9.00	105.12	23.99	88.34	6.09	80.12	11.72	79.22	21.23	82.01	13.16	94.36	13.93	104.55	17.74
Cadmium	0.26	0.09	0.15	0.07	0.26	0.11	0.42	0.38	0.25	0.12	0.23	0.18	0.37	0.14	0.21	0.12	0.28	0.12	0.28	0.18
Chromium	2.49	0.98	1.97	0.59	3.74	1.53	4.72	3.35	1.96	0.41	2.70	1.25	3.31	1.41	2.44	0.82	4.01	2.79	3.89	2.01
Cobalt	0.43	0.11	0.50	0.21	0.65	0.28	1.19	0.81	0.40	0.11	0.53	0.26	0.97	0.49	0.73	0.25	0.64	0.19	1.08	0.54
Copper	13.91	4.31	16.14	7.27	31.50	30.24	27.12	17.30	11.82	2.57	24.30	15.41	24.02	12.64	16.81	6.71	33.98	39.62	29.67	14.38
Lead	0.57	0.18	1.63	1.15	6.95	9.32	4.23	2.90	0.88	0.40	1.45	0.88	4.09	4.84	1.34	0.69	0.79	0.23	3.09	1.98
Nickel	9.28	0.91	9.32	1.87	9.40	1.58	10.94	4.14	7.76	0.72	7.87	2.06	11.18	1.94	9.11	1.60	9.97	1.46	10.23	2.33
Selenium	2.43	0.13	2.50	0.00	2.43	0.13	2.50	0.00	2.30	0.26	2.50	0.00	2.43	0.13	2.50	0.00	2.30	0.26	2.50	0.00
Silver	0.13	0.05	0.14	0.07	0.11	0.02	0.18	0.10	0.17	0.09	0.17	0.15	0.12	0.03	0.16	0.17	0.16	0.09	0.17	0.15
Zinc	58.75	7.13	40.57	10.49	130.25	115.77	65.28	29.77	59.33	14.92	53.58	16.10	93.40	50.30	40.80	12.22	73.08	31.52	75.74	35.18
Microbiology (Log)																				
Enterococcus (MPN/100 mL)	3.95	0.43	3.24	0.18	3.80	0.38	4.16	0.35	4.36	0.68	4.22	0.24	4.49	0.61	4.35	0.25	4.34	0.31	4.37	0.29
Fecal Coliform (MPN/100 mL)	3.45	0.31	2.94	0.27	3.15	0.37	3.50	0.45	4.13	0.33	3.67	0.32	4.08	0.35	3.84	0.32	3.88	0.33	3.67	0.23
Total Coliform (MPN/100 mL)	4.16	0.27	3.82	0.24	4.30	0.30	4.51	0.46	4.70	0.33	4.36	0.26	5.04	0.39	4.50	0.27	4.53	0.34	4.51	0.24
MS2 Phage (PFU/100 mL)	-0.30	0.00	0.02	0.55	-0.30	0.00	-0.09	0.52	-0.19	0.14	0.02	0.53	0.30	0.44	0.05	0.52	0.05	0.43	0.33	0.54
Somatic Phage (PFU/100 mL)	2.00	0.35	2.02	0.49	1.84	0.42	1.81	0.69	2.59	0.40	2.24	0.62	2.88	0.32	2.52	0.54	2.16	0.46	2.37	0.47
Nutrients (mg/L)																				
Ammonia as N	0.17	0.15	0.08	0.03	0.17	0.07	0.39	0.51	0.23	0.11	0.28	0.23	7.32	4.93	0.31	0.26	0.65	0.32	0.42	0.24
Nitrate/Nitrite as N	2.72	0.50	1.48	0.28	3.00	1.14	1.00	0.33	2.35	0.96	1.63	0.78	38.71	18.21	9.29	6.58	2.94	0.61	3.70	4.48
Total Kjeldahl Nitrogen	1.62	0.51	1.87	1.20	1.75	0.62	2.38	0.92	1.96	1.33	2.61	1.75	11.18	5.71	3.60	2.03	4.49	2.64	3.51	1.65
Ortho-Phosphate as P	0.65	0.15	0.64	0.12	0.80	0.25	0.73	0.14	0.79	0.39	1.21	0.75	2.93	0.90	1.55	0.57	0.87	0.25	1.00	0.22
Total Phosphorus	0.79	0.21	0.63	0.16	0.78	0.25	0.82	0.23	1.22	0.83	1.19	1.07	3.30	1.37	1.46	0.73	0.96	0.39	1.16	0.40
OP Pesticides (ng/L)																				
Chlorpyrifos	22.66	9.27	442.78	827.29									45.54	33.48	11.34	6.31	75.27	64.41	803.44	1433.34
Diazinon	1680.45	1379.39	829.56	338.72									3265.38	3277.20	1650.50	1540.87	1159.12	553.01	1738.58	721.44
Toxicity (% effluent)																				
Fertilization EC50	47.26	8.89	53.73	6.17	57.37	3.48	51.94	9.85	41.60	8.94	49.58	10.17	49.79	8.96	55.91	6.48	43.81	9.26	58.35	2.98
Fertilization NOEC	25.36	8.61	44.62	10.32	35.00	8.54	46.23	11.11	32.07	13.27	37.69	11.15	32.50	9.66	51.92	7.67	22.00	9.31	42.88	9.76
Mysid EC50	46.76	25.04	60.00	0.00	56.32	10.22	39.04	35.71	39.10	24.16	51.94	22.38	54.28	15.88	49.36	25.33	39.32	25.25	60.00	0.00
Mysid NOEC	90.71	17.23	104.00	9.49	82.14	18.13	95.00	16.20	95.71	12.20	77.50	17.53	64.29	16.73	68.50	22.30	53.86	14.81	83.00	17.96

[a] 1002, 1003, 1004=control, 1005=education, 1001=education + sprinkler retrofit

Table WQ4. Significance of ANOVA results for the effect of sprinkler + education, education alone, and the difference between sprinkler + education and education alone relative to control concentrations. No data indicates $p > 0.05$

	Effect of Sprinkler + Education	Effect of Education Alone	Difference Between Sprinkler + Education and Education Alone
Metals			
Antimony			
Arsenic			
Barium			
Cadmium			
Chromium			
Cobalt			
Copper			
Lead			
Nickel			
Selenium			
Silver			
Zinc			
Microbiology			
Enterococcus			
Fecal Coliform	0.04		
Total Coliform			
MS2 Phage			
Somatic Phage			
Nutrients			
Ammonia as N	0.03	0.02	
Nitrate/Nitrite as N	0.02		
Total Kjeldahl Nitrogen			
Ortho-Phosphate as P			
Total Phosphorus		0.03	
OP Pesticides			
Chlorpyrifos	<0.01	<0.01	<0.01
Diazinon		<0.01	
Toxicity			
Fertilization EC50			
Fertilization NOEC			
Mysid EC50			
Mysid NOEC			

Table WQ5. Mean flux (and 95% confidence interval) of constituents in dry weather discharges collected before and after intervention[a] at two residential neighborhoods in Orange County, CA.

Parameter	Site 1001				Site 1005			
	Pre-Intervention		Post-Intervention		Pre-Intervention		Post-Intervention	
	Mean Flux	95% CI	Mean Flux	95% CI	Mean Flux	95% CI	Mean Flux	95% CI
Metals (ug/hr/km^2)								
Antimony	1564	740	920	410	167	99	1756	1666
Arsenic	1476	1006	741	427	164	107	2610	2425
Barium	41644	18423	29241	11384	6537	4624	83266	71121
Beryllium	43	17	36	15	7	5	94	79
Cadmium	157	97	40	17	13	5	207	189
Chromium	880	474	562	264	155	86	3199	2810
Cobalt	273	166	131	57	41	21	958	854
Copper	4738	2383	3600	1587	2233	1178	13717	11137
Lead	1149	861	253	133	81	52	1475	1270
Nickel	4287	2096	2743	1249	636	465	7319	6221
Selenium	1075	420	910	367	177	132	2045	1894
Silver	58	19	49	35	13	8	64	73
Zinc	28968	13481	11264	9171	5589	3276	39966	39179
Microbiology (Log)								
Enterococcus (MPN/hr/km^2)	1771	768	1437	624	281	208	1822	1464
Fecal Coliform (MPN/hr/km^2))	1254	567	955	418	234	170	3393	3251
Total Coliform (MPN/hr/km^2)	1628	607	1264	489	284	193	3902	3687
Somatic Phage (PFU/hr/km^2)	976	480	650	282	57	32	748	550
Nutrients (mg/hr/km^2)								
Ammonia as N	584	324	339	260	1145	1236	2466	2475
Nitrate/Nitrite as N	12981	6366	4316	2174	1849	1706	12102	9812
Total Kjeldahl Nitrogen	8144	4881	3621	1893	3083	2614	18149	13628
Ortho-Phosphate as P	4822	2535	1516	679	504	279	6735	6634
Total Phosphorus	4875	2573	1645	657	477	308	7782	8007
Pesticides (ng/hr/km^2)								
Chlorpyrifos	8	8	7	4	3	5	26	20
Diazinon	467	606	234	185	56	36	822	579

[a] 1005=education, 1001=education + sprinkler retrofit

Table WQ6. Correlation coefficients (and p value) of constituent concentrations with toxicity endpoints (No Observed Effect Concentration, NOEC and Median Effect Concentration, EC50) in dry weather discharges from residential neighborhoods in Orange County, CA. No data indicates $p > 0.05$

	Sea Urchin Fertilization NOEC	Mysid Survival NOEC	Sea Urchin Fertilization EC50	Mysid Survival EC50
Antimony		-0.273 (0.009)		
Arsenic		-0.3396 (0.001)		
Barium				
Cadmium				
Chromium		-0.244 (0.021)		-0.219 (0.044)
Cobalt		-0.330 (0.002)		-0.279 (0.010)
Copper				
Lead		-0.215 (0.042)		
Nickel				
Silver		-0.260 (0.013)		-0.229 (0.035)
Zinc	-0.277 (0.005)		-0.274 (0.006)	
Chlorpyrifos				
Diazinon		-0.426 (0.001)		-0.468 (0.001)
Ammonia				

Table WQ7. Comparison of median effect concentrations for the mysid survival (*Americamysis bahia*) and sea urchin (*Strongylocentrotus purpuratus*) fertilization tests.

Constituent (µg/L)	Mysid Survival (EC50)	Sea Urchin Fertilization (EC50)
Antimony	>4150	-
Arsenic	1390-2725	-
Barium	>500,000	>1500
Cadmium	16.5-90.2	1,272
Chromium	1560-2450	-
Cobalt	-	-
Copper	267	30
Lead	3130	>4,000
Nickel	387-635	-
Silver	220-283	-
Zinc	400	29
Chlorpyrifos	0.04	-
Diazinon	4.5	>1,000
Ammonia	-	69

- indicates no data available

Table WQ8. Comparison of mean concentrations (95% confidence intervals) in residential dry weather discharges from this study compared to concentrations in dry weather discharges from San Diego Creek at Campus during 2001-2002 (Data from OCPFRD).

	San Diego Creek	Residential
Parameter	Mean(95% CI)	Mean(95% CI)
Nitrate	5.16(0.72)	4.76(1.96)
Phosphate	1.98(0.07)	1.16(0.20)
Diazinon	0.13(0.07)	1.52(0.52)
Chlorpyrifos	0.05(0.01)	0.35(0.44)
Copper	11.59(2.83)	23.59(5.65)
Arsenic	6.58(0.40)	2.68(0.26)
Selenium	21.22(2.65)	2.46(0.03)
Zinc	22.08(2.75)	60.09(8.26)

Figure WQ1. Monthly average concentrations in dry weather discharges from five residential neighborhoods in Orange ounty, CA.

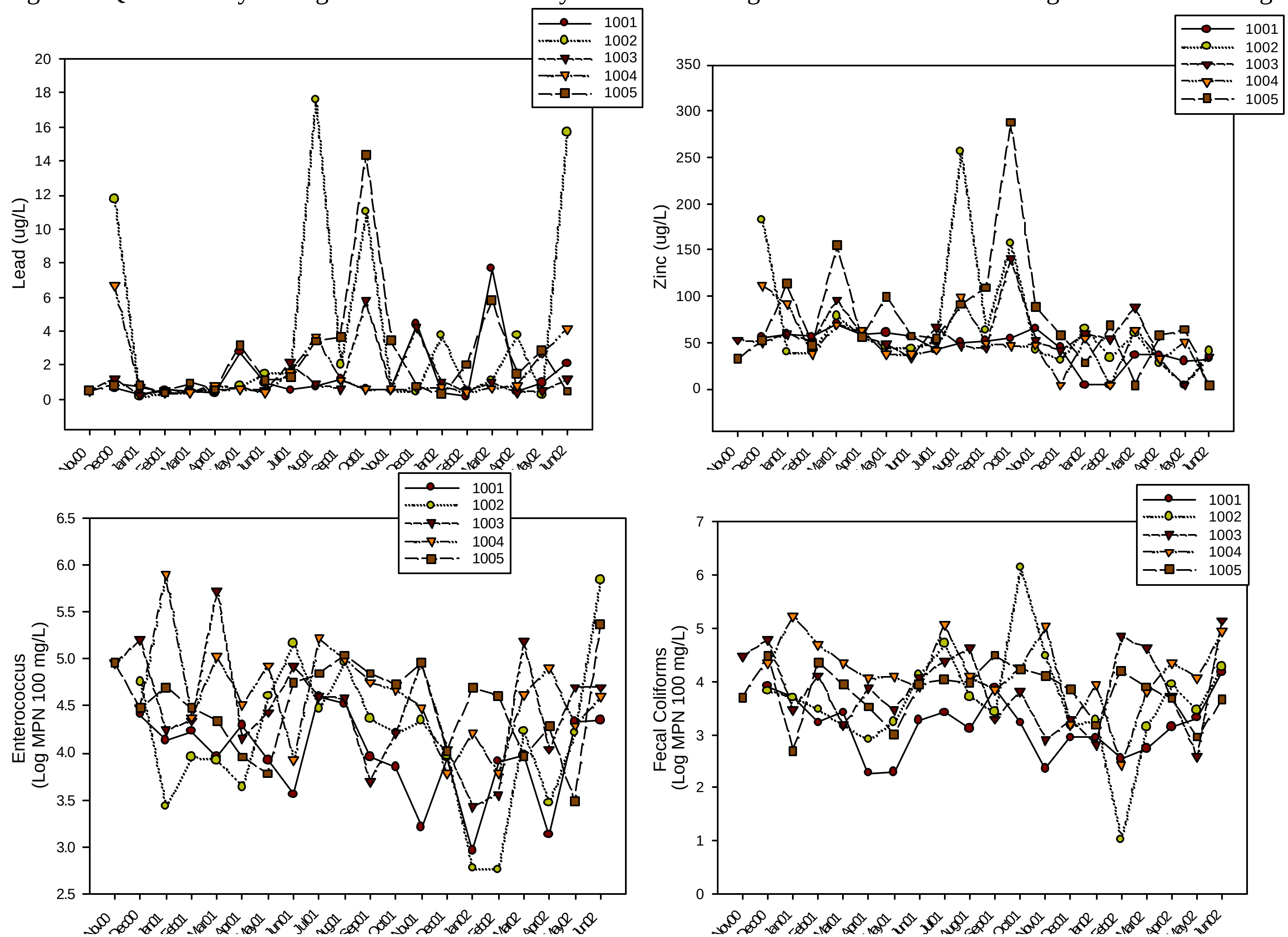


Figure WQ1 continued.

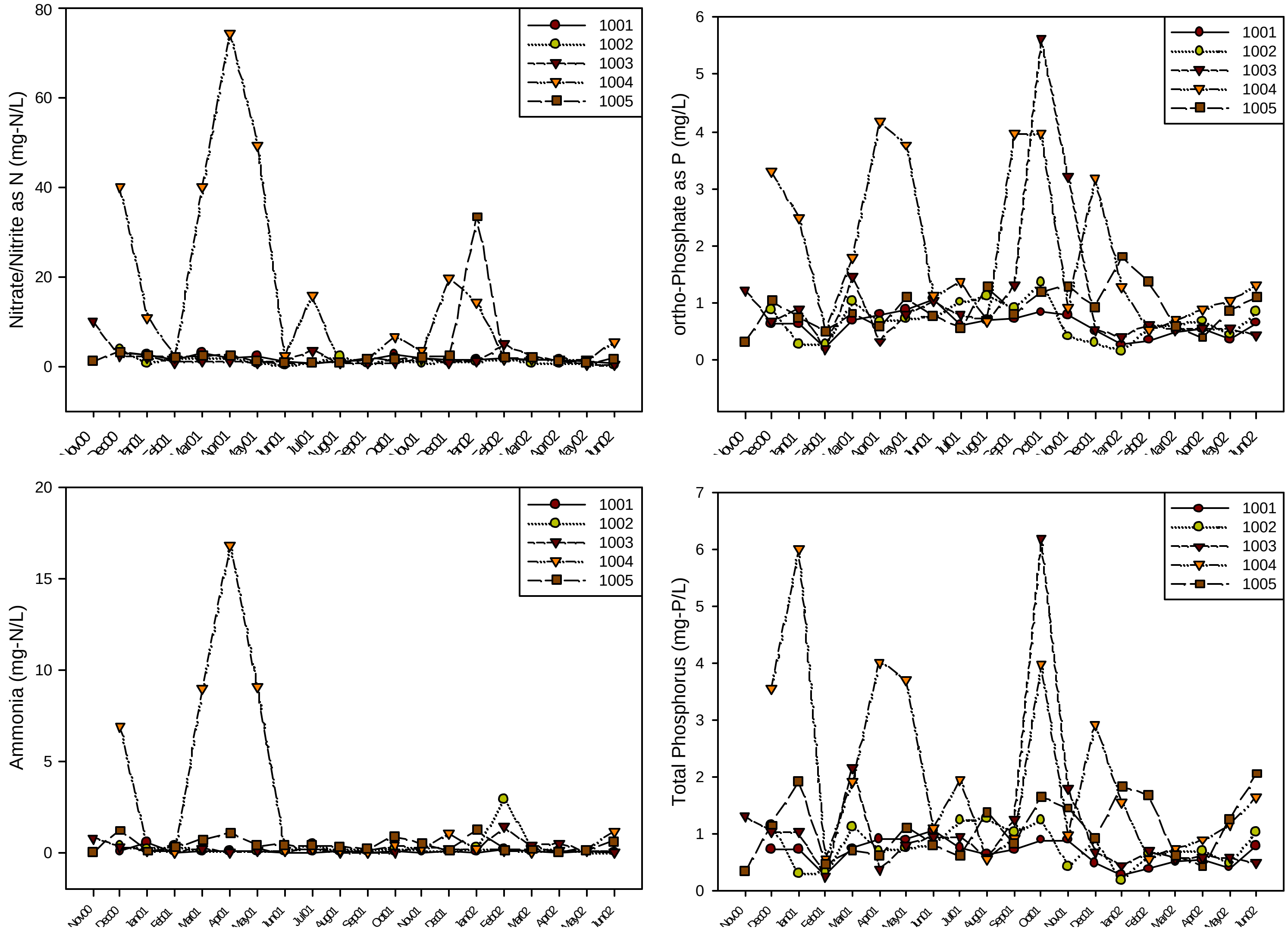
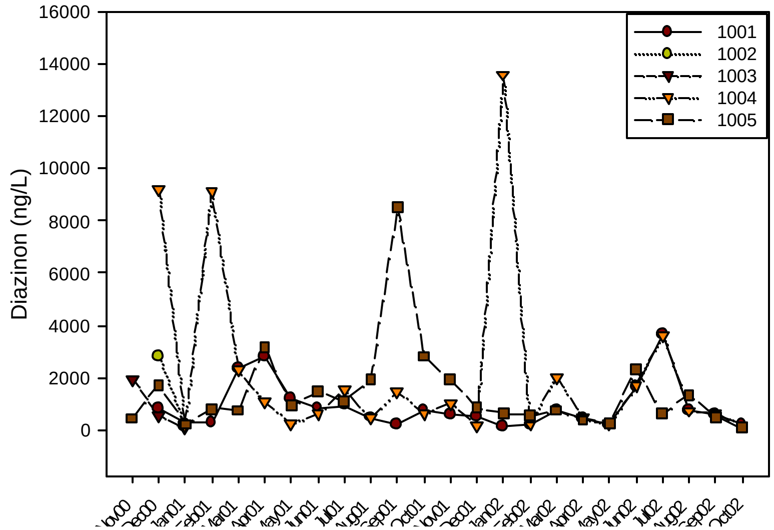


Figure WQ1 continued



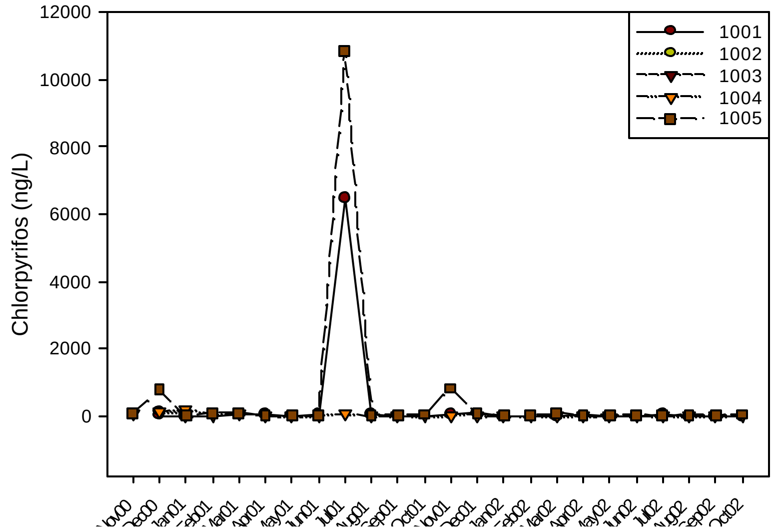
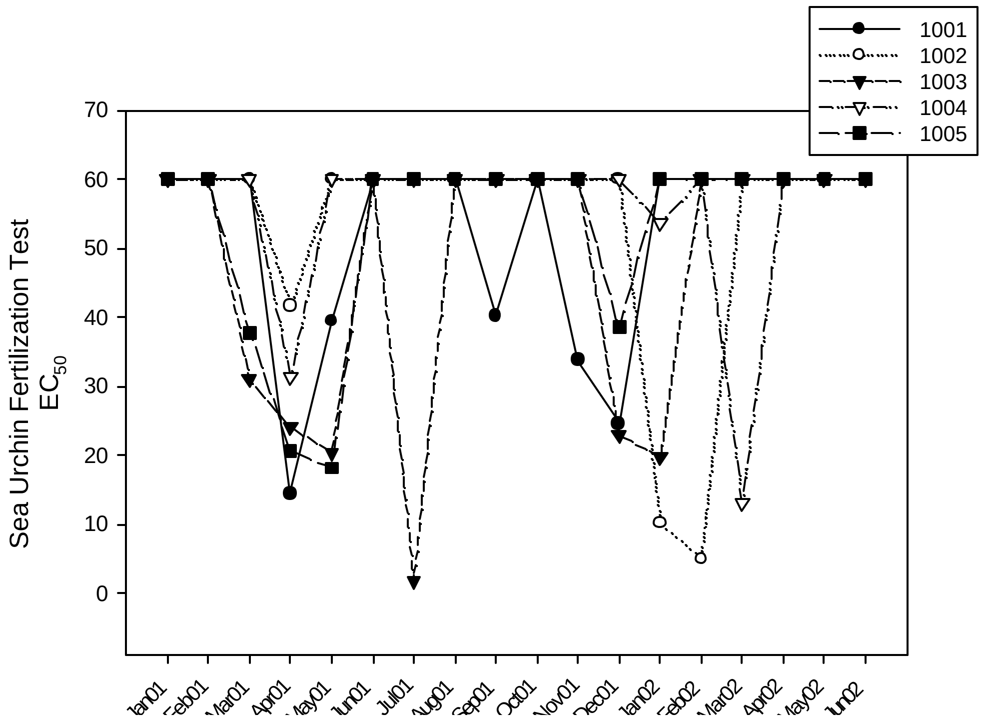
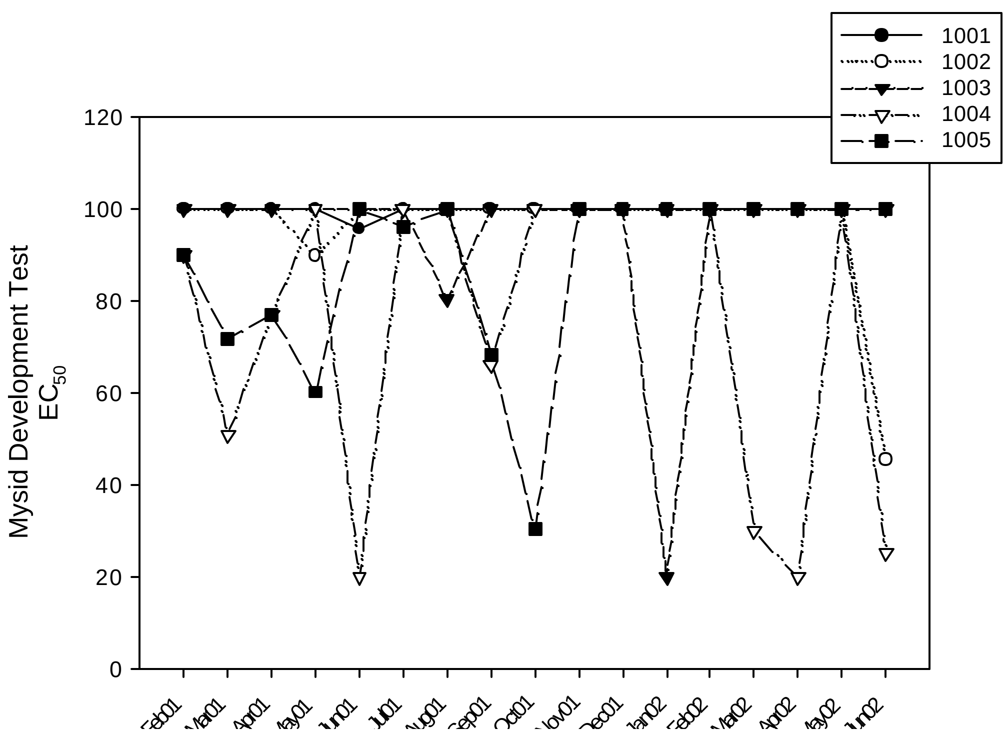


Figure WQ2. Toxicity of dry weather discharges from five residential neighborhoods in Orange County, CA





Appendix E2: Technical Assistance

The Residential Runoff Reduction Study

Appendix E2: Technical Assistance for the Residential Runoff Reduction (R3) Report

Prepared for

Irvine Ranch Water District
15600 Sand Canyon Avenue
Irvine, California 92618
(949) 453-5300

Contact:
Dick Diamond (949) 453-5594

Prepared by:

GeoSyntec Consultants
838 Southwest First Avenue • Suite 530
Portland, OR 97204
(503) 222-9518

Contacts:
Eric Strecker, (503) 222-9518

February, 2004

Table of Contents

List of Figures

List of Tables

1. Introduction

This report describes analyses and results of work conducted by GeoSyntec Consultants for the Irvine Ranch Water District (IRWD) to assist in the completion of the Residential Reduction Runoff (R3) Study. The R3 Study is an ambitious investigation to quantify the effectiveness of BMPs in reducing dry weather discharges and associated pollutants.

GeoSyntec Consultants completed the following tasks:

1. Review and Analysis of Water Quality Data. We reviewed the analyses described in Chapter 5 of the R3 report and conducted additional analyses of the water quality data and flux calculations to explore and potentially enhance the interpretation of the monitoring results.
2. Evaluation of Possible Implications on TMDL Compliance. We reviewed and summarized applicable TMDLs in the San Diego Creek Watershed. Results from Task 1 were compared with the TMDLs to evaluate whether the BMPs are beneficial to achieving the TMDL objectives.

2. GeoSyntec Review of Section 5 of the R3 Study Report

Section 5 in the R3 report describes the water quality monitoring data and analyses. The following are GeoSyntec review comments of Section 5.

- **<u>Abstract and Introduction</u>**. The abstract and introduction section provides a recap of the entire study, including a description of the study motivation and objectives. This suggests that this section of the report was originally written as a stand-alone report. In the final report we recommend that most of this information should be integrated into an earlier overall report introductory chapter. The introduction of Section 5 should be limited to a recap of the water quality and flow data, and to present the purpose/goals of the data analysis described in this section.
- **<u>Methods</u>**. The methods section similarly presents much of the study details (watershed descriptions, intervention description-BMPs applied-, etc). We recommend this information be presented in an earlier chapter in the report that describes the study design and procedures in a high degree of detail. This study description chapter could then be referenced as needed throughout the report.
- **<u>Data Analysis and Results</u>**. The 5 data analysis steps are logical and reasonable, however, the procedures, assumptions made, and results are, in some cases, unclear as discussed below. Additional details of the procedures and assumptions made, as well as the use of alternative, possibly more appropriate statistical procedures could enhance the interpretation and usefulness of the monitoring data. Some specific suggestions and comments are discussed below:

1. **Comparison of water quality data prior to intervention**. ANOVA tests were used to test for differences among the treatment sites for each constituent prior to intervention. ANOVA is a parametric test, which is identical to the t-test when comparing only two groups of data. This test assumes that all data sets are normally distributed and have equal variance. The t-test has limitedpower todetect small differences among data sets if they are not normally distributed. Currently the report states that the "data were tested for normality and homogeneous variance prior to testing...[and] only the microbiological data were determined to be non-normally distributed..." However, the results of the normality tests were not included, nor were any descriptive statistics that may indicate normality. Our analyses suggest that many of the data groups are not normally distributed. In addition the mean is not considered a good measure of central tendency for many of R3 data, because mean values can be strongly influenced by outlier values, which were frequently observed. Much of our analyses, therefore, are based on the evaluation of median concentrations. Median values are resistant to the influence of outlier values, and may therefore be a more appropriate measure of central tendency in the R3 data.

   Table WQ3 includes means and 95% confidence intervals for the water quality data before and after intervention (BMPs applied). These descriptive statistics only show part of the story. At the very least, other parametric descriptive statistics, such as the standard deviation and the coefficient of skewness should be included, as well as non-parametric (i.e., resistant to outliers) descriptive statistics, such as the median, interquartile range, and the quartile skew. These will aid in interpreting the central tendency, variation, and skewness of the data. A test on the coefficient of skewness will indicate whether the data are symmetric or not. If the null hypothesis that the data are symmetric cannot be rejected, normality tests are warranted. Otherwise, it can be safely assumed that the data do not come from a normal distribution and alternative non-parametric statistical procedures that do not require normality should to be used.

   The standard methods for calculating the 95% confidence interval about the mean (based on t-distribution) are symmetric confidence intervals that require normality, especially with small data sets. While the report does not state the method used for calculating the 95% confidence intervals, it is likely that the standard method was employed since normality was assumed for the ANOVA analysis. When data are non-normal, alternative methods for calculating the 95% confidence intervals could be used, such as the non-parametric interval estimate for the median (no specific data distribution assumed) or an asymmetric confidence interval about the mean (a specific distribution is assumed, such as the lognormal distribution). However, it should be noted that 95% confidence intervals, are appropriate, but not necessary for testing whether there are significant differences between data sets. Hypothesis tests can be used to detect differences. It is recommended that confidence intervals be reserved for showing the uncertainty in an estimate of central tendency (e.g. mean or median) to determine the likelihood for a threshold to be exceeded, such as a water quality criterion.

If one or more of the pre-intervention data sets are determined to be non-normal or unequal in variance, alternatives to the single-factor ANOVA test can be used, such as the Kruskal-Wallis (K-W) test. The K-W test will determine if all of the data sets have the same distribution and if the medians are equivalent within a specified level of confidence.

2. **Comparison of water quality concentrations over time.** Monthly mean concentrations over time were included in the report. While this is a valid approach to analyzing data, it has a tendency to mask the data's true variability, and since there were generally only two samples per month, there is no apparent advantage to averaging for this exploratory data analysis. Also, Site 1004 had large spikes in the nutrient values that when plotted on the same graph as the other sites tends to dampen and make less apparent the variability in monitoring results from the other sites. It is recommended that all data are initially plotted on separate time-series graphs to identify seasonal periodicity, step-trends, or monotonic trends for each sampling site. Time series plots are an excellent approach for presenting the data and an appropriate first step for understanding the characteristics of the data. Note that unless there are obvious trends (step or monotonic), the time-series plots should probably be placed in an appendix rather than the main body of the report, as there will be a number of them and the information provided is primarily to aid the investigator in determining the next step in the analysis.

   In addition to time series plots, other plotting procedures are available that can be useful in the visual inspection of the data. Plots that should be considered for inclusion in the report include box plots that show side-by-side comparisons of central tendency and variability, and side-by-side quantile (cumulative probability distribution) plots that give an indication of the underlying distribution and any apparent differences in those distributions. These should be included in the main body of the report.

3. **Comparison of water quality data before and after intervention.** Standard t-tests were used to compare mean concentrations before and after intervention. The report states that only 6 out of 24 constituents showed significant differences, and the differences showed a net increase from pre- to post treatment. Removing the outlier points did not affect this result. As stated above, the t-test assumes that both groups of data are normally distributed about their respective means and that they have constant variance. There is no indication that the data meet these strict requirements (water resources data rarely do). The report also states that the data were "normalized" to the grand mean of the control sites, but there is no justifiable reason for doing so, especially since the control sites varied greatly amongst themselves.

   A limitation in the comparison of mean concentrations, such as through the use of the t-test, is that the mean of the concentration data is heavily influenced by outlier values. Given that outlier values were identified and recognized to influence the results, alternative measures of central tendency that are more resistant to the influence of the outliers (e.g. median) should be investigated and presented in the report. The rank-sum test, or Mann-Whitney test, is a non-parametric test that tests whether the median of one group is significantly different from the median of another group. The rank-sum test does not assume any particular distribution or even that the two data sets come from the same distribution. Also, it has the power to detect small differences among data sets and will even work on censored data (data only known to be below the detection limit) as long as less than 50% of the data are censored. The rank-sum test is equivalent to the Kruskal-Wallis test discussed above, but applied to only two data sets. Based on the relative strengths of the rank-sum test as compared to the t-test, and for consistency in the data analysis (as it is highly unlikely the assumptions of the t-test could be met for all, if any of the data sets), it is recommended that the rank-sum (or Krsuskal-Wallis) tests be performed on all data sets.

Once it is determined that a significant difference in the medians exists, the magnitude of the difference can be calculated using the Hodges-Lehmann estimator, which is the median of all possible pair-wise differences between the two data sets. Note that this is often significantly different than the simple difference in medians. A confidence interval about the Hodges-Lehmann estimator can then be calculated to illustrate the variability of the estimate.

4. **Comparison of constituent fluxes (Mass loadings per time) before and after intervention**. Similar to the analysis of concentration data discussed above, mean fluxes for the pre- and post-intervention cases were compared using standard t-tests (for 2 sites only). In general, no difference in the mean flux was found between the pre- and post-intervention data.

   Similar to the analysis of the concentration data, the mean of the flux data is heavily influenced by outliers. Therefore, alternative measures of the central tendency should be calculated and compared. The rank-sum test could be used here as well.

5. **Correlation of toxicity measures with potential toxicants in dry weather runoff**. Correlations between toxicity data and concentration data were investigated using a Pearson product moment correlation. Based on this analysis, no correlations were found to be significant. The first and foremost step in investigating whether one variable is associated with another is to plot the two variables on opposite axes (scatterplot). This step was presented in the report and should be included. A scatterplot matrix helps to identify the nature of the correlation between several variables in one concise graph. A scatterplot will also indicate whether the use of Pearson's correlation coefficient is even appropriate, as it only tests whether there is a linear association between two variables. Due to the nature and complexity of biotic systems, the relationship between toxicity and constituent concentration are likely to be nonlinear. Therefore, an alternative measure of association should be used such as Kendall's Tau or Spearmans Rho. Both of these statistics measure the strength of the monotonic relationship between two variables.

- **Discussion and General Review Comments**. The primary conclusions drawn from the investigation were that there is no statistically significant reductions in pollutant concentration or flux (loadings) as a result of the education and/or sprinkler retrofit technology. While this may be the case, the data analysis described and presented may have had limited ability to detect differences for the particular data sets. The discussion section included two possible explanations for not being able to detect changes between pre- and post-intervention: 1) the data had too much variability and not enough samples were taken, and 2) the treatments were applied at only about one-third of the individual homes within the test watersheds, which effectively diluted the effects of the intervention. Both of these are logical explanations and should be considered in the design of future studies. A helpful assessment would be to evaluate how much data would be needed to detect levels of differences desired to be detected. This information would be valuable for planning of future studies.

Another possible explanation for having difficulty in detecting differences that was not mentioned in the report is the difference in time periods for the pre-intervention and the post-intervention. The pre-intervention period was from December 2000 to June 2001 and the post-intervention period was from July 2001 to June 2002. In other words, the post-intervention period includes summer and fall data, while the pre-intervention period does not. Moreover, there was considerably more rainfall during the pre-intervention wet season than the post intervention wet season (see Table 1).

Based on this it may be desirable to analyze differences using a truncated post-intervention data set with only winter and spring data. The downside of this approach is that it reduces the number of data points to include in the analysis. However, it is justifiable in that in the summer and fall the observed dry-weather flows are likely more associated with irrigation practices and in the winter and spring the observed dry-weather flows are likely more associated with the leaching of saturated soils. We recommend that the use of a truncated data set should be considered if additional analyses of the data using the approaches recommended above do not reveal statistically significant differences.

Table 1: Daily Rainfall Data at the Tustin-Irvine Rain Gauge (100th of inches)

		2001												2002											
	Dec 00	Jan 01	Feb 01	Mar 01	Apr 01	May 01	Jun 01	Jul 01	Aug 01	Sep 01	Oct 01	Nov 01	Dec 01	Jan 02	Feb 03	Mar 02	Apr 02	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02
1																									
2							5						15												
3																									
4				47	7							6		5											
5																									
6				3	61												12								
7																22									
8		47																							
9				33	5																				
10													10											163	
11		184										4													
12		105	36									36													
13		8	295																						
14			14																						
15																	7								
16																									99
17															40	29									8
18			3																						
19																		7							
20			9															10							85
21					52								28												
22													8												
23			29													4									9
24		32	12									46					9								
25			85																						
26		57	90	3		8											7						5		
27		13	42											46			3								
28			32											5										3	
29												18	10												13
30													35											54	
31																									
total	0	446	647	86	125	8	5	0	0	0	0	110	106	56	40	55	38	17	0	0	0	0	5	220	214

Pre-intervention period (13.2 inches from12/00-6/01) Post-intervention period (3.1 inches from12/01-6/02)

3. Examples of Recommended Approaches to Data Analysis for Chapter 5

These example analyses focus on TMDL constituents: nutrients (total nitrogen and total phosphorus), metals (copper, lead, zinc, cadmium), pesticides, and pathogens (fecal coliform). The analyses also focus on dry weather flows, as reduction of these flows was the objective of the R3 study.

Recommended Data Analysis Methods

Exploratory Data Analysis
Visual inspection of data and exploration of factors that could potentially influence data (e.g. seasonal trends, rain events)

1. Divide data into pre and post- intervention groups.
2. Construct time series plots to visually inspect data and visually examine for seasonal trends. Overlay storm event markers to identify any relation to rainfall volume or antecedent dry period (ADP).
3. Investigate normality or log normality of data sets. Select appropriate statistical tests.
4. Construct probability plots for pre-intervention and post-intervention periods.
5. Prepare quantile plots.
6. Prepare side-by-side box plots.
7. Calculate descriptive statistics

Hypothesis Testing
Test data for skewness, normality, and statistically significant differences. Note that the skewness and normality tests are only needed if parametric approaches are conducted. It is our recommendation to use non-parametric approaches for consistency because normality will not be met in all cases. Nonetheless examples have been provided to show that several of the data sets do not come from a normal distribution.

1. Skewness hypothesis test for symmetry.
2. Shipiro-Wilkes normality test.
3. Mann-Whitney rank-sum test.
4. For the data sets that have greater than 50% censored data (i.e. data only known to be less than the detection limit), hypothesis tests for differences in proportions.

Example Results

The first step in the data analysis is to construct time-series plots. Time-series plots are constructed to identify seasonal periodicity, step-trends, and monotonic trends. The original report included monthly average time-series plots with all sites included per plot. The authors noted that periodicity and trends were not apparent. However, plotting all sites on one graph tends to hide much of the information. For instance, Site 1004 had much higher nutrient concentrations than the other sites, so by including this site, the minor fluctuations in data from the other stations are less apparent. Individually plotting the time-series plots reveals more information. Also, by overlaying storm events the role of rainfall volumes and the antecedent dry period (ADP) may be more apparent and may indicate whether additional analyses are warranted (e.g., correlating ADP with concentration). Figure 1 is an example time-series plot with storm event markers overlain for total phosphorus for Site 1001. Notice the pre-intervention period had much more rainfall, which likely added to the variability in runoff concentrations and fluxes. However, it is apparent that the winter and spring concentrations appear to be lower and less variable during the post-intervention period. The irrigation controllers may have had an affect on the runoff concentrations by reducing the amount of irrigation during moister weather conditions (i.e. high soil moisture). Notice a similar effect for total nitrogen in Figure 2. Additional time-series plots are provided in Appendix A.

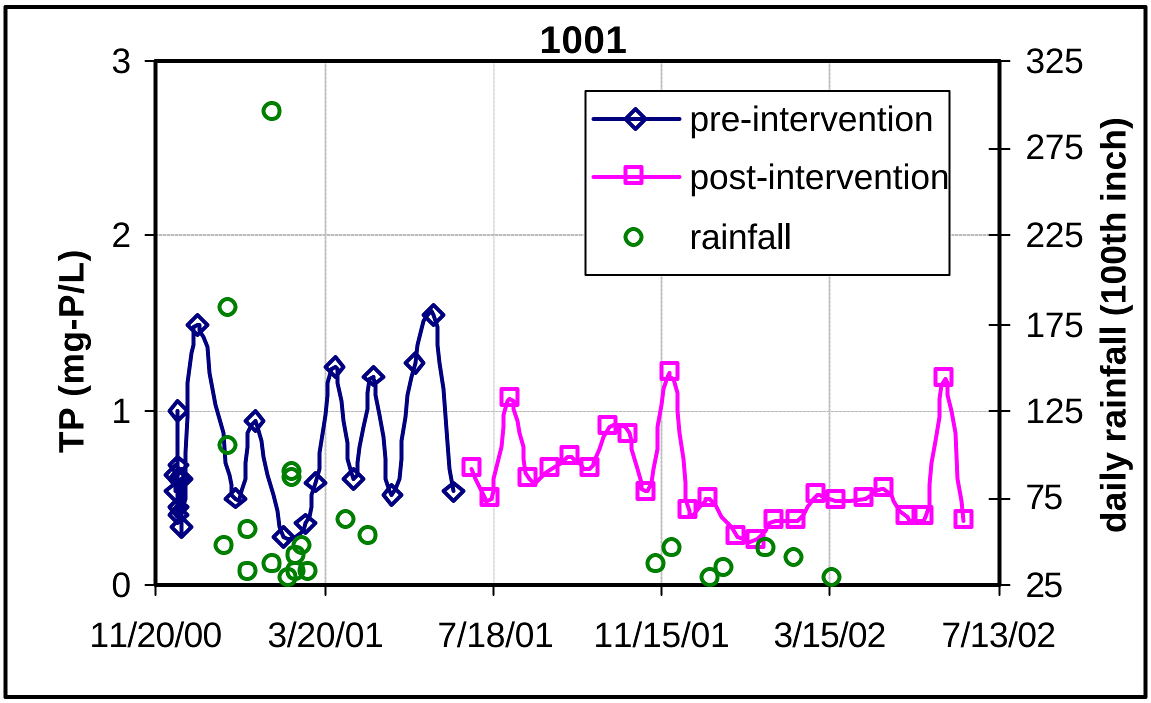


Figure 1. Example time-series plot of total phosphorus with storm event markers.

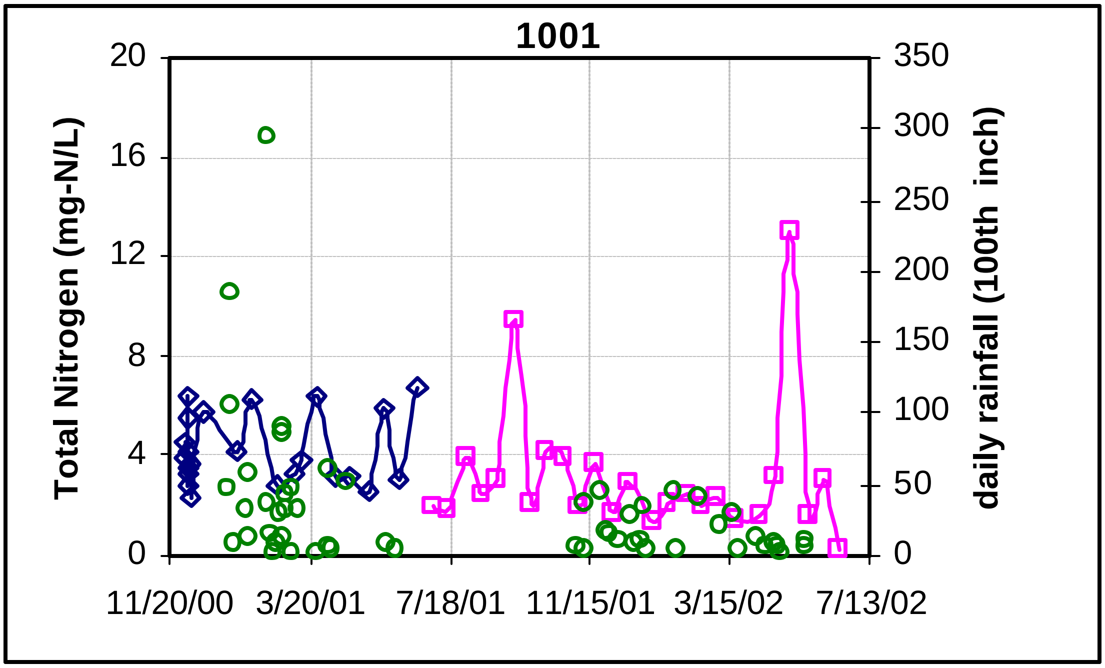


Figure 2. Example time-series plot of total nitrogen with storm event markers.

Comparison of Water Quality Data Prior to Intervention

To visually investigate whether the test sites have similar runoff characteristics, probability plots should be constructed. Figure 3 is an example of a probability plot for total phosphorus for all of the test sites. Notice that all of the sites have a similar distribution except for Site 1004. This suggests that Site 1004 should not be used for "normalizing" of the intervention sites (other information in the report indicating an unknown connection to a nursery further suggests the exclusion of site 1004). However, as mentioned above there is no advantage to normalizing the data using the control sites even if all of the sites had similar distributions.

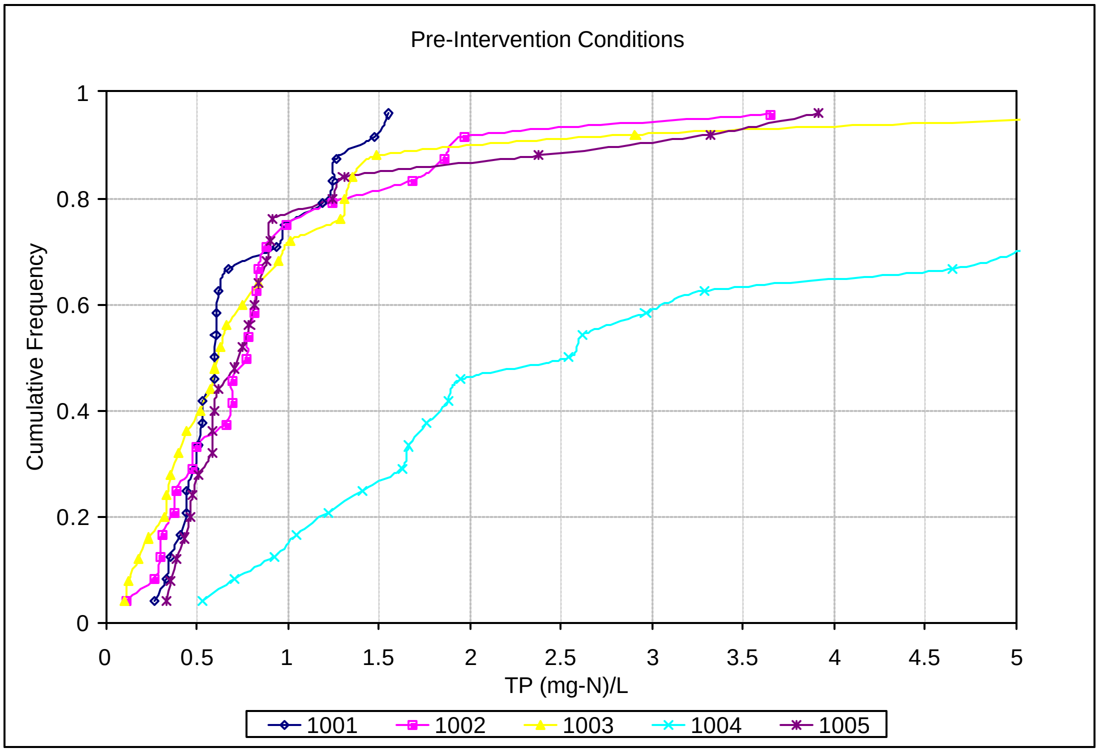


Figure 3. Example probability plot of total phosphorus for all sites prior to intervention.

The next step in the data analysis is to calculate parametric and non-parametric descriptive statistics. Table 2 is an example table of descriptive statistics for total nitrogen for all sites for both the pre- and post-intervention periods. (Additional descriptive statistics are included in Appendix B.) Table 2 includes the number of data points (n), the detection percent (%>MDL/RL), the mean, median, 25% trimmed mean, min, max, 25th percentile, 75th percentile, standard deviation, interquartile range (IQR), and the coefficient of skewness (g_s). Also included in the table are critical skewness coefficients (g_{cr}), which are readily available in statistics texts. If the coefficients of skewness are less than these critical values, then the data are symmetric. Notice that the measures of central tendency (mean and median) and variability (standard deviation) of the sites during the pre-intervention period are quite different, indicating the data arise from different distributions. The median values are consistently smaller than the mean (in some cases substantially smaller) demonstrating the influence of the outliers on the measure of central tendency. Also note that only three pre-intervention data sets are symmetric and none of the post-intervention data sets are. Failure to pass the symmetry test indicates the data are not normal. However, passing the symmetry test does not indicate the data are normal; this requires a normality test. The symmetry test, which is easier to conduct than normality tests, serves as an initial screen for normality to reduce the number of data sets needing further investigation.

Table 2. Example table of descriptive statistics for total nitrogen for each site for pre- and post-intervention.

		1001		1002		1003		1004		1005	
Parameter	**Statistic**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
TN (calculated)	**n**	23	25	23	25	23	25	23	25	23	25
(mg-N/L)	**% > MDL/RL**	100%	80%	98%	90%	98%	96%	98%	96%	100%	98%
	Mean	4.24	3.09	5.31	3.44	3.66	4.42	48.00	10.18	6.89	7.74
	Median	3.84	2.27	3.95	2.55	2.66	2.50	19.01	5.57	5.06	4.36
	Trimmed mean	3.94	2.40	4.53	2.76	2.93	3.01	33.11	6.47	5.08	4.42
	min	2.30	0.30	1.50	0.78	1.46	0.45	3.28	0.74	2.48	1.07
	max	6.76	12.99	13.83	11.40	12.12	19.91	141.06	40.80	20.41	67.12
	25th percentile	3.20	1.79	2.27	2.10	2.11	2.04	9.05	2.71	3.52	3.47
	75th percentile	5.68	3.13	8.02	4.36	4.81	5.17	94.79	19.18	7.07	5.62
	St Dev	1.41	2.67	3.56	2.51	2.48	4.39	49.17	10.73	5.29	12.85
	IQR	2.48	1.34	5.75	2.26	2.70	3.13	85.74	16.47	3.55	2.15
	Skewness, g_s	0.55	2.82	0.84	1.87	2.13	2.27	0.74	1.37	1.88	4.46
	g_{cr}	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	Symmetric ($g_s < g_{cr}$)?	Y	N	Y	N	N	N	Y	N	N	N

Non-parametric tests are recommended for all data analyses for consistency since all data sets do not meet the required assumptions for parametric tests (i.e. normality and constant variance). Non-parametric tests are not based on the assumption of normally distribution; therefore, normality tests were not warranted. It is important to note that if the data sets that passed the initial symmetry screening (Sites 1001, 1002, and 1004 in the table above) also passed a normality test, it does not indicate the data follow a normal distribution, especially for small data sets. The test simply indicates that normality cannot be rejected for the data.

As mentioned above, the non-parametric equivalent to the ANOVA test is the Kruskal-Wallis test, which tests for a difference between the medians of independent data groups. The K-W test will also test whether the datasets are derived from the same distribution. Several statistical packages will perform this test. Results of the K-W test shown in Table 3 was generated from a statistical add-on to Microsoft Excel® called Analyse-It™.

Comparison of the mean ranks in Table 3 provides an indication of whether the data groups are derived from the same distribution. A p values < 0.05 indicates that two or more the data groups have different distributions. Examination of the mean ranks in Table 3 shows that Sites 1001, 1002, and 1005 have somewhat similar mean ranks and Sites 1003 and 1004 have somewhat different mean ranks. This suggests that Sites 1003, 1004 have a different distribution than the other sites. Therefore, it is determined that the K-W test should be performed on just Sites 1001, 1002, and 1005. These results are shown in Table 4. Notice that the p-value is now greater than 0.05, so the distributions of the total nitrogen data are not significantly different. Based on this analysis, Site 1002 should be used as the only control site for comparison of total nitrogen data. These analyses will need to be repeated for the other water quality constituents.

Table 3. Example of Kruskal-Wallis test results for total nitrogen at the test sites prior to intervention.

Test	**Kruskal-Wallis ANOVA**		
Comparison	Total Nitrogen: 1001, 1002, 1003, 1004, 1005		
Performed by	GeoSyntec Consultants		
n	115		
Total Nitrogen	**n**	**Rank sum**	**Mean rank**
1001	23	1128.0	49.04
1002	23	1162.0	50.52
1003	23	774.0	33.65
1004	23	2150.0	93.48
1005	23	1456.0	63.30
Kruskal-Wallis statistic	41.71		
p	<0.0001	(chisqr approximation)	

Table 4: Example of Kruskal-Wallis test results for total nitrogen at the Site 1001, 1002, and 1005 prior to intervention.

Test	**Kruskal-Wallis ANOVA**		
Comparison	Total Nitrogen: 1001, 1002, 1005		
Performed by	GeoSyntec Consultants		
n	69		
Total Nitrogen	**n**	**Rank sum**	**Mean rank**
1001	23	710.0	30.87
1002	23	761.0	33.09
1005	23	944.0	41.04
Kruskal-Wallis statistic	3.27		
p	0.1948	(chisqr approximation)	

Based on these example analyses of the pre-intervention TN data, it is clear that Site 1004 should not be considered as a control site for total nitrogen, and Site 1003 should be used with caution.

Comparison of Water Quality Data Before and After Intervention

Side-by-side box plots and probability plot comparisons of pre-intervention and post-intervention were constructed to identify any apparent differences in the central tendency and concentration distributions between the two data sets. Figure 4 shows side-by-side box plots of total nitrogen at all of the test sites. Site 1004 was omitted due to its high variability. Notice that Site 1001 shows a distinct decrease in total nitrogen, while the other sites do not. However, other sites do show a decreasing trend in median concentration and inter-quartile ranges.

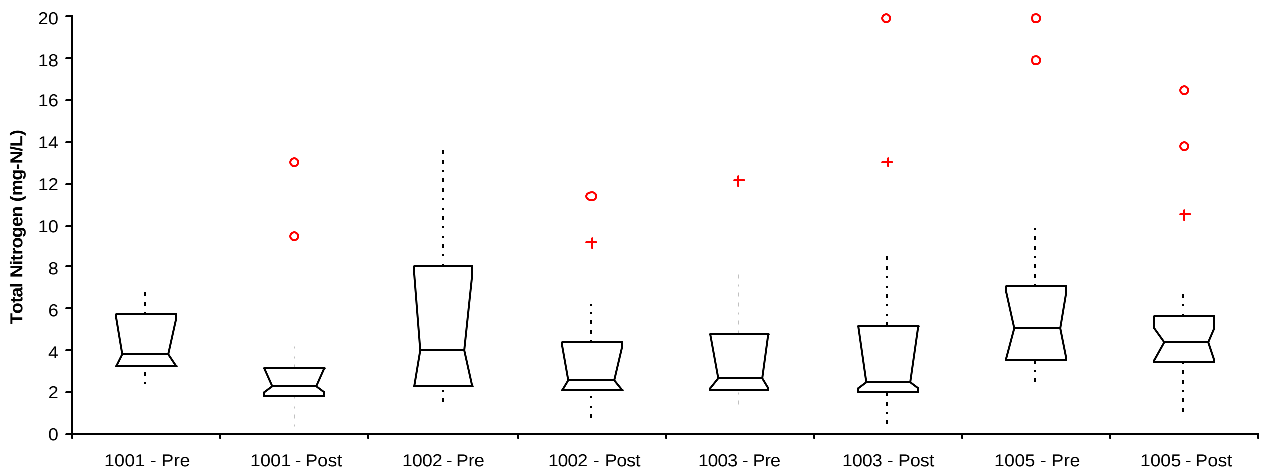


Figure 4. Side-by-side box plots of pre- versus post-intervention for total nitrogen at all sites.

Figure 5 is a probability plot of total nitrogen for Site 1001 before and after intervention. (Additional probability plot comparisons are included in Appendix C.) Notice that there is a distinct reduction in total nitrogen at the site. However, since these data are from different time-periods, this difference could be related to temporal variability.

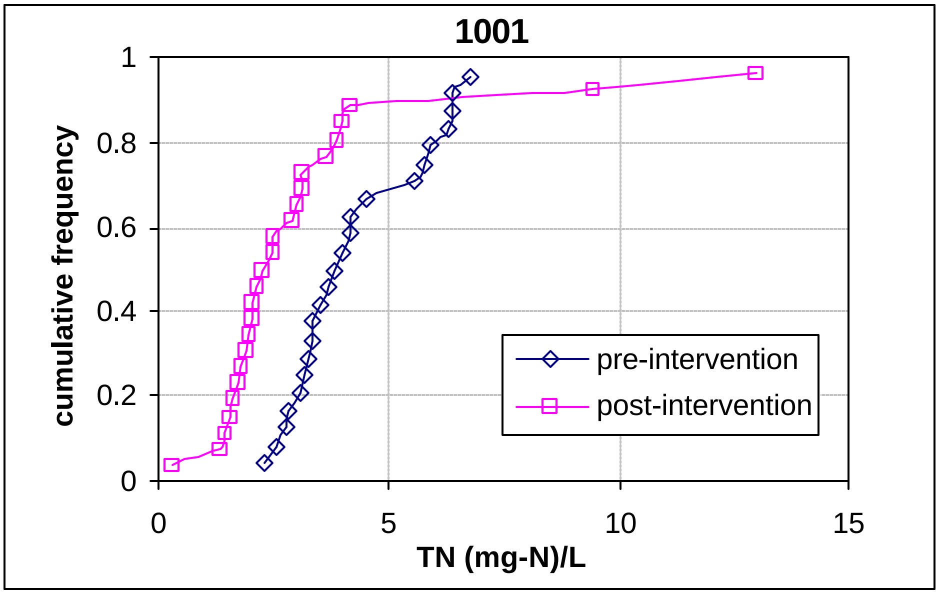


Figure 5. Example probability plot of pre- versus post-intervention at Site 1001 for total nitrogen.

To evaluate if temporal variability caused by the different monitoring periods has anything to do with the difference in total nitrogen concentrations, the probability plot of the pre- and post-intervention period for Site 1001 is plotted with those for Site 1002 and Site 1005 (as these were determined to be the only valid control sites). These comparison plots are shown in Figure 6 and Figure 7. Notice that for pre-intervention, the distribution of Site 1001 more closely follows the distribution of Site 1005 than that of Site 1002, and for post-intervention the opposite is true. This indicates that the year-to-year variability alone cannot explain the reduction in total nitrogen at Site 1001. However, this would need to be statistically verified.

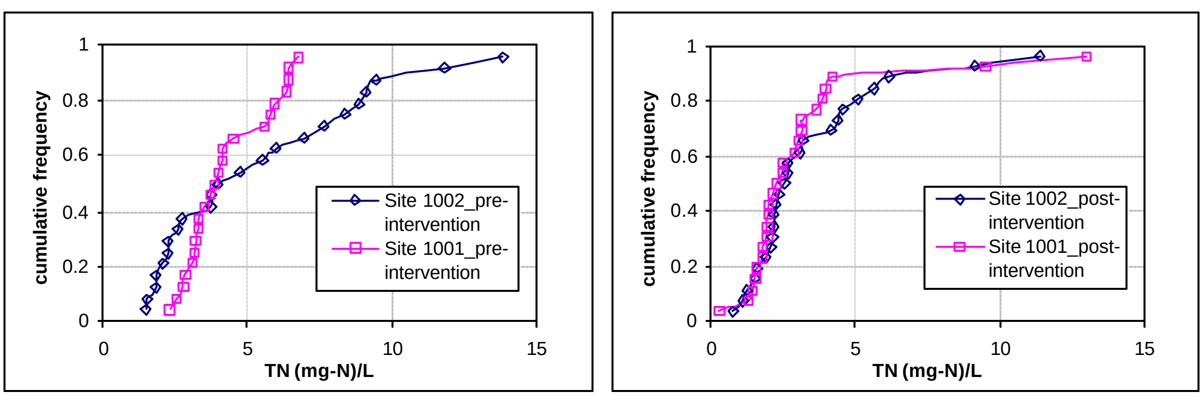


Figure 6. Example probability plot for total nitrogen of Site 1001 versus Site 1002 for the pre- and post-intervention periods.

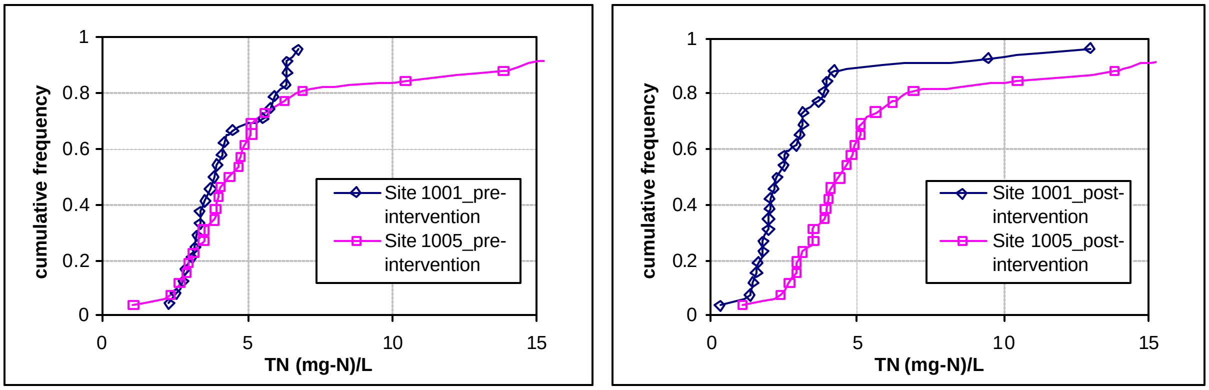


Figure 7. Example probability plot for total nitrogen of Site 1001 versus Site 1005 for the pre- and post-intervention periods.

As mentioned earlier, the Mann-Whitney test (rank-sum) can be used to determine if there is a statistical difference in the median values of two independent data sets (by rejecting the hypothesis that they are the same). Table 5, Table 6, and Table 7 show the output of the Mann-Whitney tests from the Analyse-It™ statistical package on Sites 1001, 1002, and 1005, respectively. Notice that there is a statistically significant difference ($p<0.05$) in the medians between the pre- versus post-intervention total nitrogen data at both Sites 1001 and 1002, but not at Site 1005. Furthermore, the difference in the medians at Site 1001 is at a higher level of confidence (more statistically significant) than the difference at Site 1002 (i.e., greater than 99% significant compared to about 96% significant). The magnitudes of these differences (Hodges-Lehmann estimator) are about 1.5 and 1.3 mg-N/L for Sites 1001 and 1002, respectively. These tests indicate that the difference in the total nitrogen medians at Site 1001 from pre-intervention to post-intervention cannot be explained by the year-to-year variation alone (e.g., the intervention appears to have had an effect). It also indicates that the public education applied to Site 1005 did not appear to make a significant difference.

Table 5: Example Mann-Whitney test for difference in medians for total nitrogen at Site 1001 from pre- versus post-intervention.

Test	Mann-Whitney test			
Alternative hypothesis	1001: Pre ≥ Post			
Performed by	GeoSyntec Consultants			
n	48			
1001	**n**	**Rank sum**	**Mean rank**	**U**
Pre	23	736.0	32.00	115.0
Post	25	440.0	17.60	460.0
Difference between medians	1.497			
95.2% CI	0.883	to +∞	(normal approximation)	
Mann-Whitney U statistic	115			
1-tailed p	0.0002	(normal approximation)		

Table 6. Example Mann-Whitney test for difference in medians for total nitrogen at Site 1002 from pre- versus post-intervention.

Test	Mann-Whitney test			
Alternative hypothesis	1002: Pre ≥ Post			
Performed by	GeoSyntec Consultants			
n	48			
1002	**n**	**Rank sum**	**Mean rank**	**U**
Pre	23	651.0	28.30	200.0
Post	25	525.0	21.00	375.0
Difference between medians	1.289			
95.2% CI	0.065	to +∞	(normal approximation)	
Mann-Whitney U statistic	200			
1-tailed p	0.0355	(normal approximation)		

Table 7. Example Mann-Whitney test for difference in medians for total nitrogen at Site 10052 from pre- versus post-intervention.

Test	**Mann-Whitney test**			
Alternative hypothesis	1005: Pre ≥ Post			
Performed by	GeoSyntec Consultants			
n	48			
1005	**n**	**Rank sum**	**Mean rank**	**U**
Pre	23	610.0	26.52	241.0
Post	25	566.0	22.64	334.0
Difference between medians	0.530			
95.2% CI	-0.446	to +∞	(normal approximation)	
Mann-Whitney U statistic	241			
1-tailed p	0.1686	(normal approximation, corrected for ties)		

Comparison of Constituent Fluxes Before and After Intervention

The statistical procedures applied to the concentrations examples above should also be applied to the constituent fluxes (mass loadings). For completeness, an abridged example analysis will be provided here. Figure 8 includes side-by-side box plots and probability plots of total nitrogen flux data (mg/acre/day) for Site 1001 at pre- and post-intervention. Note there appears to be a significant decrease in the median, as well as an overall reduction in the distribution of values.

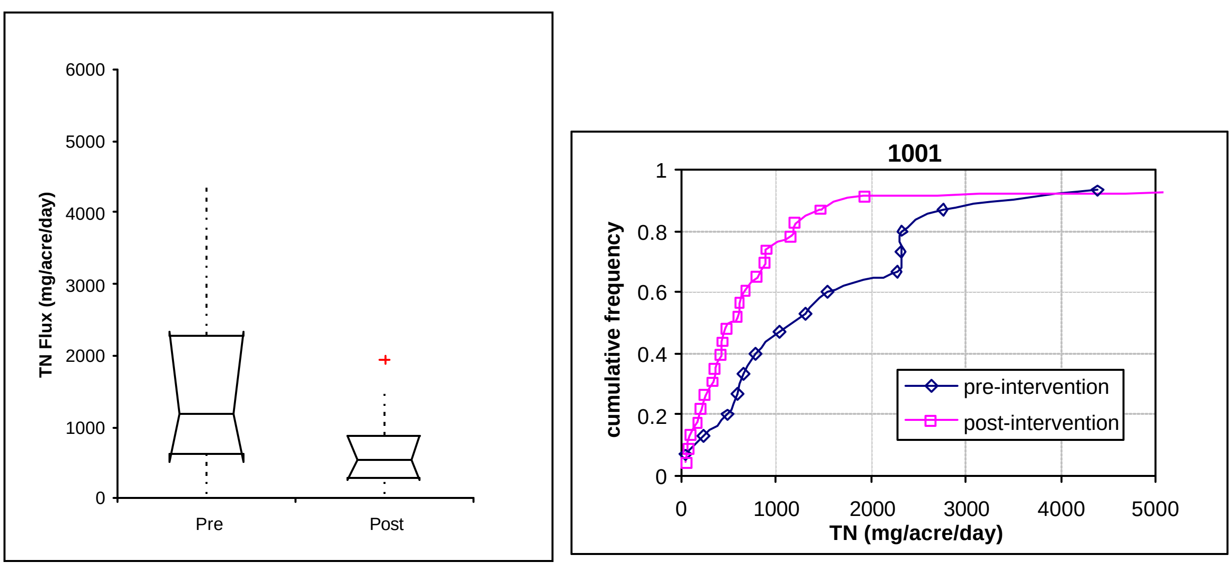


Figure 8. Side-by-side box plot and probability plots of pre- versus post-intervention for total nitrogen flues at Site 1001.

Table 8 shows the results of the Mann-Whitney test (rank-sum) for the total nitrogen flux at Site 1001. Notice the difference in the medians from pre- to post-intervention are statistically significantly different at the 95% confidence level ($p<0.05$). The magnitude of the difference (the Hodges-Lehmann estimator) is approximately 530 mg/acre/day, indicating a relatively large reduction in total nitrogen loads from the neighborhood. However, as discussed below, the extent to which the ET controllers contributed to this reduction is unclear.

The nitrogen fluxes used in this analysis were computed as the product of the measured concentration and the average daily flow. Therefore, the reduction in TN flux could be due to a reduction in flow, a reduction in concentration, or a combination of both. Analyses presented earlier showed a statistically significant reduction in median TN concentration at site 1001 between the pre- and post-intervention periods. Similarly, analyses discussed in the R3 report indicate that there was a statistically significant reduction in flow at site 1001 between the pre- to post-intervention periods; however, it was cautioned that the pre- and post-intervention periods are not comparable due to seasonal differences in the data collection period. Thus, observed reductions in flow in 1001 could be influenced by seasonal factors, and therefore the extent to which the ET controllers contributed to a reduction in flow is unknown. Consequently, reductions in TN flux could be attributed to a combination of TN reduction, flow reduction, and/or seasonal factors.

Table 8. Example Mann-Whitney test for difference in medians for total nitrogen flux at Site 1001 from pre- versus post-intervention.

Test	**Mann-Whitney test**			
Alternative hypothesis	1001_flux (mg/acre/day): Pre ≥ Post			
Performed by	GeoSyntec Consultants			
n	36			
1001_flux (mg/acre/day)	**n**	**Rank sum**	**Mean rank**	**U**
Pre	14	320.0	22.86	93.0
Post	22	346.0	15.73	215.0
Difference between medians	529.389			
95.1% CI	115.985	to +∞	(normal approximation)	
Mann-Whitney U statistic	93			
1-tailed p	0.0239	(normal approximation)		

Based upon the above results, we believe that it would be valuable to complete a more robust statistical evaluation of the data, as we believe that some significant management implications could be determined.

4. Possible Implications for TMDL Compliance.

The R3 Study results were examined in the context of existing TMDLs in the San Diego Watershed. Most of the existing TMDLs are reviewed below and possible inferences and implications of the R3 Study data for TMDL compliance are discussed. The sediment and organophosphorus pesticide TMDLs were not reviewed because sediment data were not collected (the vast majority of sediments are transported by storm flows) and because Schiff and Tiefenthaler (2003) have previously conducted an extensive analysis of the organophosphorus pesticide data.

4.1. Nitrogen

Nitrogen Water Quality Objectives and TMDLs **–** The Basin Plan water quality objectives for nitrogen in San Diego Creek are 13 mg/L Total Inorganic Nitrogen (TIN) in Reach 1, and 5 mg/L TIN in Reach 2 (RWQCB, 1995). Reach 1 extends from Newport Bay to Jefferey Road, and Reach 2 extends from Jefferey Road to the headwaters. There is no numeric standard for nitrogen in Upper Newport Bay in the Basin Plan.

The nitrogen TMDL for Upper Newport Bay is based on the general goal of reducing nutrient loads to Newport Bay by 50 percent, to levels observed in the early 1970's (USEPA, 1998b). The nitrogen TMDL sets phase-in limits on total nitrogen (TN) loads to Newport Bay (see Table 9). Separate loads are established for the dry and wet seasons (dry season is from April 1 to September 30). In addition, the winter load is exclusive of storm flows with an average daily flow greater than 50 cfs in San Diego Creek at Campus Drive.

There is no TMDL for nitrogen loads in San Diego Creek, Reach 1 because it was reasoned that attainment of the 50 percent reduction in nitrogen loads to Newport Bay would result in compliance with the Basin Plan in-stream water quality standard for Reach 1 (13 mg/l TIN). However, for Reach 2 it was determined that the average in-stream nitrogen concentrations would likely remain close to or above the Basin Plan in-stream water quality standard (5 mg/L TIN), even with attainment of the Newport Bay TMDLs. Therefore a TMDL of 14 lbs/day TN was established for Reach 2 (see Table 9) and is applicable for all flows exclusive of storm flows greater than an average daily flow of 25 cfs in San Diego Creek at Culver Drive.

Table 9: Summary of Nutrient TMDLs for Upper Newport Bay and San Diego Creek

TMDL	Dec 31, 2002	Dec 31, 2007	Dec 31, 2012
Newport Bay Watershed, TN – Summer load (4/1 to 9/30)	200,097 lbs	153,861 lbs	
Newport Bay Watershed, TN – Winter load (10/1 to 3/31; non-storm)			144,364 lbs
Newport Bay Watershed, Total Phosphorus – Annual Load	86,912 lbs	62,080 lbs	
San Diego Creek, Reach 2, daily load			14 lbs/day
Urban Runoff Allocation for the Newport Bay Watershed Summer load Winter load	 22,963	 11,481	 38,283

Study Data Comparison with Nitrogen Water Quality Objective – The Basin Plan water quality objectives are expressed in terms of total inorganic nitrogen (TIN), which is comprised of nitrate/nitrite nitrogen and ammonia. By far the majority of the TIN in San Diego Creek is comprised of nitrate/nitrite nitrogen, as measured ammonia concentrations were typically quite low with a majority below the detection limit. For this reason, only the nitrate/nitrate concentration data are compared to the Basin Plan objectives in this report.

Table 10 shows the mean and median nitrate/nitrite concentrations measured in the five study watersheds. The mean and median nitrate/nitrite concentration in all watersheds except 1004 are below the Reach 2 Basin Plan objective of 5 mg/l TIN. As discussed previously, Site 1004 may not be a representative control site because the underlying distribution of pre-intervention nitrogen data appears to be different from the other sites. Similar arguments may also be true Site 1003. With exception of Site 1004, mean nitrate/nitrite concentrations suggests that, on average, residential runoff from these watersheds do not contribute to the exceedance of Basin Plan standards for TIN in receiving waters in San Diego Creek, Reach 1 and 2. The Reach 2 water quality objective was occasionally exceeded in the all watersheds, except for the post intervention conditions in 1001 and 1002.

The mean and median nitrate/nitrate concentrations in watershed 1004, and 1005 exhibit exceedances of the 5 mg/l standard during pre- and/or post intervention conditions. Watershed 1004, in particular, had high levels of measured nitrate/nitrite concentrations, especially during the pre-intervention period. A number of these high readings exceed the Reach 1 water quality objective of 13 mg/l TIC. The results from watershed 1004 are not consistent with those from the other four study watersheds, and the source of the high readings is unknown. Localized conditions involving excessive fertilizer usage by a few users could possibly be a factor in these elevated readings. In particular, the R3 mentions an unknown connection to a neighboring watershed, which could explain the source of elevated nutrient levels.

Table 10: Mean and Median Nitrate/Nitrite Concentration (mg/l) by Watershed (all data)

	1001		1002		1003		1004		1005	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
n	23	25	23	25	24	25	23	25	24	25
Mean	2.56	1.47	2.57	1.07	2.13	1.71	36.50	6.61	2.61	4.13
Median	2.32	1.38	1.56	0.93	1.68	0.94	16.88	2.29	2.45	1.48
n>5 mg/l	1	0	4	0	1	2	18	8	2	1
n>13 mg/l	0	0	0	0	0	0	12	4	0	1

The Mann-Whitney (rank-sum) test was performed to compare the statistical difference between median concentrations during pre- and post-intervention periods (see example in Section 3 above). The median nitrate/nitrite in the post-intervention period was lower in all watersheds, and the difference was statistically significant at the 0.05 confidence level. As the control stations exhibited this trend, these data (i.e. entire data sets with unequal seasonal coverage) cannot be used to ascertain if the structural and educational BMPs were effective in reducing the runoff concentrations of nitrate/nitrite.

Clearly there is another factor contributing to reduced concentrations in the post intervention period. One possibility that was investigated is differences in seasons, year-to-year variability, and sampling times of the pre- and post-intervention data. Table 11 shows mean and median concentrations for comparable seasons and sampling times. Note there are still noticeable reductions in all of the median concentrations, except Site 1005. Applying the Mann-Whitney (rank-sum) test to these data it was found that statistically significant differences between median nitrate/nitrite concentrations in the pre- and post-intervention periods occurred only in watersheds 1001 and 1004, as compared to all watershed when all data are considered. These results indicate that seasonal effects are present in these data and should be considered in the study evaluation. It may be inferred from these result that there were significant reductions in the nitrate/nitrite concentration in the intervention watershed during the wet season that may, in part, be attributable to the structural BMPs. It is unknown whether similar reductions would occur in dry weather runoff during the dry season because such data were not collected during the pre-intervention period.

Table 11: Mean and Median Nitrate/Nitrite Concentration (mg/l) by Watershed for Comparable Seasons and Sampling Times[1]

	1001		1002		1003		1004		1005	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
n	18	14	18	14	19	14	18	14	19	14
Mean	2.38	1.43	1.95	0.95	2.17	1.66	26.24	6.57	2.24	6.27
Median	2.22	1.48	1.16	0.96	1.50	1.02	8.94	2.06	2.03	1.96
n>5 mg/l	0	0	2	0	1	1	13	4	1	1
n>13 mg/l	0	0	0	0	0	0	7	3	0	1

1 – evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.

Study Data Comparison with Nitrogen TMDLs - The nitrogen TMDL is expressed in terms of total nitrogen (TN) loads. TN concentrations were calculated from the monitoring data as the sum of the nitrate/nitrite nitrogen and TKN nitrogen. Table 12 shows the mean and median TN concentrations measured in the five study watersheds. The mean and median TN concentration in dry weather runoff are generally in the range of 2 to 5 mg/l, with the exception of watershed 1004 where substantially higher concentrations were measured. The rank sum tests indicated that median TN concentrations are significantly lower (in a statistically sense) in the post-intervention period in watershed 1001 (structural BMPs, see Table 5), and in watershed 1002 (control, see Table 6), and based on the probability plots in Appendix C, Site 1004 is expected to as well. However, sites 1003 and 1005 did not show statistically significant reductions. These results did not change when only subsets of the data were used to consider possible affects stemming from the sampling time and sampling months.

Table 12: Mean and Median TN Concentration (mg/l) by Watershed

	1001		1002		1003		1004		1005	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
All Data										
n	23	25	23	25	23	25	23	25	23	25
Mean	4.24	3.09	5.31	3.44	3.66	4.42	48.00	10.18	6.89	7.74
Median	3.84	2.27	3.95	2.55	2.66	2.50	19.01	5.57	5.06	4.36
Subsets [1]										
n	18	14	18	14	18	14	18	14	18	14
Mean	4.18	2.78	4.51	2.63	3.71	3.71	33.99	8.91	6.98	9.91
Median	3.62	2.02	3.22	2.21	2.51	2.47	12.14	3.74	4.17	3.96

1 – Data subsets with comparable sampling time and seasons. Evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.

TN flux estimates were calculated for watersheds 1001 and 1005 (Table 13). The draft R3 report indicates that the flow measurements in watershed 1002-1004 are not reliable and therefore flux estimates were not calculated for these watersheds. Flux estimates were calculated as the product of the constituent concentration and the average daily flow occurring on the day of the sample collection. The flux estimates were found to be quite variable as they depend on both flow and concentration measurements. Table 13 shows that median TN flux estimates decrease from the pre- to post-intervention periods for both watersheds. Mann-Whitney (rank sum) tests show the reductions to be statistically significant (Table 8). Because comparable data are not available for the control sites, it is not possible to infer whether these reductions are influenced by the ET controllers in the intervention watershed (1001). Also, as previously discussed, the reduction in TN flux may be attributable to a reduction in flow, a reduction in concentration, seasonal factors, or a combination of these.

Table 13: Mean and Median TN Flux (mg-N/acre/day) by Watershed

	1001		1005	
	Pre	**Post**	**Pre**	**Post**
All data				
n	14	22	10	21
Mean	1476	1667	2104	6537
Median	1164	530	1568	1177
Subset[1]				
n	12	14	10*	8
Mean	1384	587	2104	1716
Median	902	497	1568	960

1 – Data subsets with comparable sampling time and seasons. Evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.
* – Same as the all data case

Although the flux estimates in Table 13 are limited in number, duration, and location, they can be used to speculate about the magnitude of the urban area contribution of TN loads to Newport Bay and the potential reduction in loads from structural and nonstructural BMPs. Based on the limited flux data, the annual TN load to Newport Bay in dry weather runoff from urban areas in the San Diego Creek Watershed is estimated to range between 37,000 to 50,000 lbs per year under existing land-use conditions (see Table 14). This is for the most part below the 2012 urban runoff allocation of 49,764 lbs. The annual TN load is estimated to increase to 50,000-67,000 lbs per year under built-out conditions.

According to the 2001 report on the nutrient TMDL (OCPFED, 2001), the average daily TN load in San Diego Creek at Campus Drive was 540 lbs/day between July 2000 and June 2001. This converts to an annual load of about 197000 lbs, which is below the 2007 TMDL (note: San Diego Creek is the majority but not sole contributor of TN loads to Newport Bay). Estimates in Table 14 suggest that dry weather runoff from urban areas account for about 20 to 25% of the annual TN in the San Diego Creek Watershed. If it is assumed that flux reductions observed in the post intervention period are attributable to the structural and nonstructural BMPs, and if similar interventions could hypothetically be implemented on a watershed-wide basis, then the potential reduction in annual dry weather TN loads is estimated to range between 12,500-20,000. This would represent a reduction of about 6-10% of the current TN loads and about 30-40% of the estimated current dry weather urban loads. Note these estimates are based on few data collected in a limited area, and should therefore be considered preliminary in nature.

Table 14: Estimated Annual TN Loads in Dry Weather Runoff from Urban Areas in the San Diego Creek Watershed

	TN flux (mg-N/acre/d)	Annual TN Load to Newport Bay (lbs) Existing land-use[1]	Annual TN Load to Newport Bay (lbs) Built-out land-use[2]
Pre-intervention conditions	1160 – 1560	37,300 – 50,500	50,000 – 67,000
Post-intervention conditions	530 – 1180	17,000 – 38,000	23,000 – 51,000
Potential reduction		~12,500 – 20,000	~16,000 – 27,000

1 –Used 40000 acres or about 53% of the San Diego Creek Watershed area (IRWD, 2003). For comparison, urban land use in 1999 use was estimated at 35,500 acres of the watershed area at Campus Drive (Tetra-Tech, 2000).

2 – Used 53500 acres or about 71% of the San Diego Creek Watershed area (IRWD, 2003).

The following conclusion can be made based on the analyses above:

- Average and median nitrate/nitrite concentrations in dry weather runoff are below the Reach 2 water quality objective (5 mg/l), for most but not all study watersheds.
- Occasional exceedance of the Reach 2 water quality objective occurred in all study watersheds
- The majority of measured nitrate/nitrite concentrations in watershed 1004 during the pre-intervention period were greater than the Reach 2 water quality objective of 5 mg/l. These data are not consistent with those from the other watersheds. The cause is unknown, but could possibly be related to the unknown connection to neighboring nursery discussed in the R3 report.
- Sampling periods (months) and sampling time (morning versus evening) was found to affect the statistical significance of differences between pre- and post- intervention median nitrate/nitrate concentration in some of the watersheds. The sampling period and sampling time did not affect the statistical significance of differences between pre- and post-intervention median TN concentrations.
- Median TN fluxes in watershed 1001 and 1005 were statistically smaller in the post-intervention period. The extent to which the structural and nonstructural BMPs contributed to these reductions cannot be determined due to the lack of reliable flow data in the control sites.
- Preliminary estimates of annual TN loads to Newport Bay in dry weather runoff from urban sources range between 37,000 to 50,000 lbs per year, or about 20 to 25% of the current TN loads.
- The potential reductions in annual dry weather TN loads due implementation of BMPs on a watershed basis is estimated to range between 12,500-20,000 pounds per year. This would represent a reduction of about 6-10% of the current TN loads and 30-40% of the urban loads.

4.2. Phosphorus

The majority of the annual TP load in the San Diego Creek Watershed occurs in the wet season, and has been correlated with sediment loads generated by storm events (USEPA, 1998b). This correlation suggests that a majority of phosphorus occurs in particulate form attached to sediments. The main sources of the total phosphorus (TP) are in Peters Canyon Wash and San Diego Creek above Culver Drive (USEPA, 1998b).

Phosphorus TMDL – There is no numeric objective for phosphorus for San Diego Creek in the Basin Plan. Because measured TP and sediment loads are correlated, it was determined in the TMDL that a 50 percent reduction in TP loads would be achieved through compliance with the sediment TMDL (USEPA, 1998a). Accordingly, the TMDL for TP was based on a 50 percent reduction of average annual load estimated at 124,160 lbs (USEPA, 1998b). The TMDLs are applicable for all flow conditions. The target compliance date was set for December 31, 2007.

The annual TP load allocation for urban areas is 4102 lbs by 2002, reducing to 2960 lbs by 2007. According to the USEPA (1998b) the TP is allocated in the same proportion as sediments. The annual urban area (stabilized vs. construction) sediment allocation for the Newport Bay Watershed is 50 tons distributed over 95.3 square miles (see Table 5 in USEPA, 1998a). This is a very small allocation over a large area. By contrast, note that the annual construction allocation is 6500 tons distributed over the assumed 3.0 square miles under construction in any one year. Using the same proportions of sediment load allocations, the TP load rate based on the 2007 urban allocation is 2960 lbs/95.3 square miles = 0.0485 lbs/acre/yr. If the construction and urban allocations are combined, the TP load rate based on the combined 2007 urban and construction allocations is (2960+12810) lbs/(95.3+3.0) square miles = 0.251 lbs/acre/yr.

Study Data Comparison with TMDLs **–** Similar to the nitrogen TMDL, the phosphorus TMDL is expressed in terms of total annual (TP) loads. Table 15 shows the mean and median TP concentrations measured in the five study watersheds. The mean and median TP concentrations in dry weather runoff are below 1.2 mg/l in all watersheds, with the exception of watershed 1004 where substantially higher concentrations were measured. Comparison of the pre- and post-intervention median TP concentrations in all data (Table 15) reveals an increase in the median TP concentration during the post-intervention period for all watersheds except the intervention watershed 1001 and 1004. In contrast, when subsets of the data with similar seasons and sampling times are considered (Table 15), there is a decrease in the median TP concentration in all watersheds except 1005. This indicates that there are seasonal influences in the data, which presumably are related to rainfall. Unfortunately there are no data available to permit comparison of pre- and post-intervention concentrations for dry weather flows during the dry season.

Table 15: Mean and Median TP Concentration (mg/l) by Watershed

	1001		1002		1003		1004		1005	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
All Data										
n	23	25	23	25	24	25	23	24	24	25
Mean	0.73	0.60	0.92	0.84	0.98	1.21	3.33	1.50	1.01	1.19
Median	0.60	0.51	0.77	0.82	0.62	0.67	2.54	1.05	0.73	0.85
Subsets[1]										
n	18	14	18	14	19	14	18	13	19	14
Mean	0.78	0.47	0.91	0.67	1.13	0.57	2.62	1.33	0.93	1.24
Median	0.61	0.41	0.73	0.56	0.75	0.58	1.82	1.07	0.75	0.83

1 – Data subsets with comparable sampling time and seasons. Evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.

TP flux estimates were calculated for watersheds 1001 and 1005 using the approach discussed in the nitrogen section above. Table 16 shows that median TP flux estimates decrease from the pre- to post-intervention periods in the intervention watershed (1001) but not in the education only watershed. Mean fluxes increase in both watersheds, but as discussed earlier, the mean values are strongly influenced by outliers and do not provide a good measure of central tendency for these data. Application of the Mann-Whitney (rank sum) test shows the reduction in median TP flux in 1001 is statistically significant. This suggests that the structural BMPs had a positive influence in reducing the TP fluxes, but because comparable data are not available for the control sites, it is not possible to ascertain the extent to which the ET controllers contributed to these reductions. Also, as discussed previously, reductions in flux could be influenced by several factors: reduction in concentration, reduction in flow, and/or seasonal variability.

Table 16: Mean and Median TP Flux (mg-P/acre/day) by Watershed (all data)

	1001		1005	
	Pre	Post	Pre	Post
All data				
n	14	22	10	21
Mean	265	370	473	1327
Median	164	109	219	219

Similar to the previous analyses of TN loads, the TP flux estimates in Table 16 can be used to speculate about the magnitude of the urban area contribution of TP loads to Newport Bay and the potential reduction in loads from structural BMPs. Based on the limited flux data, the annual TP load to Newport Bay in dry weather runoff from urban areas in the Newport Bay Watershed is estimated to range between about 5,000 to 11,000 lbs per year (see Table 17) based on a total urban area of 95.3 square miles obtained from Table 5 of the sediment TMDL (USEPA, 1998a). These estimated annual TP loads are greater than the urban allocation (for both dry and wet weather) and are less than the combined urban and construction allocations (Table 17). Note, however, that these estimates are based on dry weather data only, and it is expected that a major portion of the TP loads will occur in runoff from winter storms. Therefore, actual annual TP loads would be expected to be greater. If it hypothesized that flux reductions observed in the intervention watershed 1001 could be realized over the entire watershed, then the potential reduction in annual dry weather TP loads from urban areas is estimated at 2700 lbs. As stated previously, these estimates are based on few data collected in a limited area, and should therefore be considered preliminary in nature.

Table 17: Estimated Annual TP Loads in Dry Weather Runoff from Urban Areas in the San Diego Creek Watershed

	TP flux (mg-P/acre/d)	Annual TP Load Rate to Newport Bay (lbs/acre/year)[1]	Annual TP Load to Newport Bay (lbs/year)
2007 Urban Area Allocatoion for Newport Bay		0.0485	2960
2007 Combined Urban and Construction Area Allocatoion for Newport Bay		0.251	15770
Pre-intervention conditions (median fluxes)	164 – 219	0.132 – 0.176	8049 – 10748
Post-intervention conditions (median fluxes)	109 – 219	0.088 – 0.176	5350 – 10748
Potential reduction			2700

1 - urban area is 95.3 square miles and the construction area is 3.0 square miles based on Table 5 in USEPA, 1998a

4.3. Metals

Metals TMDLs **–** The USEPA (June 2002) determined that TMDLs are required for dissolved copper, lead, and zinc in San Diego Creek, Upper Newport Bay, and Lower Newport Bay, and that TMDLs are required for cadmium in San Diego Creek and the Upper Newport Bay. The TMDLs for San Diego Creek are expressed as concentration limits, based on the CTR criteria at various hardness values that are associated with different flow regimes (Table 18). The flow regimes are based on 19 years of flow measurements in San Diego Creek at Campus Drive. The concentration-based TMDLs apply to all freshwater discharges to San Diego Creek, including discharges from agricultural, urban, and residential lands, and storm flow discharges. The applicable flow regime at any location in the entire watershed is determined on the basis of discharge at Campus Drive.

Table 18: Summary of Dissolved Metal TMDLs for San Diego Creek

Dissolved Metal (μg/l)	Base flow (0–20 cfs) hardness @ 400 mg/L		Small flows (21-181 cfs) hardness @ 322 mg/L		Medium flows (182-814 cfs) hardness @ 236 mg/L		Large flows (>814 cfs) hardness @ 197 mg/L
	Acute	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**
Cadmium	19.1	6.2	15.1	5.3	10.8	4.2	8.9
Copper	50	29.3	40	24.3	30.2	18.7	25.5
Lead	281	10.9	224	8.8	162	6.3	134
Zinc	379	382	316	318	243	244	208

Metals Sources – The USEPA (June 2002) conducted a source analysis as part of the TMDL preparation. Surface runoff is the largest contributor of metals loads in the San Diego Creek Watershed, which includes natural and man made source (USEPA , June 2002). Much of the metals loads are from natural sources. The estimated anthropogenic contributions are metal specific and range from about 33% for zinc to 63% for cadmium (USEPA, June 2002). A primary anthropogenic source of heavy metals is runoff from urban roads, which contributes to sources of cadmium (tire wear), copper (brakes, tires), lead (brakes, tires, fuels and oils), and zinc (tires, brakes, galvanized metals). Use of copper sulfate by nurseries may also be a minor source of copper loads. Other copper and zinc uses in building materials (roofing and roof drains) may be another source.

The USEPA found that metal inputs were heavily influenced by rainfall and stream flow rates. Monitoring results were reported to be highly variable due to different rainfall amounts and flows during each water year. The EPA estimated that base flows account for 25% of the total metal loadings, with the remainder from low, medium and large flows caused by storms.

The EPA's preliminary analyses suggest that: 1) a primary source of metals in dry weather runoff in the study watershed is from roads (i.e. wash off of metals in driveways, parking lots, streets, gutters, etc.); 2) the runoff concentrations will be influenced by rainfall which result in wash off of accumulated metals; and 3) the concentrations can be variable depending on the amount of rainfall.

Study Data Comparison with Base Flow TMDLs – The metals TMDLs for base flow conditions are based on meeting the CTR criteria at a total hardness of 400 mg/l. The CTR criteria express maximum allowable concentrations in receiving waters for acute (short term) and chronic (4-day) exposure periods. The acute and chronic criteria are expressed as values that cannot be exceeded more that once in three years. Although the criteria are applicable in the receiving waters and not in the urban runoff per se (i.e. the measured dry weather discharge), exceedance of the CTR in the urban discharge would suggest a potential for the discharge to contribute to an exceedance in the receiving waters.

Table 19 shows the mean and median heavy metal concentrations in the five study watersheds. (*Note to IRWD reviewer: we assumed that the analytical results are for dissolved metals based on guidance from IRWD, but this is not clearly indicated in the data base or draft report; it is likely the case as base flows are typically low in suspended sediments.*) With the exception of mean copper concentrations in some of the watersheds, all mean and median concentrations were below the chronic and acute CTR criteria. Copper, lead, and zinc concentrations occasionally exceeded the chronic CTR criteria, and copper and zinc concentrations occasionally exceeded the acute criteria. These exceedances suggest that the dry weather runoff can potentially contribute to an exceedance in the receiving waters. However, if intervention is determined to be effective in reducing runoff flows, then the BMPs would help to reduce impacts of these potential exceedances by allowing for greater dilution with the in-stream flows.

Table 19: Mean and Median Metal Concentrations (mg/l) by Watershed (all data)

	1001		1002		1003		1004		1005	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Cadmium										
n	23	25	23	25	24	25	23	25	24	25
Mean	0.26	0.14	0.47	0.44	0.27	0.17	0.64	0.22	0.21	0.29
Median	0.27	0.10	0.24	0.10	0.10	0.10	0.36	0.10	0.10	0.10
n>6.2 µg/l	0	0	0	0	0	0	0	0	0	0
n>19.1 µg/l	0	0	0	0	0	0	0	0	0	0
Copper										
n	23	25	23	25	24	25	23	25	24	25
Mean	13.5	16.9	27.3	30.3	11.5	26.6	21.8	17.7	32.1	30.8
Median	11.5	11.4	10.9	14.0	11.1	14.3	12.7	11.4	12.3	20.4
n>29.3 µg/l	2	2	3	7	0	2	5	4	3	5
n>50 µg/l	0	1	3	3	0	2	2	3	3	2
Lead										
n	23	25	23	25	24	25	23	25	24	25
Mean	0.8	1.6	5.9	4.7	0.8	1.6	3.5	1.5	1.0	3.2
Median	0.6	0.6	0.9	1.2	0.6	0.8	0.7	0.7	0.7	1.3
n>10.9 µg/l	2	1	2	3	0	0	2	0	0	1
n>281 µg/l	0	0	0	0	0	0	0	0	0	0
Zinc										
n	23	25	23	25	24	25	23	25	24	25
Mean	58.7	37.2	115.2	86.3	56.3	56.8	83.6	40.9	74.0	75.0
Median	56.0	50.2	53.4	57.2	50.7	53.9	50.8	43.8	52.4	54.5
n>382 µg/l	0	0	1	2	0	0	1	0	0	0
n>379 µg/l	0	0	1	2	0	0	1	0	0	0

We were unable to locate dry weather metals monitoring information in the Central Irvine Channel, which is the immediate receiving water of the study watersheds (*IRWD please confirm*). OCPFRD dry weather monitoring data are available in San Diego Creek at Campus Drive, which is quite a ways downstream from the study watersheds. Data collected between 12/01 and 6/02 (Table 20) show that average dry weather concentrations at Campus Drive are well below mean and median concentrations measured in dry weather runoff from the study watersheds. Similar comparisons cannot be made for lead and cadmium because the method detection limits in the OCPFRD data are greater than those in the R3 data. None of the OCPFRD dry weather data exceed the chronic or acute criteria.

These comparisons suggest that metal loads in dry weather runoff from the study (urban) watersheds could be a contributing factor to dry weather copper and zinc loads measured at Campus Drive. These dry weather discharges do not result in non-compliance of the base flow metal TMDL at Campus (based on the reviewed data only). It is unknown if the elevated concentrations measured in the dry weather urban runoff result in exceedance of the CTR criteria in the immediate receiving waters. Note that if flow reductions observed in the intervention watershed are attributable to the ET controllers, then these controllers would help to reduce impacts from any potential exceedances of the TMDL because the discharges would be subject to greater dilution by the in-stream flows.

Table 20: Summary of OCPFRD Dry Weather Monitoring Data in San Diego Creek at Campus Drive (12/01 to 6/02)

	Cadmium	Copper	Lead	Zinc
Sample number	24	24	24	24
Range	All < 1 μg/l	<2 – 16 μg/l	<2-2.4 μg/l	<10-16
Mean		7.4 μg/l	most <2 μg/l	most <10
Median-		6.8 μg/l		

4.4. Pathogens

Pathogens are agents or organisms that can cause diseases or illnesses, such as bacteria and viruses. Fecal coliform bacteria are typically used as an indicator organism because direct monitoring of human pathogens is generally not practical. Fecal coliform are a group of bacteria that are present in large numbers in the feces and intestinal tracts of humans and animals, and can enter water bodies from human and animal waste. The presence of fecal coliform bacteria implies the water body is potentially contaminated with human and/or animal waste, suggesting the potential presence of associated pathogenic organisms.

***Fecal Coliform TMDL* –** The RWQCB has adopted phased TMDL criteria for pathogens, with the initial focus on additional monitoring and assessment to address areas of uncertainty. The goal of the Newport Bay TMDL is compliance with water contact recreational standards by 2014:

> Fecal coliform concentration of not less than five samples per 30 days shall have a geometric mean less than 200 most probable number (MPN)/100ml, and not more than 10 percent of the samples shall exceed 400 MPN/100ml for any 30-day period.

A second goal is to achieve the shellfish harvesting standards by 2020:

> The monthly median fecal coliform concentration shall be less than 14 MPN/100 mL, and not more than 10 percent of the samples shall exceed 43 MPN/100 mL.

The TMDLs are applicable for all flow regimes.

Study Data Comparison with Fecal Coliform TMDLs **–** Table 21 shows the mean and median fecal coliform concentrations measured in the five study watersheds. 70% to 100% percent of all fecal coliform measurements were greater than 400 MPN/ml in all study watersheds. This level of exceedance is substantially greater than the allowable 10%. The mean and median fecal coliform concentrations also exceed the 400 MPN/100ml criterion in all study watersheds. There was insufficient data to calculate the 30-day geometric mean (a minimum of 5 samples per 30 days needed), however, the TMDL criterion (30-day geometric < 200 MPN/100 ml) would likely be exceeded, assuming that any additional data would be of the same magnitude as those collected. Exceedance of the TMDL criteria in all study watersheds suggests that urban dry weather runoff is likely a contributing factor to any dry weather exceedance of the TMDL in the receiving waters.

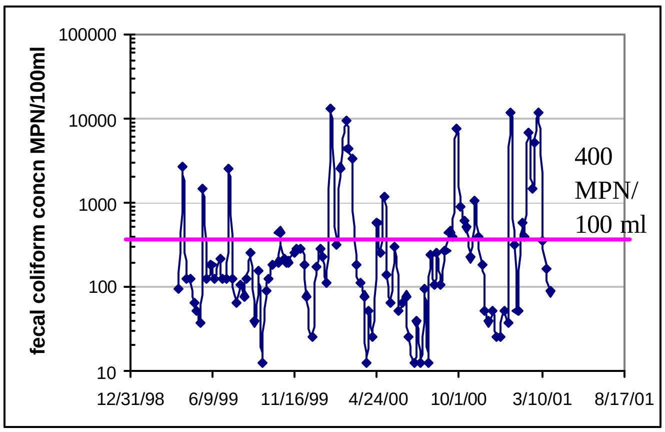
Table 21: Mean and Median Fecal Coliform Concentration (MPN/100ml) by Watershed

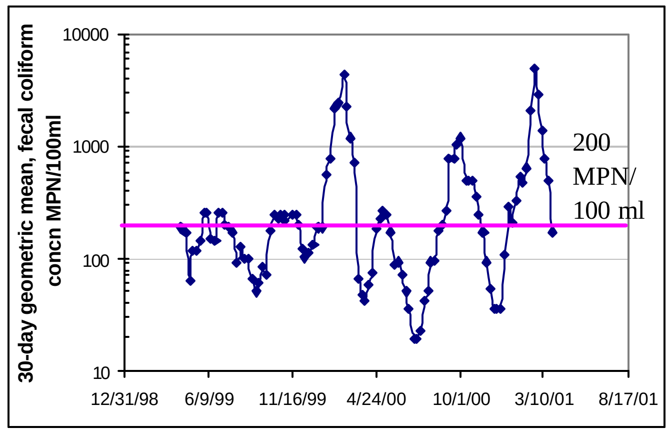
	1001		1002		1003		1004		1005	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
All Data										
n	22	24	21	24	23	24	21	24	23	24
Mean	4921	3003	5582	128193	34526	28980	28205	34185	17976	10326
Median	2300	1400	1700	3000	13000	4000	13000	13000	8000	8000
% > 400 MPN/100ml	82%	67%	86%	79%	100%	88%	95%	83%	92%	93%
Subsets [1]										
n	17	14	17	14	18	14	17	14	18	14
Mean	2545	3054	3090	5074	13783	37479	23312	20166	8524	6109
Median	2200	950	1400	1400	8000	2650	8000	6500	4000	2900
% > 400 MPN/100ml	100%	71%	82%	79%	100%	86%	94%	79%	100%	93%

1 – Data subsets with comparable sampling time and seasons. Evening samples were deleted from the pre-intervention data. The post-intervention data include only those data collected in months identical to the pre-intervention period.

We were unable to locate dry weather coliform monitoring information in the Central Irvine Channel, which is the immediate receiving water of the study watersheds (*IRWD please confirm*). Therefore it is unknown if elevated fecal coliform concentrations measured in the study watershed contribute to an exceedance of the TMDL in the immediate receiving waters. The OCPFRD has collected dry and wet weather *E. coli* monitoring information in San Diego Creek at Campus Drive (OCPFRD, September 2001), which is considerably downstream from the study watersheds. A plot of the equivalent fecal coliform concentration (assuming an 80% *E. coli* content) shows exceedance of the TMDL occurs primarily during the wet season, although dry season exceedances are also evident (see Figure 9). This suggests that dry weather urban runoff is potentially a contributing factor to exceedance of the TMDL in dry weather flows at Campus Drive. The ET controllers would reduce the impacts from these potential exceedances if they were determined to be effective reducing the dry weather runoff volumes.

Figure 9: Time Series of Fecal Coliform Levels San Diego Creek at Campus Drive (converted from measured E. coli concentrations)





Median fecal coliform concentrations presented in Table 21 may be used to evaluate the influence of the structural and non-structural BMPs. When all monitoring dataset is considered, the median fecal coliform concentrations are equivalent or increase from pre- to post-intervention conditions in all watersheds except the 1001 (intervention watershed) and 1003 (a control watershed). Based on the Mann-Whitney (rank-sum) test, the reduction in median concentrations in 1001 and 1003 is significantly significant at the 95% confidence level. Thus the watershed with the irrigation controllers corresponded to a significant reduction in median fecal coliform concentrations, in comparison to 2 of the 3 control sites, while the education only watershed exhibited no discernable reduction in median concentrations.

When subsets of the data with similar seasons and sampling times are considered (Table 21), there is a decrease in the median fecal coliform concentration in all watersheds except 1002. However, because of the smaller sample sizes, the decrease is median concentration is statistically significant only in watershed 1003. This suggests that there could be seasonal influences in the monitoring data, but the data are not sufficient to determine if there are statistically significant differences in the median concentrations.

5. References

IRWD, March 2003. Irvine Ranch Water District San Diego Creek Watershed Natural Treatment System Draft Master Plan.

OCPFRD, 2001. County of Orange Public Facilities and Resources Department, NPDE Annual Progress Report.

OCPFRD, September 2001. Newport Bay Fecal Coliform TMDL Annual Data Report.

RWQCB, 1995. Water Quality Control Plan, Santa Ana River Basin (8).

Schiff, K.C. and L.L.Tiefenthaler, June 2003. Contributions of organophosphorus pesticides from residential land uses during dry and wet weather. Technical Report 406, Southern California Coastal Water Research Project.

USEPA (Region 9), 1998a. *Total Maximum Daily Loads for Sediment and Monitoring and Implementation Recommendations; San Diego Creek and Newport Bay, California*

USEPA (Region 9), 1998b. *Total Maximum Daily Loads for Nutrients; San Diego Creek and Newport Bay, California*

USEPA, June 2002. Total Maximum Daily Loads for Toxic Pollutants – San Diego Creek and Newport Bay, California, June 14, 2002.

Tetra Tech, Inc., July 2000c. Newport Bay Watershed Urban Nutrient TMDL Compliance Evaluation.

Appendix A - Time-Series Plots

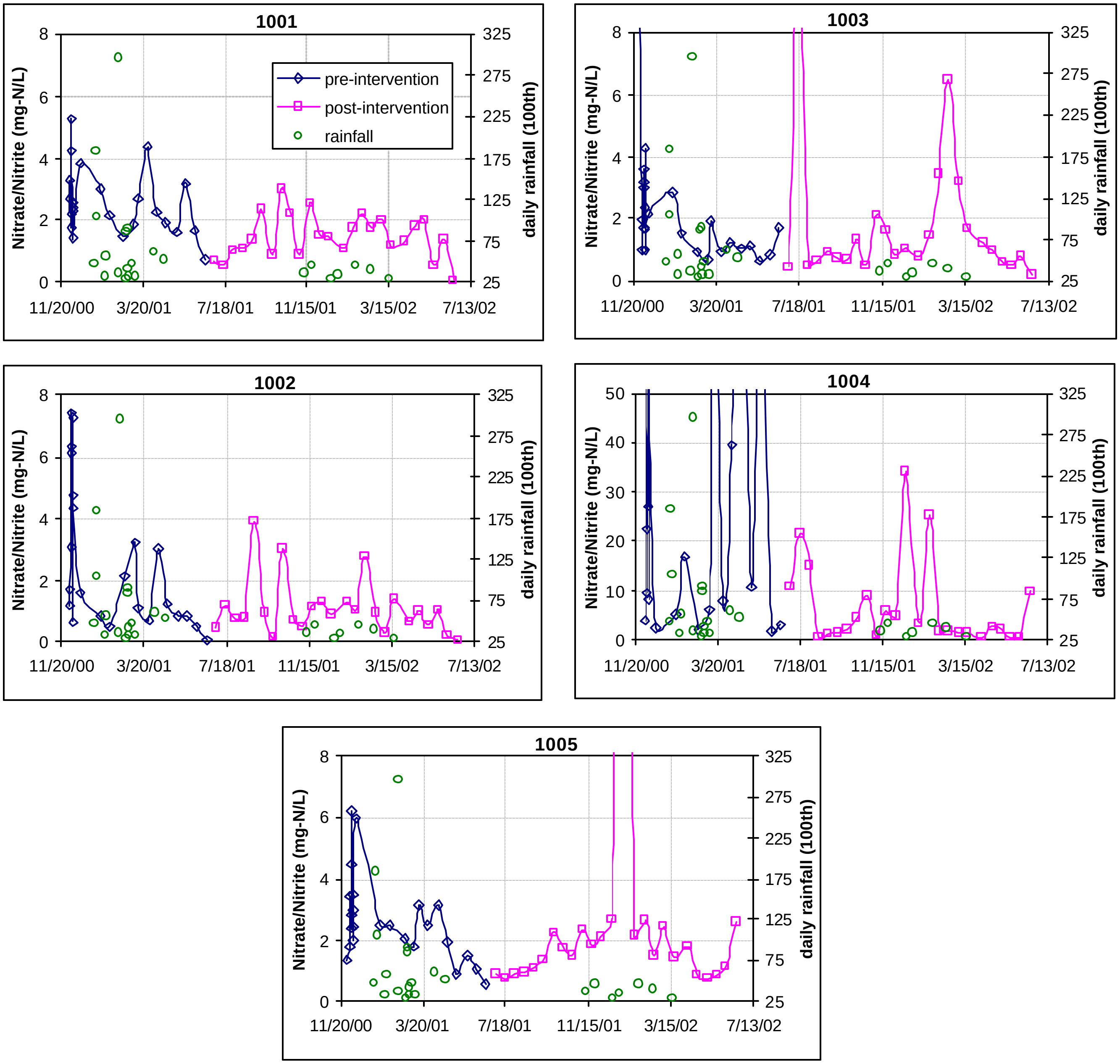


Figure A-1: Time Series of Nitrate/Nitrite in Dry Weather Samples (all data)

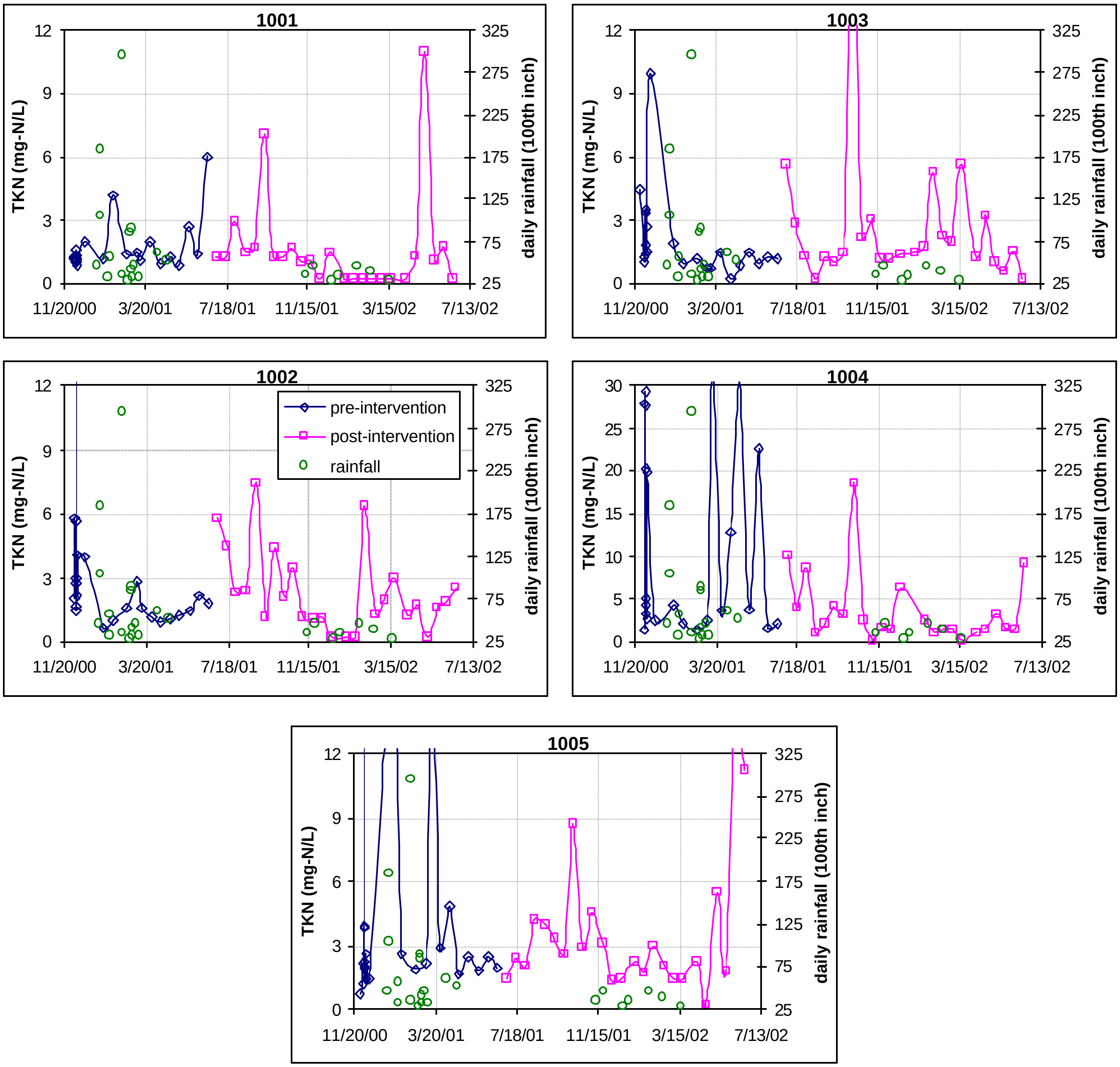


Figure A-2: Time Series of TKN in Dry Weather Samples (all data)

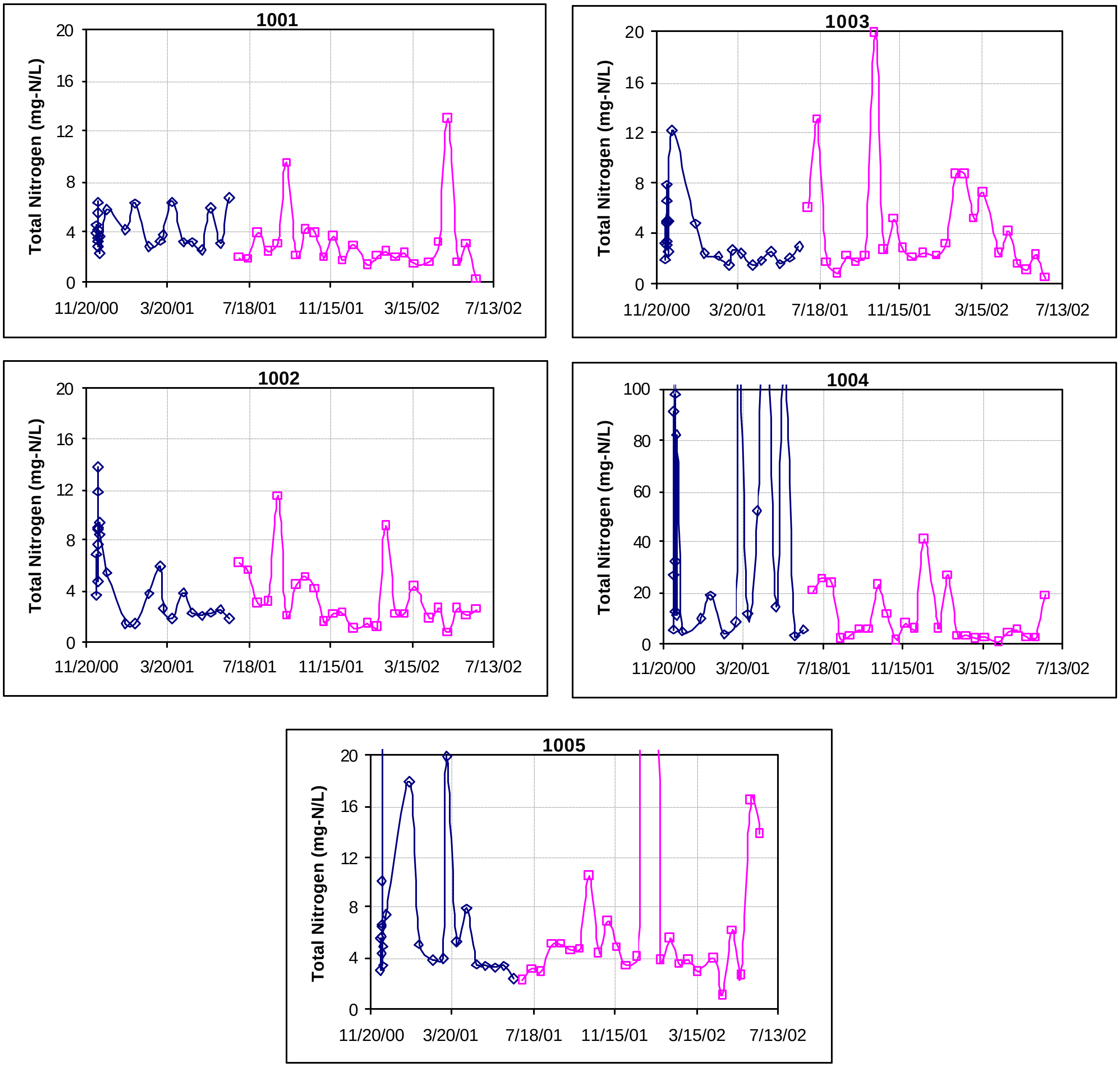


Figure A-3: Time Series of TN (Calculated) in Dry Weather Samples (all data)

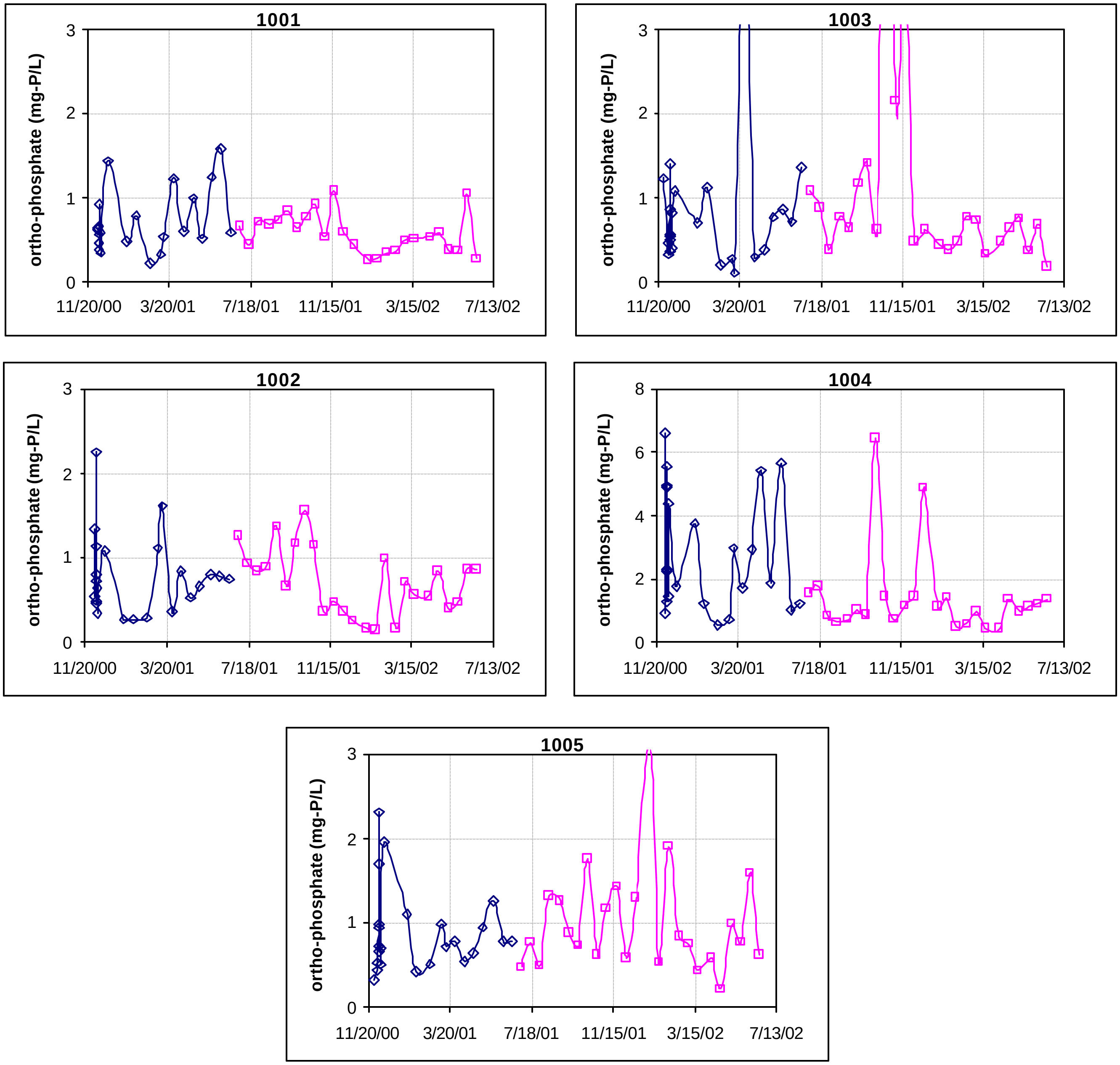


Figure A-4: Time Series of Ortho-Phosphate in Dry Weather Samples (all data)

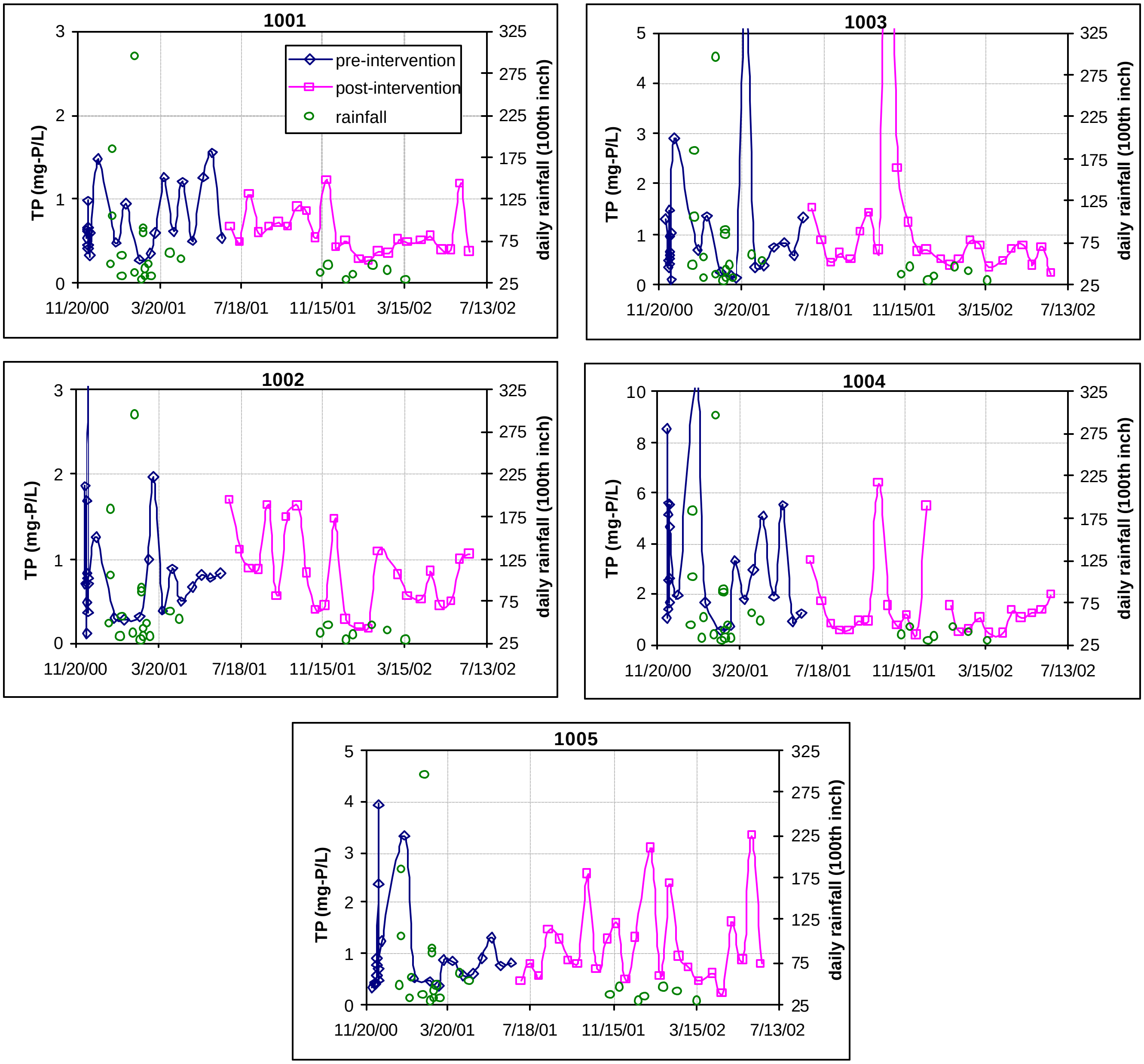


Figure A-5: Time Series of Total-Phosphorus in Dry Weather Samples (all data)

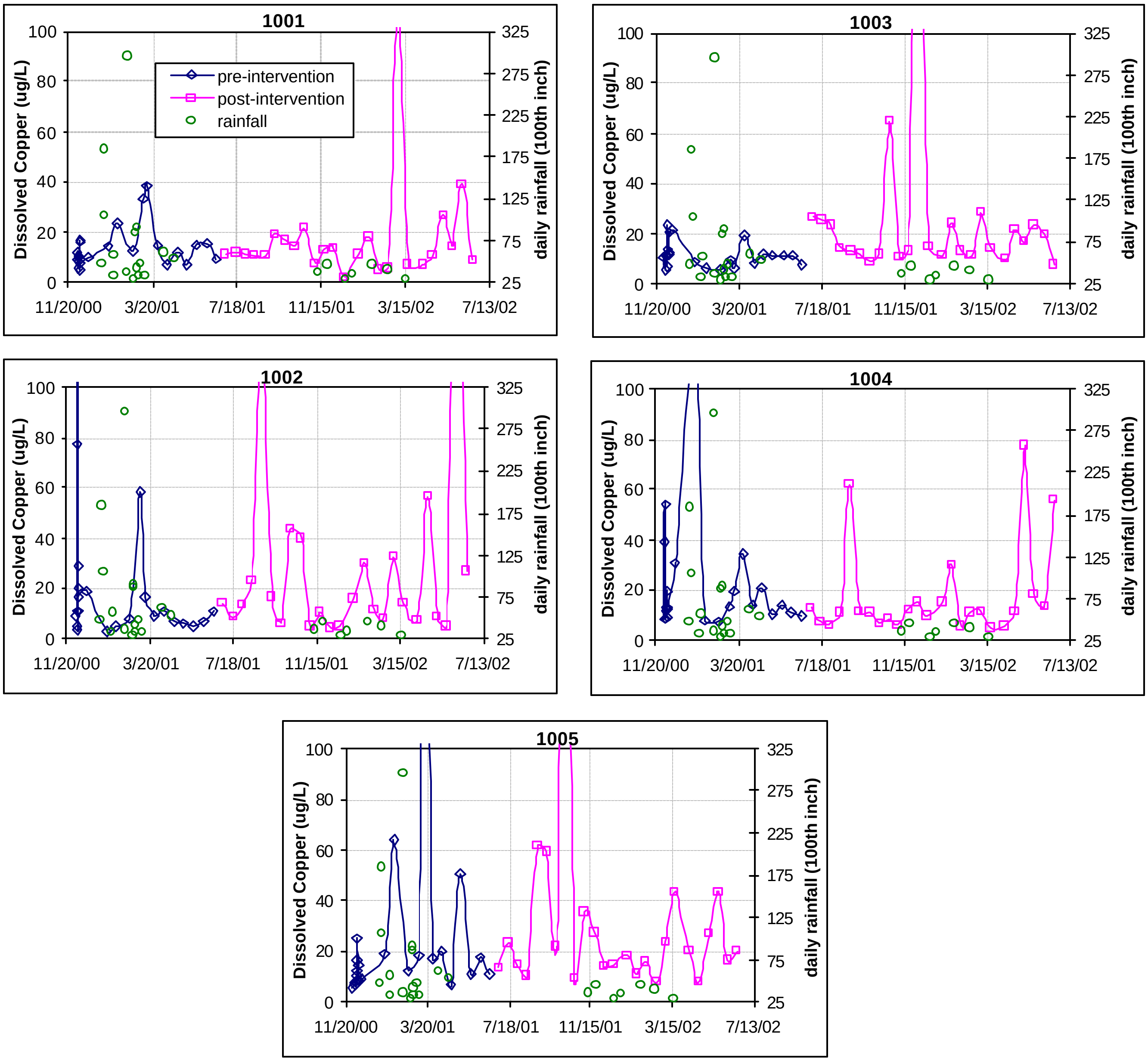


Figure A-6: Time Series of Dissolved Copper in Dry Weather Samples (all data)

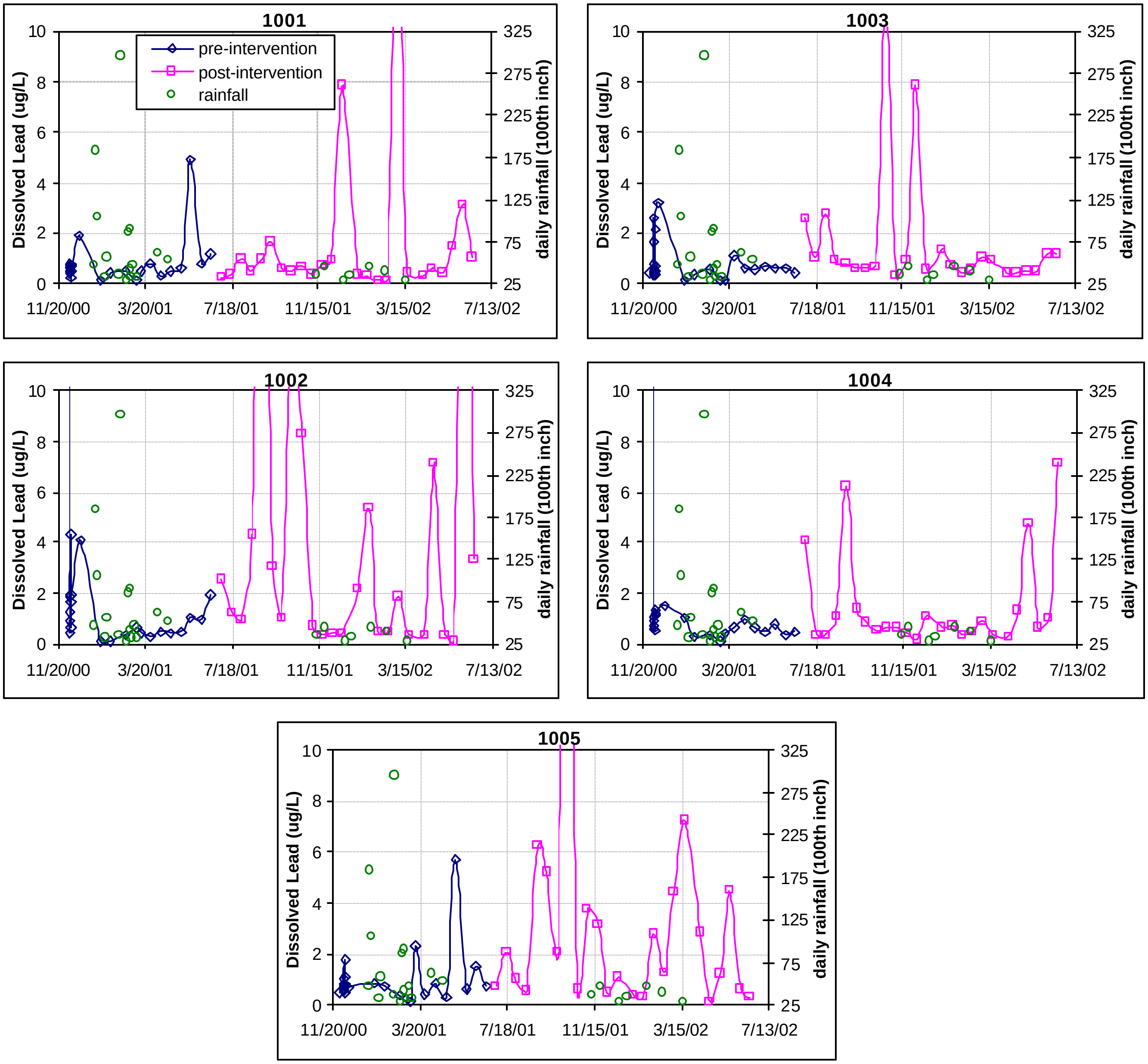


Figure A-7: Time Series of Dissolved Lead in Dry Weather Samples (all data)

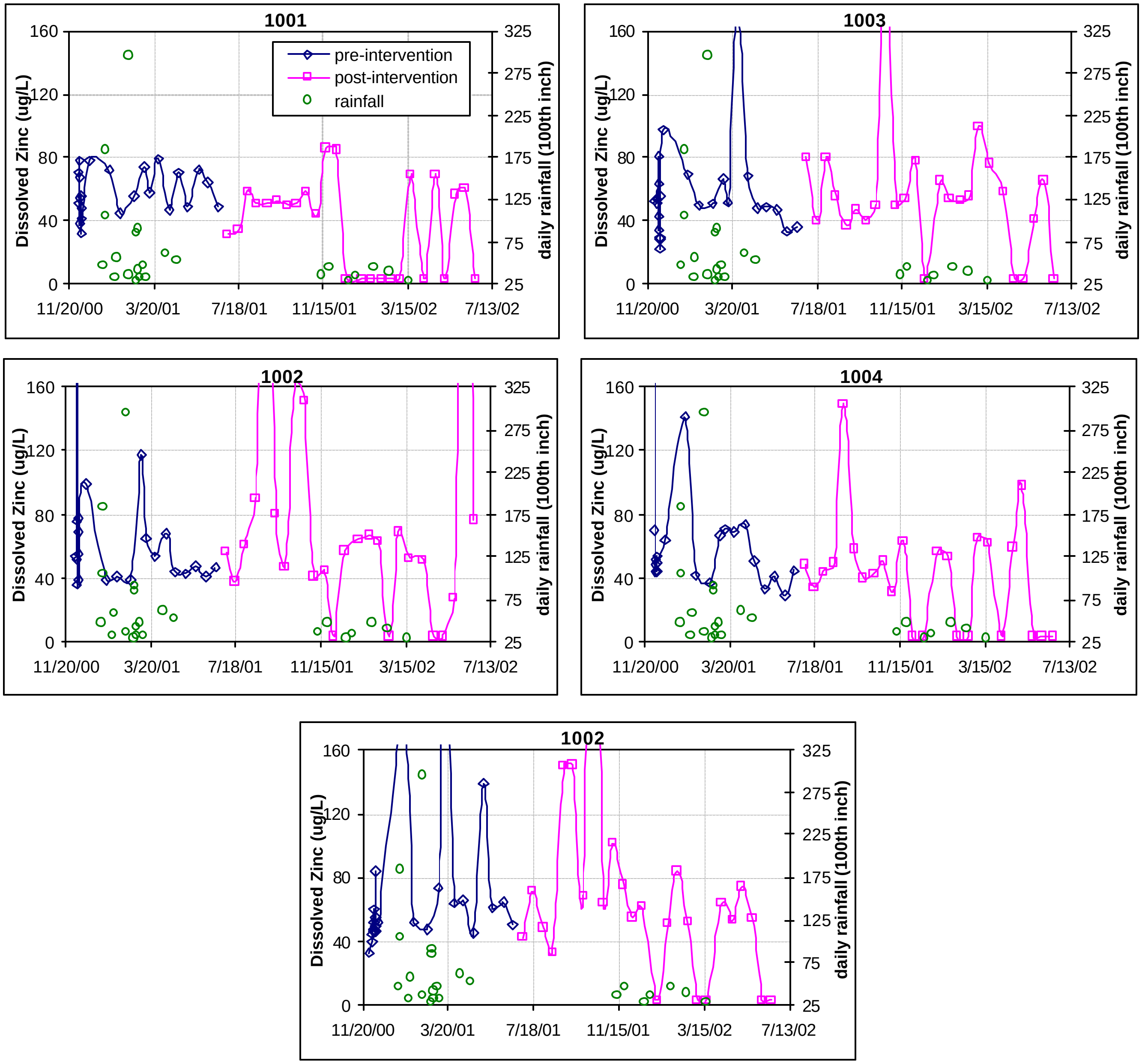


Figure A-8: Time Series of Dissolved Zinc in Dry Weather Samples (all data)

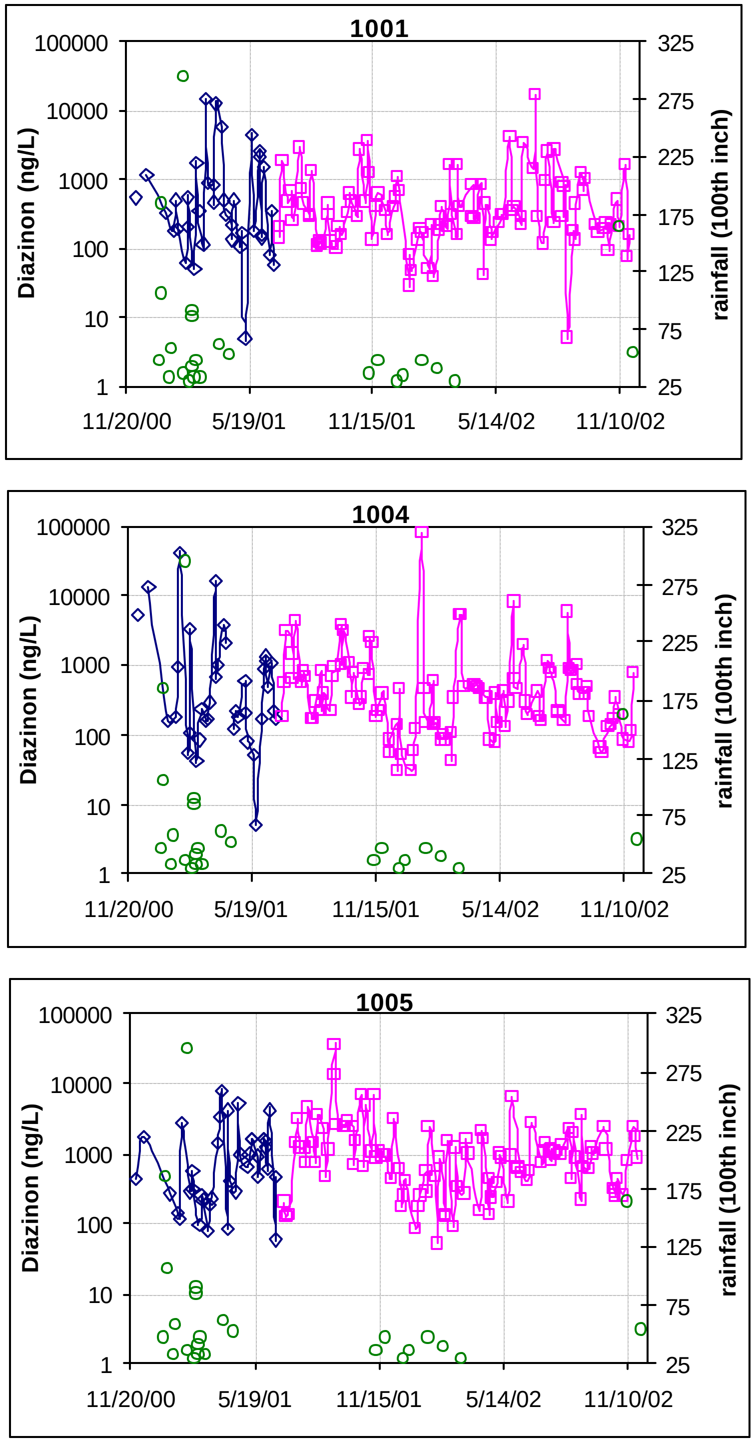


Figure A-9: Time Series of Diazinon in Dry Weather Samples (all data)

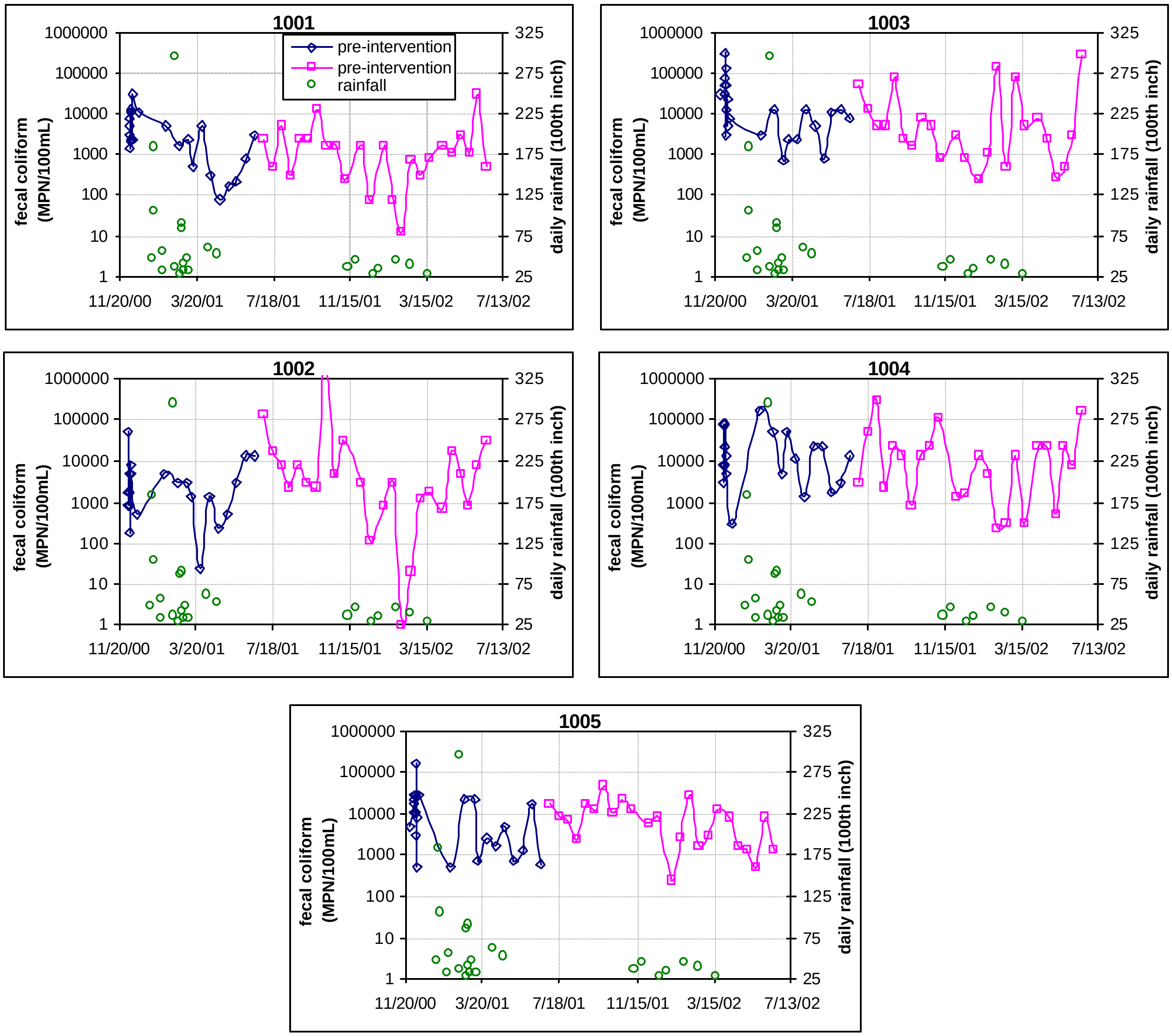


Figure A-10: Time Series of Fecal Coliform in Dry Weather Samples (all data)

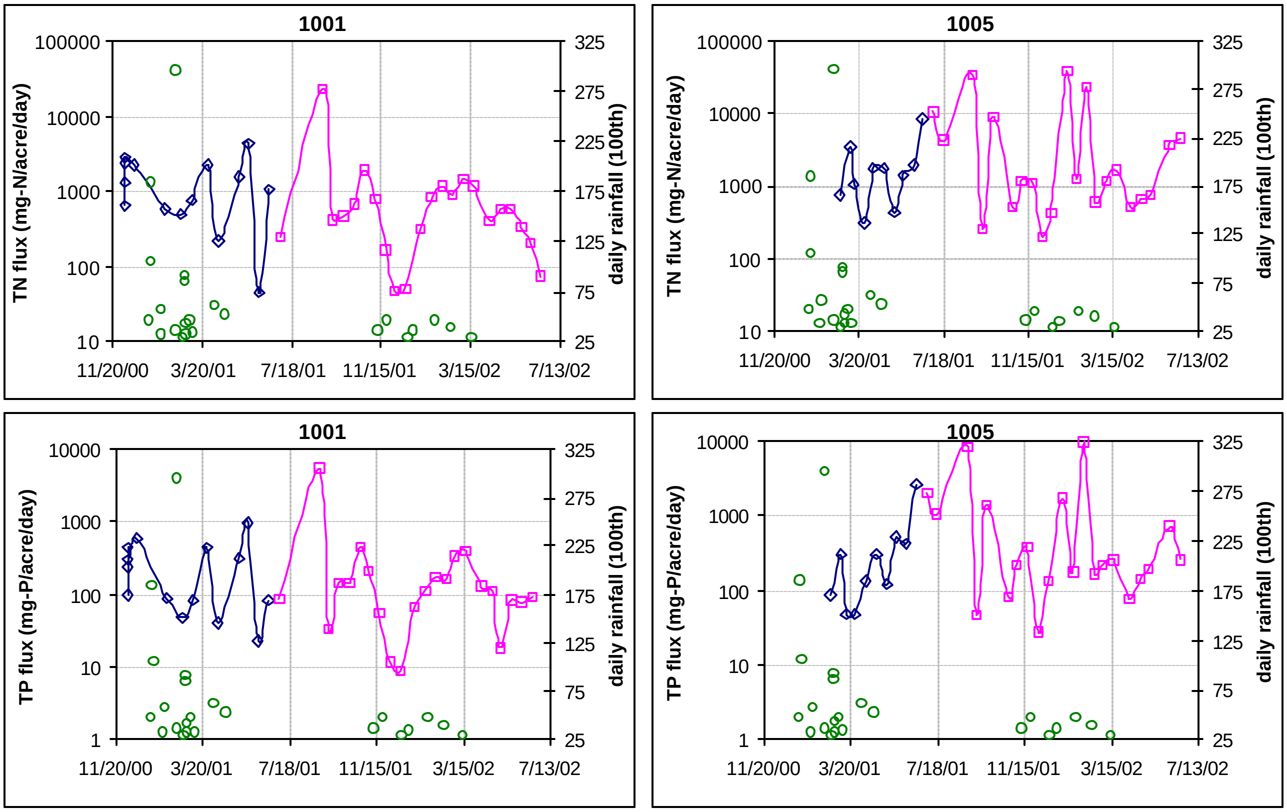


Figure A-11: Time Series of Nutrient Fluxes in Dry Weather Samples (all data)

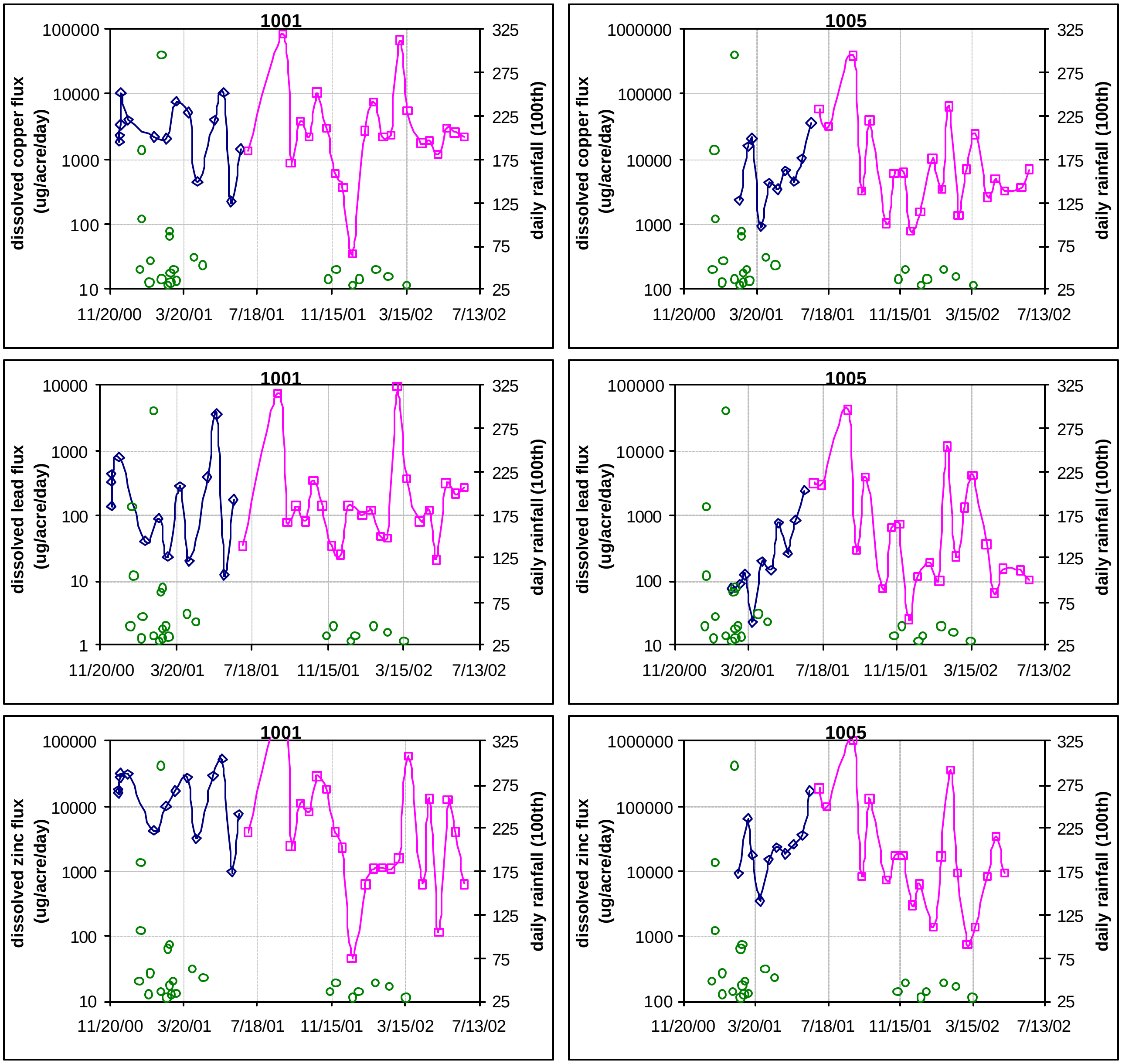


Figure A-12: Time Series of Dissolved Metal Fluxes in Dry Weather Samples (all data)

Appendix B – Summary Statistics

Table B-1: Descriptive Statistics

		1001		1002		1003		1004		1005	
Parameter	**Statistic**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Nitrate/Nitrite as N	**n**	23	25	23	25	24	25	23	25	24	25
(mg-N/L)	**% > MDL/RL**	100%	96%	96%	96%	100%	100%	100%	100%	100%	100%
	Mean	2.56	1.47	2.57	1.07	2.13	1.71	36.50	6.61	2.61	4.13
	Median	2.32	1.38	1.56	0.93	1.68	0.94	16.88	2.29	2.45	1.48
	Trimmed mean	2.37	1.44	1.80	0.89	1.61	1.01	25.04	3.33	2.41	1.60
	min	0.74	0.05	0.05	0.05	0.65	0.20	1.70	0.60	0.54	0.73
	max	5.26	2.97	7.42	3.92	9.96	10.16	109.90	34.40	6.21	64.90
	25th percentile	1.81	1.05	0.82	0.53	0.98	0.64	5.62	1.43	1.79	0.96
	75th percentile	3.10	1.99	3.77	1.18	2.49	1.60	70.76	8.95	3.11	2.22
	St Dev	1.08	0.70	2.34	0.91	1.94	2.21	37.82	8.78	1.40	12.68
	IQR	1.29	0.94	2.95	0.65	1.51	0.96	65.14	7.52	1.32	1.26
	Skewness, gs	0.84	0.14	1.00	1.89	3.11	2.96	0.76	2.01	1.19	4.98
	gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	symmetric?	Y	Y	N	N	N	N	Y	N	N	N
TKN	**n**	23	25	23	25	24	25	23	24	24	25
(mg-N/L)	**% > MDL/RL**	100%	64%	100%	84%	96%	92%	96%	92%	100%	96%
	Mean	1.68	1.63	2.74	2.37	1.97	2.71	11.50	3.72	4.08	3.61
	Median	1.27	1.21	1.78	1.90	1.38	1.46	4.26	1.91	2.23	2.39
	Trimmed mean	1.29	0.77	1.95	1.87	1.40	1.69	7.51	2.23	2.29	2.57
	min	0.88	0.25	0.68	0.25	0.25	0.25	1.44	0.25	0.76	0.25
	max	6.02	11.00	13.20	7.48	9.97	18.60	31.81	18.60	17.43	15.30
	25th percentile	1.13	0.25	1.33	1.13	1.01	1.20	2.55	1.41	1.88	1.71
	75th percentile	1.57	1.46	2.86	2.98	1.85	2.87	21.46	4.03	3.15	4.01
	St Dev	1.19	2.40	2.68	1.96	1.97	3.64	11.61	4.21	4.90	3.41
	IQR	0.44	1.21	1.53	1.85	0.84	1.67	18.90	2.62	1.26	2.30
	Skewness	2.84	3.16	3.00	1.23	3.24	3.77	0.75	2.31	2.29	2.34
	Gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	symmetric?	N	N	N	N	N	N	Y	N	N	N
Ammonia as N	**n**	23	25	23	25	24	25	23	24	24	25

Parameter	Statistic	1001 Pre	1001 Post	1002 Pre	1002 Post	1003 Pre	1003 Post	1004 Pre	1004 Post	1005 Pre	1005 Post
(mg-N/L)	% > MDL/RL	30%	20%	74%	64%	75%	52%	87%	71%	92%	96%
	Mean	0.13	0.08	0.25	0.42	0.26	0.29	7.05	0.25	0.85	0.42
	Median	0.05	0.05	0.18	0.20	0.17	0.10	0.71	0.14	0.43	0.22
	Trimmed mean	0.05	0.05	0.19	0.13	0.19	0.11	3.43	0.12	0.50	0.24
	min	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	max	1.12	0.36	0.90	5.45	1.06	2.29	26.34	2.03	6.92	2.41
	25th percentile	0.05	0.05	0.08	0.05	0.09	0.05	0.24	0.05	0.24	0.15
	75th percentile	0.12	0.05	0.30	0.28	0.29	0.36	13.69	0.28	0.94	0.42
	St Dev	0.23	0.07	0.22	1.06	0.26	0.48	9.14	0.40	1.39	0.50
	IQR	0.07	0.00	0.22	0.23	0.20	0.31	13.45	0.23	0.70	0.27
	Skewness	4.04	3.08	1.66	4.78	1.98	3.40	0.93	4.09	3.95	3.01
	gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	symmetric?	N	N	N	N	N	N	Y	N	N	N
TN (calculated)	n	23	25	23	25	23	25	23	25	23	25
(mg-N/L)	% > MDL/RL	100%	80%	98%	90%	98%	96%	98%	96%	100%	98%
	Mean	4.24	3.09	5.31	3.44	3.66	4.42	48.00	10.18	6.89	7.74
	Median	3.84	2.27	3.95	2.55	2.66	2.50	19.01	5.57	5.06	4.36
	Trimmed mean	3.94	2.40	4.53	2.76	2.93	3.01	33.11	6.47	5.08	4.42
	min	2.30	0.30	1.50	0.78	1.46	0.45	3.28	0.74	2.48	1.07
	max	6.76	12.99	13.83	11.40	12.12	19.91	141.06	40.80	20.41	67.12
	25th percentile	3.20	1.79	2.27	2.10	2.11	2.04	9.05	2.71	3.52	3.47
	75th percentile	5.68	3.13	8.02	4.36	4.81	5.17	94.79	19.18	7.07	5.62
	St Dev	1.41	2.67	3.56	2.51	2.48	4.39	49.17	10.73	5.29	12.85
	IQR	2.48	1.34	5.75	2.26	2.70	3.13	85.74	16.47	3.55	2.15
	Skewness	0.55	2.82	0.84	1.87	2.13	2.27	0.74	1.37	1.88	4.46
	gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	symmetric?	Y	N	Y	N	N	N	Y	N	N	N
ortho-phosphate	n	23	25	23	25	24	25	23	25	24	25
(mg-P/L)	% > MDL/RL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Mean	0.71	0.58	0.79	0.72	0.81	1.26	2.84	1.40	0.89	1.00
	Median	0.58	0.53	0.73	0.72	0.64	0.64	2.23	1.10	0.76	0.77
	Trimmed mean	0.60	0.56	0.69	0.70	0.63	0.66	2.42	1.10	0.77	0.87
	min	0.23	0.26	0.28	0.15	0.11	0.19	0.52	0.43	0.33	0.22
	max	1.58	1.08	2.25	1.56	4.01	10.60	6.57	6.45	2.31	3.11
	25th percentile	0.47	0.38	0.48	0.41	0.38	0.47	1.25	0.75	0.55	0.59
	75th	0.86	0.72	0.96	0.93	0.92	0.89	4.63	1.42	0.98	1.29

		1001		1002		1003		1004		1005	
Parameter	Statistic	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	percentile										
	St Dev	0.37	0.23	0.47	0.39	0.77	2.11	1.89	1.35	0.49	0.62
	IQR	0.39	0.34	0.48	0.52	0.54	0.42	3.38	0.67	0.44	0.70
	Skewness	1.13	0.60	1.55	0.32	3.27	4.03	0.60	3.03	1.66	1.79
	gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	symmetric?	N	Y	N	Y	N	N	Y	N	N	N
TP	n	23	25	23	25	24	25	23	24	24	25
(mg-P/L)	% > MDL/RL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Mean	0.73	0.60	0.92	0.84	0.98	1.21	3.33	1.50	1.01	1.19
	Median	0.60	0.51	0.77	0.82	0.62	0.67	2.54	1.05	0.73	0.85
	Trimmed mean	0.61	0.53	0.72	0.77	0.65	0.68	2.73	1.06	0.72	0.95
	min	0.27	0.26	0.11	0.16	0.11	0.23	0.53	0.34	0.33	0.22
	max	1.55	1.22	3.65	1.69	6.18	11.70	10.37	6.38	3.92	3.32
	25th percentile	0.47	0.39	0.43	0.49	0.35	0.49	1.52	0.60	0.50	0.60
	75th percentile	0.97	0.67	0.94	1.08	1.08	0.87	5.11	1.55	0.91	1.46
	St Dev	0.38	0.27	0.77	0.47	1.26	2.23	2.58	1.51	0.92	0.83
	IQR	0.50	0.28	0.51	0.59	0.73	0.38	3.59	0.96	0.40	0.86
	Skewness	1.00	1.07	2.27	0.49	3.39	4.68	1.26	2.41	2.35	1.38
	gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	symmetric?	N	N	N	Y	N	N	N	N	N	N
Cadmium	n	23	25	23	25	24	25	23	25	24	25
(ug/L)	% > MDL/RL	61%	12%	61%	36%	38%	16%	74%	36%	38%	44%
	Mean	0.26	0.14	0.47	0.44	0.27	0.17	0.64	0.22	0.21	0.29
	Median	0.27	0.10	0.24	0.10	0.10	0.10	0.36	0.10	0.10	0.10
	Trimmed mean	0.20	0.10	0.20	0.12	0.12	0.10	0.33	0.12	0.12	0.15
	min	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	max	0.56	0.79	3.40	3.50	1.77	0.92	4.54	1.22	0.92	1.89
	25th percentile	0.10	0.10	0.10	0.10	0.10	0.10	0.16	0.10	0.10	0.10
	75th percentile	0.39	0.10	0.40	0.26	0.26	0.10	0.42	0.23	0.25	0.45
	St Dev	0.15	0.15	0.78	0.79	0.37	0.20	1.15	0.25	0.20	0.37
	IQR	0.29	0.00	0.30	0.16	0.16	0.00	0.27	0.13	0.15	0.35
	Skewness	0.29	4.04	3.21	3.06	3.37	3.08	3.09	3.05	2.56	3.47
	gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	symmetric?	Y	N	N	N	N	N	N	N	N	N
Copper	n	23	25	23	25	24	25	23	25	24	25
(ug/L)	% > MDL/RL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Mean	13.5	16.9	27.3	30.3	11.5	26.6	21.8	17.7	32.1	30.8
	Median	11.5	11.4	10.9	14.0	11.1	14.3	12.7	11.4	12.3	20.4

		1001		1002		1003		1004		1005	
Parameter	**Statistic**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
	Trimmed mean	11.6	12.1	10.7	15.4	10.7	16.2	13.9	11.3	13.2	19.8
	min	5.2	1.9	3.2	4.6	5.6	7.2	7.3	5.1	5.4	7.9
	max	38.4	108.0	278.4	226.6	23.4	227.0	119.3	77.4	389.6	210.0
	25th percentile	8.4	8.8	6.2	8.0	8.0	11.6	10.0	7.5	8.7	14.2
	75th percentile	15.0	16.9	17.9	29.8	12.3	23.4	20.5	15.2	18.6	27.5
	St Dev	8.3	20.5	57.5	48.2	5.1	43.3	24.2	18.9	77.4	40.2
	IQR	6.7	8.1	11.8	21.8	4.2	11.8	10.5	7.7	9.9	13.3
	Skewness	1.9	4.0	4.1	3.3	1.1	4.5	3.3	2.3	4.7	4.0
	gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	symmetric?	N	N	N	N	N	N	N	N	N	N
Lead	**n**	23	25	23	25	24	25	23	25	24	25
(ug/L)	**% > MDL/RL**	91%	92%	91%	96%	88%	100%	96%	100%	96%	96%
	Mean	0.79	1.59	5.93	4.72	0.82	1.59	3.47	1.47	1.01	3.24
	Median	0.60	0.60	0.89	1.20	0.59	0.81	0.72	0.69	0.74	1.30
	Trimmed mean	0.57	0.62	0.94	1.65	0.56	0.81	0.77	0.76	0.72	1.79
	min	0.10	0.10	0.10	0.10	0.10	0.28	0.10	0.21	0.10	0.10
	max	4.91	14.90	81.70	30.87	3.19	10.90	37.74	7.16	5.70	28.10
	25th percentile	0.46	0.38	0.41	0.40	0.42	0.53	0.48	0.44	0.52	0.62
	75th percentile	0.74	0.97	1.91	4.30	0.71	1.14	1.13	1.09	0.92	3.77
	St Dev	0.97	3.18	17.63	8.10	0.79	2.46	9.19	1.91	1.11	5.56
	IQR	0.28	0.59	1.50	3.90	0.29	0.61	0.65	0.65	0.40	3.15
	Skewness	3.81	3.63	4.06	2.58	1.95	3.16	3.32	2.14	3.62	4.02
	gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92
	symmetric?	N	N	N	N	N	N	N	N	N	N
Zinc	**n**	23	25	23	25	24	25	23	25	24	25
(ug/L)	**% > MDL/RL**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Mean	58.7	37.2	115.2	86.3	56.3	56.8	83.6	40.9	74.0	75.0
	Median	56.0	50.2	53.4	57.2	50.7	53.9	50.8	43.8	52.4	54.5
	Trimmed mean	58.6	26.4	54.2	57.6	51.2	53.1	53.2	27.7	54.5	58.3
	min	32.5	2.5	35.4	2.5	22.1	2.5	29.5	2.5	32.3	2.5
	max	79.2	86.2	1069.7	429.6	171.0	231.0	429.0	149.0	330.0	512.0
	25th percentile	48.1	2.5	41.7	40.4	40.9	40.2	43.3	2.5	46.9	42.8
	75th percentile	71.4	58.2	72.1	76.9	63.9	65.5	69.0	58.6	64.6	74.5
	St Dev	14.1	29.1	219.7	109.1	29.9	44.4	97.0	35.1	63.0	99.1
	IQR	23.2	55.7	30.4	36.5	23.0	25.3	25.7	56.1	17.7	31.7
	Skewness	-0.1	-0.1	4.1	2.6	2.6	2.4	3.0	1.1	3.4	3.8
	gcr	0.96	0.92	0.96	0.92	0.94	0.92	0.96	0.92	0.94	0.92

		1001		1002		1003		1004		1005	
Parameter	**Statistic**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
	symmetric?	Y	Y	N	N	N	N	N	N	N	N
Diazinon	**n**	37	104					36	104	39	104
(ng/L)	**% > MDL/RL**	97%	99%					97%	100%	100%	100%
	Mean	1457	748					2694	1556	1295	1711
	Median	345	291					231	346	614	884
	Trimmed mean	420	352					442	369	783	902
	min	5	5					5	29	60	53
	max	14465	16590					41402	80969	7910	34838
	25th percentile	156.8	166.6					157.6	150.2	262.8	415.8
	75th percentile	890.4	641.6					1119.2	791.3	1601.5	1609.8
	St Dev	3140.5	1753.2					7505.6	7977.2	1655.4	3741.7
	IQR	733.6	475.0					961.6	641.1	1338.7	1194.0
	Skewness	3.4	7.5					4.4	9.8	2.3	7.2
	gcr	0.77	0.47					0.78	0.47	0.75	0.47
	symmetric?	N	N					N	N	N	N
Chlorpyrifos	**n**	37	104								
(ng/L)	**% > MDL/RL**	57%	40%								
	Mean	38.3	456.4								
	Median	25.0	10.0								
	Trimmed mean	18.9	10.0								
	min	5.0	5.0								
	max	213.7	45094.0								
	25th percentile	10.0	5.0								
	75th percentile	42.2	28.7								
	St Dev	51.1	4419.7								
	IQR	32.2	23.7								
	Skewness	2.5	10.2								
	gcr	0.77	0.47								
	symmetric?	N	N								

Appendix C – Probability Plot Comparisons

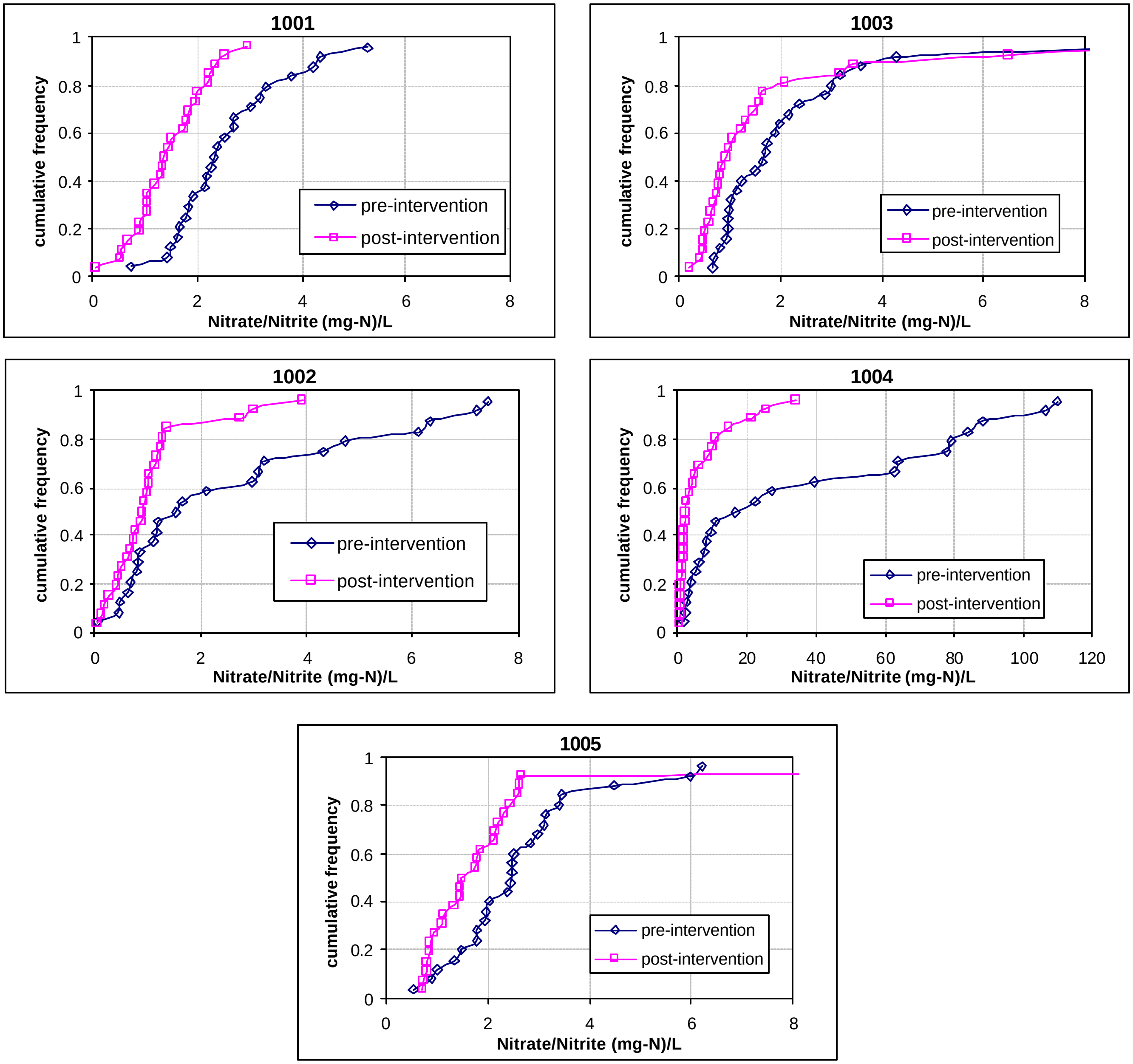


Figure C-1: Cumulative Frequency of Nitrate/Nitrite in Dry Weather Samples (all data)

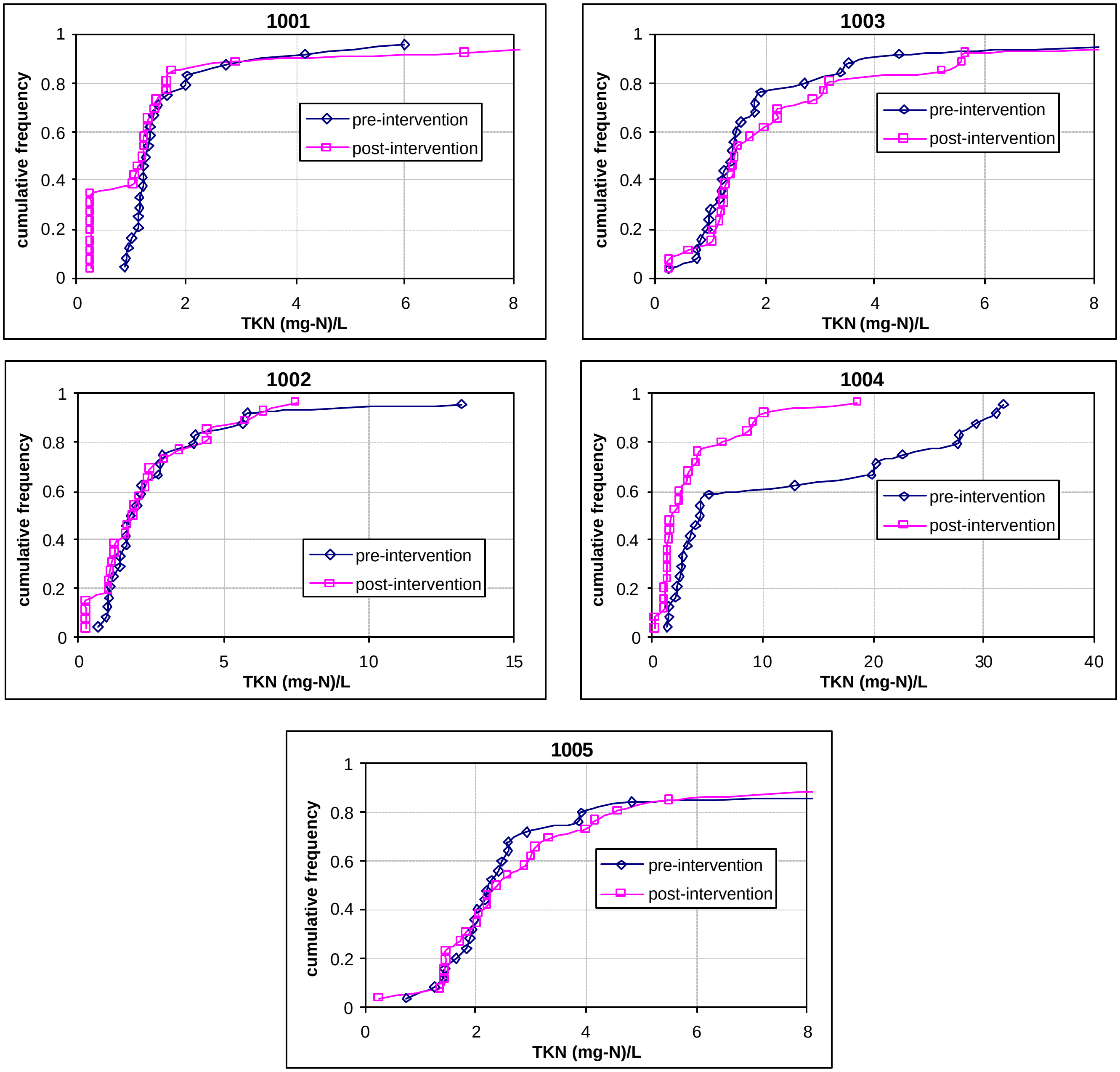


Figure C-2: Cumulative Distribution of TKN in Dry Weather Samples (all data)

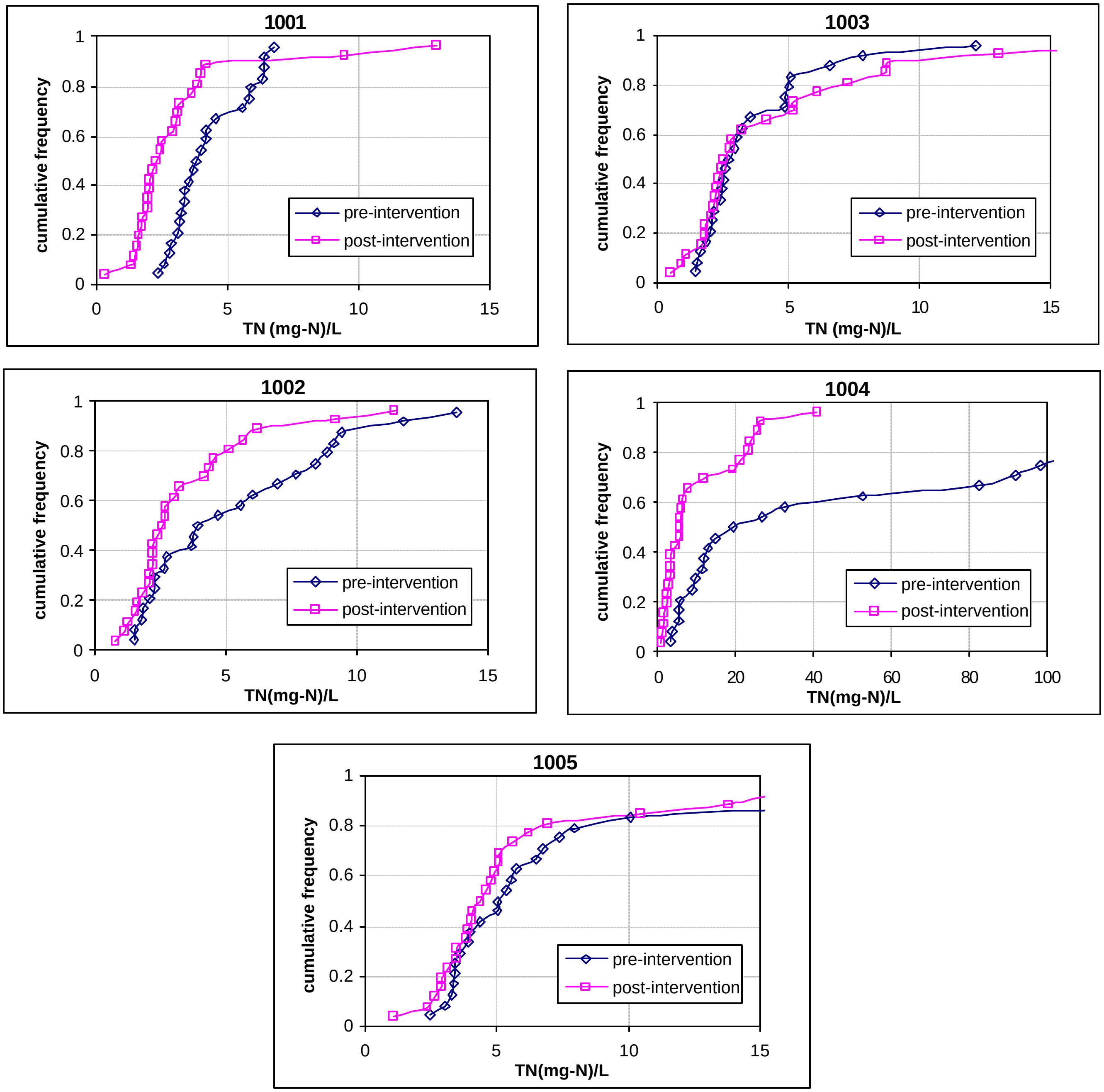


Figure C-3: Cumulative Distribution of TN (Calculated) in Dry Weather Samples (all data)

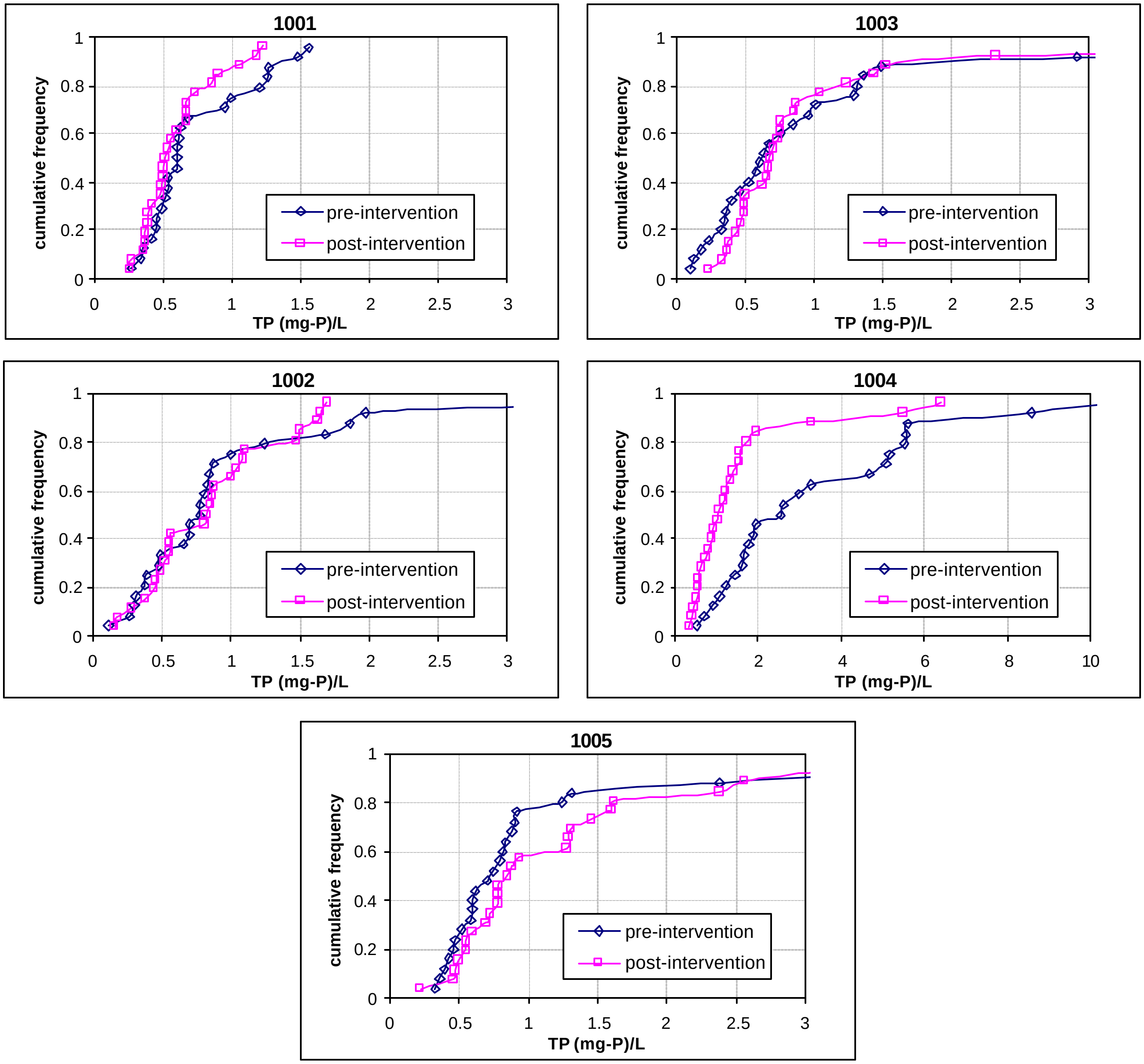


Figure C-4: Cumulative Distribution of TP in Dry Weather Samples (all data)

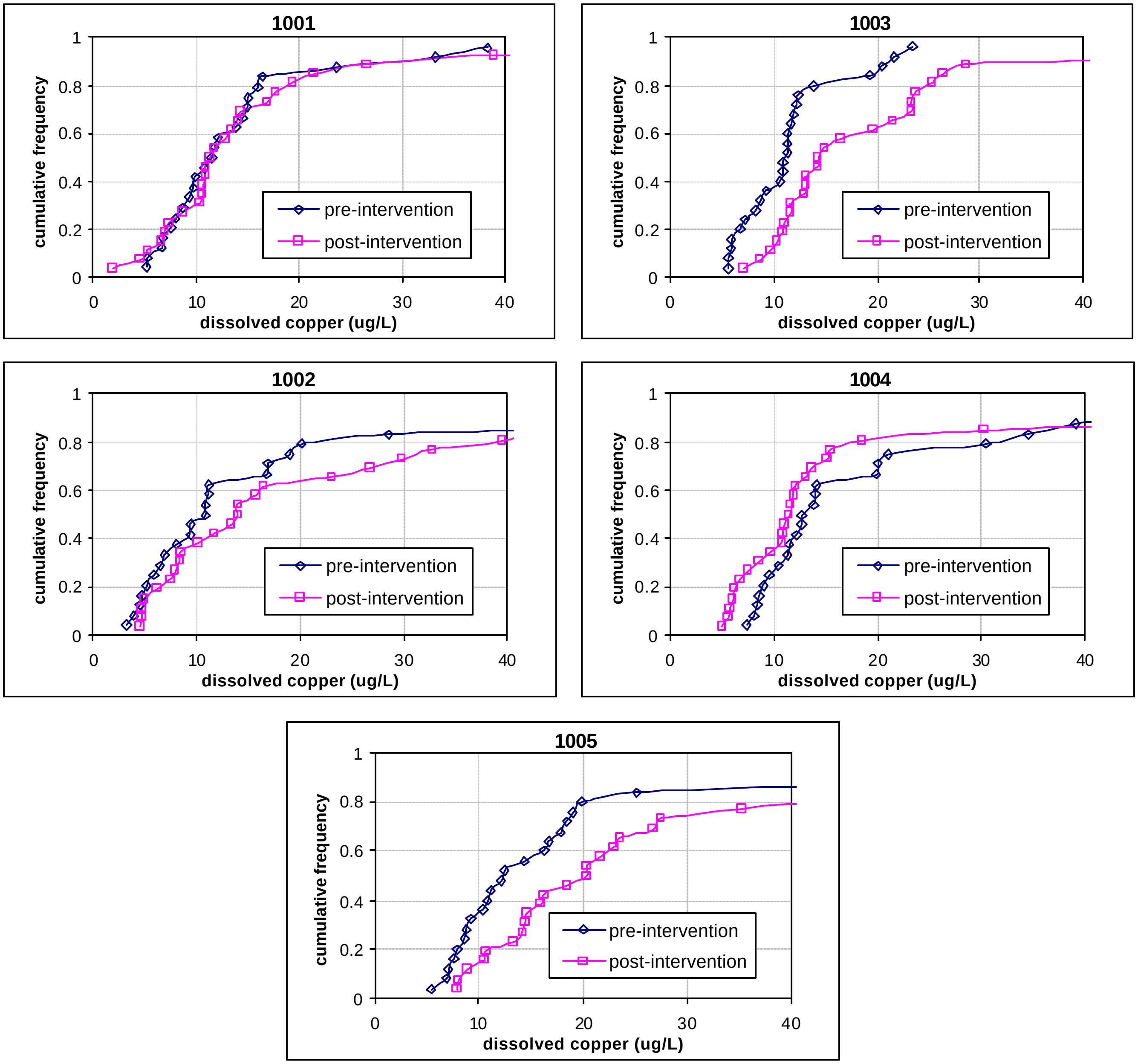


Figure C-5: Cumulative Distribution of Dissolved Copper in Dry Weather Samples (all data)

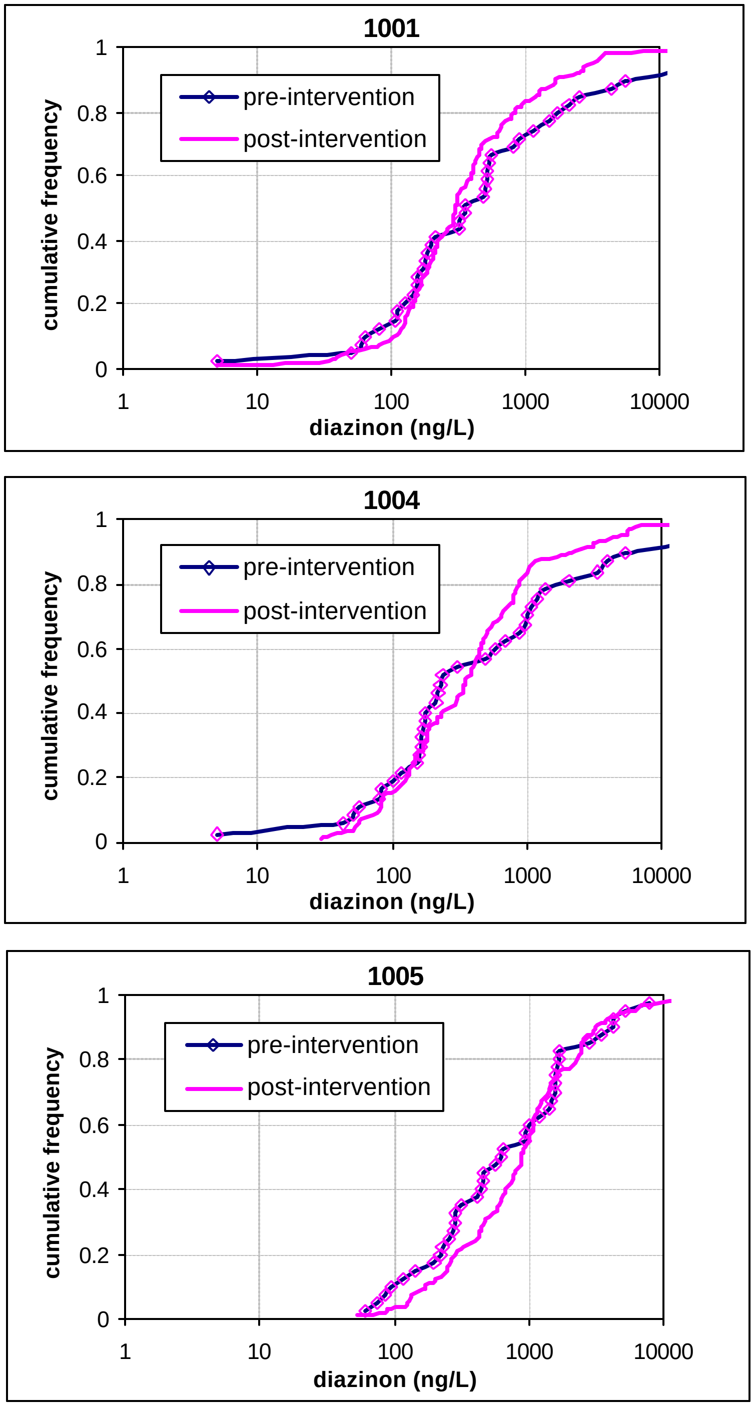


Figure C-6: Cumulative Distribution of Diazinon in Dry Weather Samples (all data)

Appendix F: Public Acceptance

The Residential Runoff Reduction Study

Appendix F: Public Acceptance

This appendix is divided into two parts. The first section describes the customer service program during the R3 Study time period and includes results of pre- and post-intervention surveys. The second part provides a representative sampling of public education materials distributed during the study. There were three groups of R3 study participants. The first group was the education group and the second group was the participants who had their home irrigation controllers replaced with an ET controller and lastly the control groups that received no treatment. The education group was self and randomly selected. Some of the education group participants voluntarily choose to participate in the study by replying to a letter. However, the majority of the education group was randomly selected through a door-to door campaign. The retrofit participants were selected through random "cold knocking" and through letter solicitations that explained the study.

Customer Interactions

ET Controller Installation Overview

ET Controllers were installed in two phases. The first phase was the installation of controllers at residences. The controllers were installed on the weekends between April and June 2001. The second phase of the installation process was the retrofit of City of Irvine and HOA sites. The retrofitted HOA sites watered the common areas of condominium and the City of Irvine sites watered the medians and streetscapes. Both of these two groups were all in the same watershed as the residential homes that were retrofitted. Initially, the time per installation was approximately one to one and one-half hours, depending on the number of valves. However, as the IRWD staff became familiar with the process, which most had never done before, the time dropped to approximately one-half hour.

Residential post-installation concerns and problems

Home residents were advised that if they had any problems with the controller or if the controller required any adjustments, they should call the water district for assistance. IRWD's customer service department telephone number was left on the ET controller on a sticker. All calls related to the ET controller were logged in separately and routed to the appropriate staff member for assistance. Table 1 presents a summary of calls received from residential residents during the R3 study period. Generally, there were four common types of calls: 1) customer misunderstanding ("no problem" category), 2) installation-related issues, 3) system flaws, and 4) ET controller malfunctions.

Table 1: Telephone Log Summary

April 2001	1	August 2001	13	December 2001	1	April 2002	2
May 2001	12	September 2001	4	January 2002	4	May 2002	3
June 2001	7	October 2001	5	February 2002	9	June 2002	6
July 2001	13	November 2001	3	March 2002	4	July 2002	2

The first type were calls where the customer had a misunderstanding on the way the ET controllers were supposed to operate. In this type of call there was a "problem, where no problem actually existed". A common example was when a resident called to say that the sprinklers were not turning on every night. The staff member would then explain to the resident that with proper irrigation management it is normal if the irrigation sprinklers do not turn on every night.

The second types of calls received were either related to programming or installation-related mistakes. These usually occurred when the installation staff entered an incorrect value in the programming process. In other cases, a landscape contractor for the City of Irvine or HOA sites had incorrectly programmed the controller. Both groups were instructed at the beginning of the study to call IRWD to meet with a staff member who would adjust the ET controller for them.

The third category of calls included problems that were a result of a lack of irrigation system maintenance or a flaw in the design of the system. These problems were the responsibility of the homeowner to fix and were not related to the actual malfunctioning of the ET controller. For example, a customer called customer service and said that his lawn was turning brown because it was not being watered correctly. A site visit by staff would discover that the controller was set correctly, but the problem was that overgrown plant material was interfering with the normal spray pattern of the nozzle. It was this obstruction by plant material that caused the brown spot and not the settings on the ET controller.

The fourth category of calls was related to the ET controller malfunctioning. The calls from study participants were that the controller had stopped responding and the display was frozen, incorrect date or time display, or a signal dropout caused by a faulty program version. If resetting the unit or resending the ET signal could not correct the problem, the ET controllers were often changed out with a new controller with the latest version of the program. City of Irvine and HOA controllers with older versions of the controller were upgraded by uploading a new version of the program from a device provided by the manufacturer.

Tracking of Water Consumption of the City of Irvine and HOA Sites

In addition to responding to CSR calls, weekly meter reads were incorporated into the study as part of irrigation water management in order to monitor each site for excessive water usage. One ET controller installed for selected City of Irvine street landscapes was able to cover a larger area than the same controller installed in a residence. In addition, each of the City of Irvine retrofit sites had dedicated landscape irrigation water. Because of this, it was easier to track weekly water consumption of 18 meters instead of monitoring 112 residential meters. Weekly meter reads was a convenient way for staff to monitor water usage and to evaluate the performance of the ET controllers. Study staff periodically met with City of Irvine landscape staff to discuss the condition of the landscape and to discuss any other concerns. The landscape supervisor said that the appearance of the landscapes with the ET controllers were equal to similar city sites that did not have the ET controller.

One of the advantages of the ET controller is that it was able to receive a new ET signal if there was an unexpected change in weather conditions after a weekly signal had already been sent out. The controllers were grouped by water district zone, ET zone, and Zip code. Changes in weather conditions warranted staff to either increase the ETo or decrease the ET_o. During the rainy weeks, a signal would be sent to the all of the controllers that would pause the watering schedule for the appropriate number of days, this was referred to as a "rain pause signal". Additionally, the controllers had a feature that allowed each valve to be micro-managed without having to adjust the entire watering schedule.

City of Irvine and Home Owner Associations

There are numerous benefits that can result from the installation of the ET controllers in a City environment as a water management tool. Costs that are associated with maintaining a city streetscape are labor hours and equipment. During the rainy season, city staff shuts off irrigation controllers for a given number of days that is determined by the amount of rainfall. This process is completed by manually having a city employee drive to each controller and turn the controllers off. This can be a very time intensive activity. In comparison the ET controllers are able to receive a rain pause signal and all the controllers in an area can be turned off within minutes. Hence, the ET controller can provide potential savings in labor and equipment required for programming each individual controller. It eliminates the guesswork as to whether or not to turn off the controllers. This savings in time and labor can be very substantial when the system needs to be shut down and then turned back on due to rain. With this system the city can allocate their resources more efficiently by focusing on landscape system maintenance instead of spending time on those tasks that can be performed with the ET controller technology. In addition, city staff will be able to cover a larger area. The water management features of the technology can maintain healthy landscapes and can help the city avoid penalty charges.

City and HOA controllers could be installed during regular business hours and no overtime was required for staff. These two groups were flexible about the installation times. In future programs or implementation of this technology it may be possible to train the local landscaper or contractor to install and monitor the controller. Monitoring the controller includes inspections of the irrigated area and meter reads. The local landscapers are probably the most familiar with irrigation controllers and could be cost effective to have them install the ET controller.

Customer Surveys

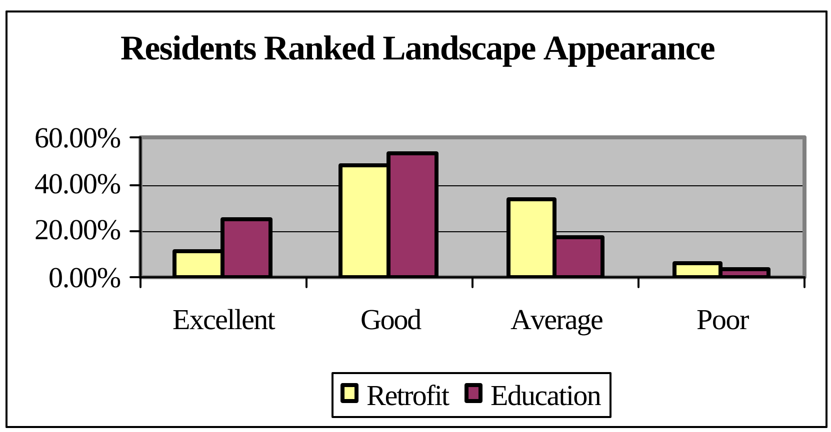
Pre-Survey Goal

The purpose of the pre-survey was to determine if the retrofit group and the education had similar irrigation practices and attitudes.

Survey Distribution

The pre-survey was distributed to the retrofit group while installation of the controller was taking place. Retrofit study participants were asked to fill-out the survey while staff was installing the controller. The education group received their survey as part of the initial educational packet that was randomly distributed to residents. Education group participants were provided a stamped addressed envelope to return their survey to the Irvine Ranch Water District. Ninety-seven (109/112) percent of those that received a survey from the retrofit group mailed the survey back. Twenty-four percent (53/225) of residents in the education group mailed back a survey.

Figure 1: Landscape Appearance

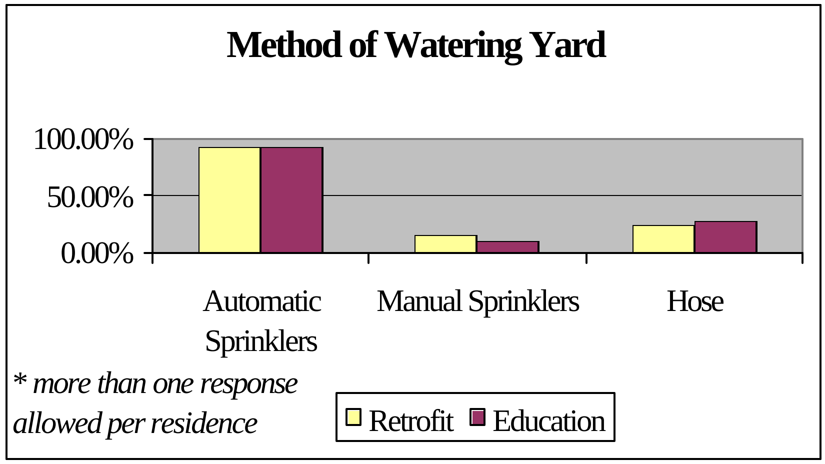


Selected Responses

A look at Figure 1 to the right shows the responses of both of the groups. Both groups gave similar responses. A majority of the residents in both groups believe that the appearance of the yard is average to good. Notice that the "excellent" response was selected by more of the education group that the retrofit group. One possible explanation for this response is that the staff was on-site while people were filling out their survey in the retrofit group.

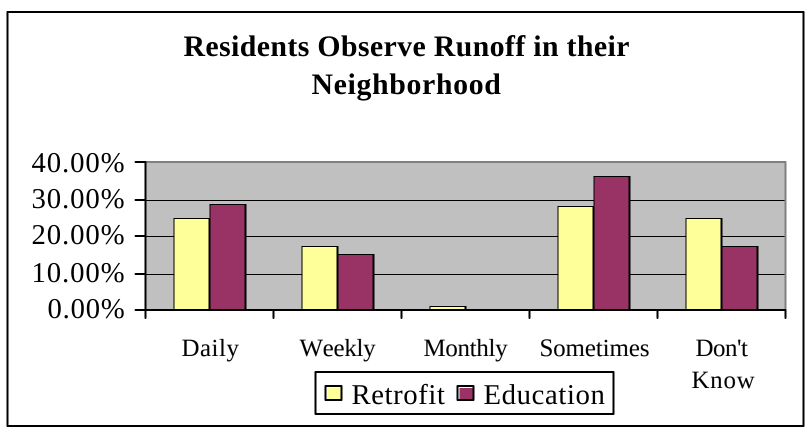
Residents were asked how they watered their lawn. Figure 2 shows responses across groups were very similar. The percentage of people in the retrofit and education group that use automatic sprinklers, manual sprinklers, or a hose are similar. The survey shows that the retrofit and education groups have similar watering behaviors. A majority of the participants used automatic sprinklers. This is important because the R3 study focuses on retrofitting the automatic irrigation controllers as a water management tool.

Figure 2: Watering Methods



Residents were asked how often they observed runoff in their neighborhood. The data presented in Figure 3 shows that residents in both groups have similar attitudes and views of urban runoff.

Figure 3: Runoff Observed



Residents were asked if they used fertilizers in their landscape. As shown Figure 4 at right, fertilizer use in both groups is almost the same. Their behavior when it comes to applying fertilizers is also the same.

Figure 4: Use of Fertilizers

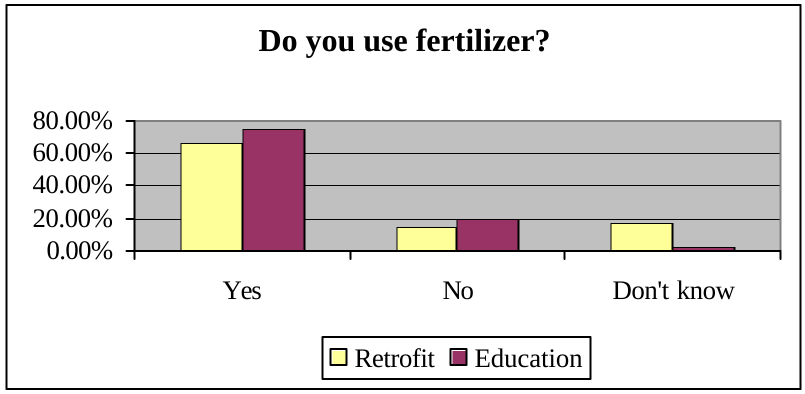


Figure 5: Use of Chemicals

Residents were also asked if they used chemicals to control pests or weeds in their yard. Figure 5 shows their responses.

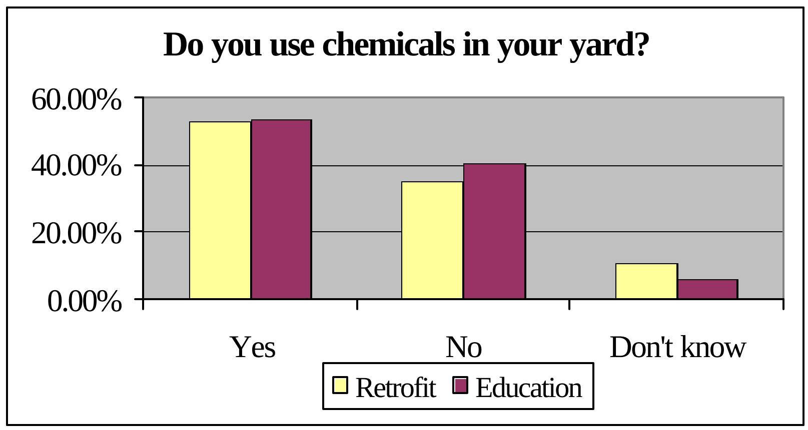


Table 2: Pre-Survey Responses

R3 Study Pre-Survey Results		
	Retro	Education
Who is responsible for yard maintenance at your home?		
Adult	68.81%	76.92%
Children	3.67%	3.85%
Yard Service	49.54%	40.38%
How is your yard watered?		
Automatic Sprinklers	92.66%	92.31%
Manual Sprinklers	14.68%	9.62%
Hose	23.85%	26.92%
How often is your yard watered?		
Summer- Days Per Week	RV	RV
Summer-Minutes Per Day	RV	RV
Summer-Don't Know	10.09%	5.77%
Winter - Days Per Week	RV	RV
Winter - Minutes Per Day	RV	RV
Winter-Don't Know	10.09%	9.62%
Controller Times Changed	RV	RV
How often do you see water runoff in your neighborhood?		
Runoff in Neighborhood-Daily	24.77%	28.85%
Runoff in Neighborhood-Weekly	17.43%	15.38%
Runoff in Neighborhood-Monthly	0.92%	0.00%
Runoff in Neighborhood-Sometimes	28.44%	36.54%
Runoff in Neighborhood-Don't Know	24.77%	17.31%
How often are patios, sidewalks, and driveways cleaned at your home?		
Driveways are cleaned-Daily	0.00%	1.92%
Driveways are cleaned-Weekly	39.45%	40.38%
Driveways are cleaned-Monthly	24.77%	21.15%
Driveways are cleaned-Sometimes	33.03%	34.62%
Driveways are cleaned-Other	RV	RV
How do you clean driveways	RV	RV
Who is responsible for pest and weed control in your yard?		
I am - Responsible for Weed/Pest Control	59.63%	67.31%
Yard Service- Responsible for Weed/Pest Control	30.28%	17.31%
Pest Control Service - Responsible for Weed/Pest Control	15.60%	25.00%
Dont Use Weed or Pest Control Service	6.42%	11.54%
Other - Responsible for Weed/Pest Control	0.00%	0.00%
Do you use chemicals to control pests or weeds in your yard?		
Chemicals are used to control pests/weeds	53.21%	53.85%
Chemicals are not used to control pests/weeds	34.86%	40.38%
Don't know if chemicals are used	11.01%	5.77%
Chemicals used are	RV	RV
Chemicals used, How often?	RV	RV

Do you use fertilizer in your yard?		
Fertilizer is used	66.06%	75.00%
Fertilizer is NOT used	14.68%	19.23%
Don't know if fertilizer is used	16.51%	1.92%
If Fertilizer used, which ones?	RV	RV
If Fertilizer used,how often?	RV	RV
Who is responsible for dispocal of unused landscape chemicals?		
I am - Responsible for disposal of unused chems	48.62%	63.46%
Pest Control - Responsible for disposal of unused chems	8.26%	5.77%
Yard Service - Responsible for disposal of unused chems	0.00%	0.00%
Don't know who - Responsible for disposal of unused chems	11.93%	7.69%
How are chems disposed of?	RV	RV
Rank the overall appearance of your yard?		
Appearance of yard-Excellent	11.93%	25.00%
Appearance of yard-Good	48.62%	53.85%
Appearance of yard-Average	33.94%	17.31%
Appearance of yard-Poor	6.42%	3.85%
Appearance of yard-Very Poor	0.00%	0.00%
How serious do you consider urban ruoff?		
Neighborhood Urban Runoff = Very Serious	6.42%	15.38%
Neighborhood Urban Runoff = Serious	16.51%	17.31%
Neighborhood Urban Runoff = Needs Improvement	46.79%	38.46%
Neighborhood Urban Runoff = No Problem	22.02%	23.08%
Irvine Urban Runoff = Very Serious	5.50%	15.38%
Irvine Urban Runoff = Serious	15.60%	11.54%
Irvine Urban Runoff = Needs Improvement	39.45%	42.31%
Irvine Urban Runoff = No Problem	18.35%	11.54%
Orange Co Urban Runoff = Very Serious	7.34%	15.38%
Orange Co Urban Runoff = Serious	21.10%	25.00%
Orange Co Urban Runoff = Needs Improvement	44.95%	34.62%
Orange Co Urban Runoff = No Problem	4.59%	1.92%
California Urban Runoff = Very Serious	13.76%	19.23%
California Urban Runoff = Serious	19.27%	21.15%
California Urban Runoff = Needs Improvement	40.37%	36.54%
California Urban Runoff = No Problem	3.67%	1.92%
Is there animal waste that gets left in you yard?		
Animal Waste is left in yard	35.78%	26.92%
Animal Wate is NOT left in yard	63.30%	69.23%
If Animal Waste is left in yard, then what type of animal	RV	RV
How many people live in your home?		
Household Adults	RV	RV
Household Children	RV	RV
*(RV) Responses Varied		

Post-Survey Goal

The purpose of the post-survey was to determine the attitudes of the study participants towards the ET controller and to determine if the education material had an impact on modifying behavior of the recipients. Specifically, determining whether or not there was an acceptance of the ET controller as a way of managing their landscape and was there a change in irrigation practices and behaviors because of the education material.

Survey Distribution

The post-survey was distributed to both of the groups through the mail. Twenty-three (52/225) percent of the education group participants responded to the survey and forty-five percent (50/112) of the retrofit group participants responded.

ET Controller

The majority of the retrofit households acknowledged their satisfaction with the ET controller's performance and agreed that they would recommend the ET controller to their friends. It appears that the residents liked the controller and did not mind having someone else manage their irrigation-watering schedule. Data shows that households accepted the controller as a method of saving water, reducing runoff, and watering their landscape. The survey shows that twice the number of retrofit households observed a decrease in their water bill than the education households did. A majority of the education households did not observe a change in their water bills. Data appears to show that the appearances of the retrofit landscapes were ranked equally with those landscapes that were part of the education group. It can therefore be concluded that the survey showed that the lower use of water did not create landscaped that were inferior to the education group. The customer's perception of a lower bill is important for the success of any long-term conservation program.

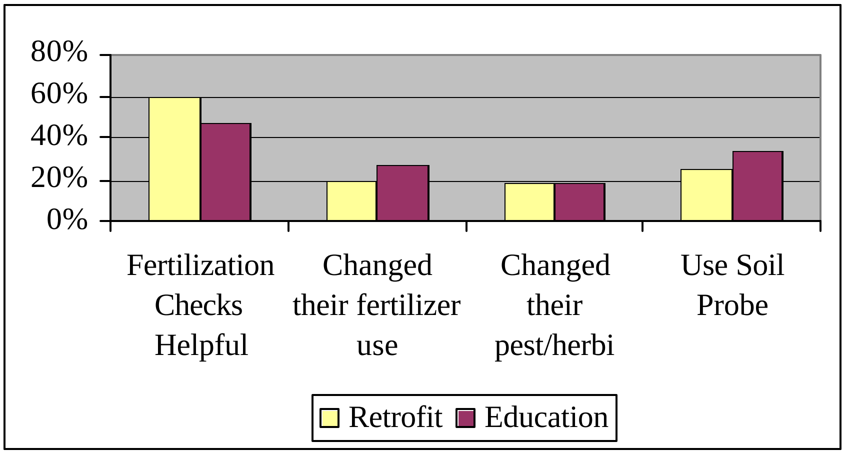
The retrofit and education group were asked if they were willing to pay for an ET controller signal. A majority of the households in both of the groups would not be willing to pay for an ET signal. The ET controller costs approximately $150.00 and the signal fee is $48 per year. The ET controller would be able to save less than 2 ccfs per month, which is a savings of about $14 per year. It appears that the savings in water use per year is not large enough for the water customer to pay for an ET signal.

ET Controller Selected Responses

- 72% of the retrofit households were satisfied with the ET Controller.
- 70% of the retrofit households would recommend the ET Controller to others.
- 44% of the retrofit households saw a decrease in their water bill,
- 38% saw their bill as unchanged.
- 23% of the education households saw a decrease in their water bill,
- 63% saw their water bills as unchanged.
- 69% of the education households ranked the appearance of their yard as good to excellent.
- 70% of the retrofit households ranked the appearance of their yard as good to excellent.
- 69% of the education households would not be willing to pay for an ET signal.
- 58% of the retrofit households would not be willing to pay for an ET signal.

Education Program

Figure 6: Impacts on Education Program



The results of the education program are summarized on Figure 6. More than half of the education households acknowledged that they sometimes or most of the time would change the settings on their controller according to ET via the monthly letter's suggested schedule. Monthly letters provided monthly landscape maintenance tips. Here, the majority of the households in both of the groups liked the tips on the irrigation checks, and fertilization sections. Although most people read these sections, a vast majority (80%) of households in both of the groups did not change their use of pesticides, herbicides, or fertilizers. In addition to the education materials, a soil probe was given to both groups at the beginning of the study. A soil probe is a tool that takes a soil sample and allows the user to see the depth and amount of moisture available to the plants. This allows the user of the soil probe to determine if the plants require more or less irrigation. More than half of the households in both groups only used the soil probe once or not at all. The majority of the people never used the soil probe at all. From a program point of view, people enjoy the education materials but they appear to have little effect on modifying behavior.

Education Material Selected Responses

- 54% of the education households changed their irrigation controller schedule (based on the recommendations included in the monthly tips) most of the time or sometimes.
- 58% of the education households and 42% of the retrofit households believed that the irrigation checks (part of the monthly tips) were helpful.
- 44% of the education households and 58% of the retrofit households believed that the fertilization checks (part of the monthly tips) were helpful.
- 81% of the education and 82% of the retrofit households have not changed their use of pesticides and herbicides.
- 73% of the education households and 80% of the retrofit households have not changed their use of fertilizer.
- 62% of the education households and 76% of retrofit households did not use the soil probe or they only used it once.

Table 3: Post-Survey Results

R3 Study Post-Survey Results						
1. Rank the overall appearance of your yard.						
	Excellent	Good	Average	Poor	Very Poor	
Education	9.62%	59.62%	30.77%	1.92%	0.00%	
Retrofit	16.00%	54.00%	24.00%	4.00%	2.00%	
2. Have you seen any change in your water bill in the past 12 months?						
	Increase	Decrease	Unchanged			
Education	9.62%	23.08%	63.46%			
Retrofit	14.00%	44.00%	38.00%			
3. Which monthly monthly tips were helpful to you?						
	Irrigation Checks	Watching for Runoff	Pest& Weed Control	Fertilization	None were Helpful	Dd Not Read
Education	57.69%	28.85%	23.08%	44.23%	1.92%	9.62%
Retrofit	42.00%	30.00%	46.00%	58.00%	2.00%	18.00%
4. How often did you use the soil probe?						
	Once	2 to 6 times	More than 6 times	Only for the Rain	Did Not Use	
Education	11.54%	30.77%	1.92%	3.85%	50.00%	
Retrofit	12.00%	16.00%	6.00%	0.00%	64.00%	
5. How often do you see water runoff in your neighborhood? (choose one)						
	Daily	Weekly	Monthly	Sometimes	Don't Know	
Education	25.00%	32.69%	5.77%	26.92%	11.54%	
Retrofit	10.00%	36.00%	2.00%	40.00%	16.00%	
6. How often are patios, sidewalks and driveways cleaned at your home? (choose						
	Daily	Weekly	Monthly	Sometimes	Never	
Education	0.00%	46.15%	21.15%	30.77%	3.85%	
Retrofit	2.00%	48.00%	16.00%	32.00%	4.00%	
7. How do you clean patios, sidewalks and driveways at your home?						
	Hose	Broom	Blower	Other		
Education	44.23%	63.46%	30.77%	RV		
Retrofit	48.00%	58.00%	36.00%	RV		
8. Have you changed your use of pesticides and herbicides in the yard in the past 12 months?						
	Yes	No	How?			
Education	15.38%	80.77%	RV			
Retrofit	16.00%	82.00%	RV			
9. Have you changed the use of fertilizer in your yard in the past 12 months?						
	Yes	No	How?			
Education	23.08%	73.08%	RV			
Retrofit	18.00%	80.00%	RV			
10. Is there animal waste that gets left in your yard?						
	Yes	No	What type of animal			
Education	21.15%	75.00%	RV			
Retrofit	36.00%	64.00%	RV			
11. How serious a problem do you consider urban runoff? (choose one)						
	Very Serious	Serious	Needs Improvement	No Problem		
Education	3.85%	38.46%	46.15%	9.62%		
Retrofit	12.00%	28.00%	52.00%	10.00%		
12. Were you satisfied with the test irrigation controller installed to manage the landscape water?						
	YES	NO	Why			
Retrofit	72.00%	24.00%	RV			
13. Would you recommend this irrigation controller to others?						
	YES	NO	Why			
Retrofit	70.00%	24.00%	RV			
14. Would you pay a monthly fee to have signal sent to the controller for landscape water management as tested in this study						
	YES	NO	How Much?			
Education	26.92%	69.23%	RV			
Retrofit	38.00%	58.00%	RV			
15. How often did you change your irrigation controller to the times provided in the monthly tips?						
	Every Month	Most of the Time	Sometimes	Once or Twice	Never	
Education	5.77%	28.85%	25.00%	23.08%	15.38%	

Central Basin Municipal Water District

2005 Urban Water Management Plan

Prepared by:
Central Basin Municipal Water District
17140 S. Avalon Blvd., Suite 210
Carson, CA 90746

www.centralbasin.org

Central Basin Municipal Water District

2005 Urban Water Management Plan

Prepared by:

Central Basin Municipal Water District
17140 S. Avalon Blvd., Suite 210
Carson, CA 90746

MESSAGE FROM THE BOARD OF DIRECTORS

Since the District's formation in 1952, Central Basin Municipal Water District has remained steadfast in its commitment to ensure a safe and reliable water supply for the region. Through the years, the District has grown and transformed, seeking innovative and viable solutions to meet the changing needs of its communities. All of us at Central Basin continue to expand our efforts to meet the growing water demand while preserving our limited and precious water resource. Through our water recycling, conservation, education and outreach programs, Central Basin has evolved from a potable water wholesaler to a leader safeguarding the region's water supply.

We are proud to submit this 2005 Urban Water Management Plan to the State Department of Water Resources. The Plan reports all current and projected water supplies and demands within Central Basin's service area, demonstrates water reliability for the next 25 years, and provides a comprehensive overview of the District's various programs.

DIRECTORS

Division I - Edward C. Vasquez
Bell Gardens, Downey, Montebello, Norwalk and Vernon

Division II - Robert Apodaca
La Habra Heights, La Mirada, Pico Rivera, Santa Fe Springs and Whittier

Division III - George Cole
Bell, Commerce, Huntington Park, Maywood, portions of Cudahy, Monterey Park and unincorporated areas of East Los Angeles

Division IV - Olga E. Gonzalez
Lynwood, South Gate, portions of Cudahy, Carson, Florence-Graham and Willowbrook

Division V - Phillip D. Hawkins
Artesia, Bellflower, Cerritos, Lakewood, Paramount and Signal Hill

MISSION STATEMENT

"To acquire, sell and conserve imported and other water that meets all required standards and to furnish it to our customers in a planned, timely and cost effective manner that anticipates future needs. The District serves as the official representative for its public at the Metropolitan Water District of Southern California. It also provides leadership, support, advice and communication on water issues to the people and agencies within and outside its boundaries, as appropriate."

Tables of Contents

APPENDICES

List of Figures

List of Tables

Executive Summary


17140

Executive Summary

This section is a summary of the components of this Plan

A BRIEF HISTORY

The legislative requirement to prepare an Urban Water Management Plan (UWMP) every five years provides Central Basin Municipal Water District (Central Basin) with an opportunity to affirm and support its primary purpose - to ensure the long-term water supply reliability of its region. Although the District's overall mission has not changed in more than five decades, techniques for meeting its objective are continuously evolving.

The history of Central Basin is representative of how water resource management has evolved in southern California during the past half a century. Ensuring that residents and businesses in southern California have safe and reliable supply of water requires the cooperation of local water purveyors as well as regional wholesalers.

When native groundwater supplies in the growing southeastern part of Los Angeles County became critically over-drafted in the 1940s, groundwater producers formed a regional agency, Central Basin, in 1953 that would join the Metropolitan Water District of Southern California (MWD). MWD had been created in 1928 by 11 cities (13 in 1933 and now 26 member agencies) for the purpose of constructing a 240-mile aqueduct from the Colorado River. The era of "imported water" and mega-projects that began at the turn of the last century with construction of the Los Angeles Aqueduct from the Owens Valley by the City of Los Angeles, and continued with the extension of the California Aqueduct into southern California in the 1970s, was well underway. Central Basin joined this era to provide a new source of water for groundwater replenishment and to meet the needs of many cities and agencies with little or no access to groundwater.

Imported water was the fuel that drove the economic engine of southern California for decades. Through the 1960s, 70s and 80s, imported water provided by Central Basin offered the reliability enjoyed by groundwater producers and non-producers alike. During this time, not only did population within Central Basin's service area grow by 136% from about 593,000 in 1950 to more than 1.4 million people by 1990, but the area also became an industrial center in the region.

A DIFFERENT APPROACH TO WATER MANAGEMENT

The paradigm of ensuring reliability while continuing to provide unlimited supplies of imported water began to change with the drought of 1989-1992. Even before the near-reality of mandatory water rationing in the spring of 1992, plans had begun to enhance conservation practices and to consider the development of locally-produced sources of water that, through the long-term, would significantly reduce southern California's reliance on supply systems subject to hydrology and environmental pressures.

Central Basin was at the forefront of this change in approach to water management. By 1990, funding mechanisms were in place and designs were being drawn up for a regional recycled water distribution system that would directly offset potable imported water for non-potable uses such as irrigation and industrial applications. Central Basin would also become renowned for its highly successful conservation and education programs that, combined with recycled water, have helped conserve more than 38.3 billion gallons of potable water during the past decade.

By 1996, local programs were accounted for within MWD's Southern California Integrated Resources Plan (IRP), which established a rolling 20-year roadmap for diversified supply investments in recycled water, brackish groundwater treatment, surface and groundwater storage, water transfers and exchanges, conservation practices and accessibility to imported water. A recent update of the IRP also includes ocean water desalination as an additional resource for ensuring the long-term reliability of regional water supplies.

Central Basin's aggressive pursuit of the resource development targets within the IRP is changing the face of water supply in the region from mostly groundwater to a more diverse set of supply options.

WATER DEMAND

Total water use, or demand, within Central Basin's service area includes retail demand and groundwater replenishment. Retail demand is defined as all municipal (residential, firefighting, parks, etc.) and industrial uses, and represents the population's total direct water consumption. Replenishment includes deliveries to the Rio Hondo and San Gabriel River Spreading Grounds in the Montebello Forebay. Table ES-1 summarizes the current and projected retail and replenishment demands.

IMPACTS OF CONSERVATION AND EDUCATION: REDUCED DEMAND

Although not a traditional "wet" water supply like imported water or recycled water, water use efficiency, including conservation and education, is considered part of Central Basin's water supply portfolio because it results in less retail need, or demand, for wet supplies than would otherwise be the case. Perhaps the most telling picture of the impact of conservation and education on retail demand is conveyed by Figure ES-1.

Retail water use within Central Basin's service area is largely the same today as it was 10 years ago despite the addition of more than 145,000 people. The average retail demand for the past 15 years is approximately 260,500 AFY. Clearly, residents are now using less water on an individual, or "per capita," basis, as shown in Figure ES-2.

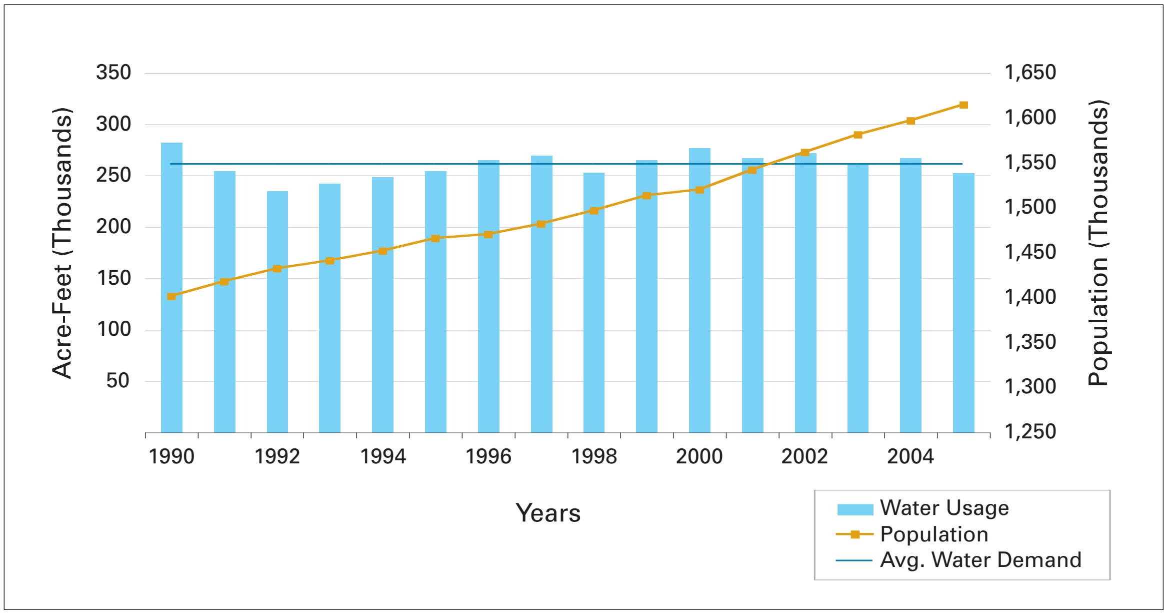
It is apparent that the trend of lower per capita water usage through time, with assistance from MWD and its member agencies, has been successful in continuing a water conservation ethic begun 15 years ago during the last major drought.

Table ES-1
Central Basin's Current and Projected Water Demand
(In Acre-Feet)

District Water Demands	2005[1]	2010	2015	2020	2025	2030
Retail Municipal & Industrial Use						
Groundwater[2]	186,549	202,000	202,000	202,000	202,000	202,000
Imported Water	61,033	59,091	64,691	70,462	74,409	82,535
Recycled Water[3]	5,217	12,900	14,150	15,400	16,650	17,900
Total Retail Demand	**252,799**	**273,991**	**280,841**	**287,862**	**295,059**	**302,435**
Replenishment Use						
Imported Water	27,758	27,600	27,600	27,600	27,600	27,600
Recycled Water	50,000	50,000	50,000	50,000	50,000	50,000
Total Replenishment Demand	**77,758**	**77,600**	**77,600**	**77,600**	**77,600**	**77,600**
TOTAL DEMAND	**330,557**	**351,591**	**358,441**	**365,462**	**372,659**	**380,035**

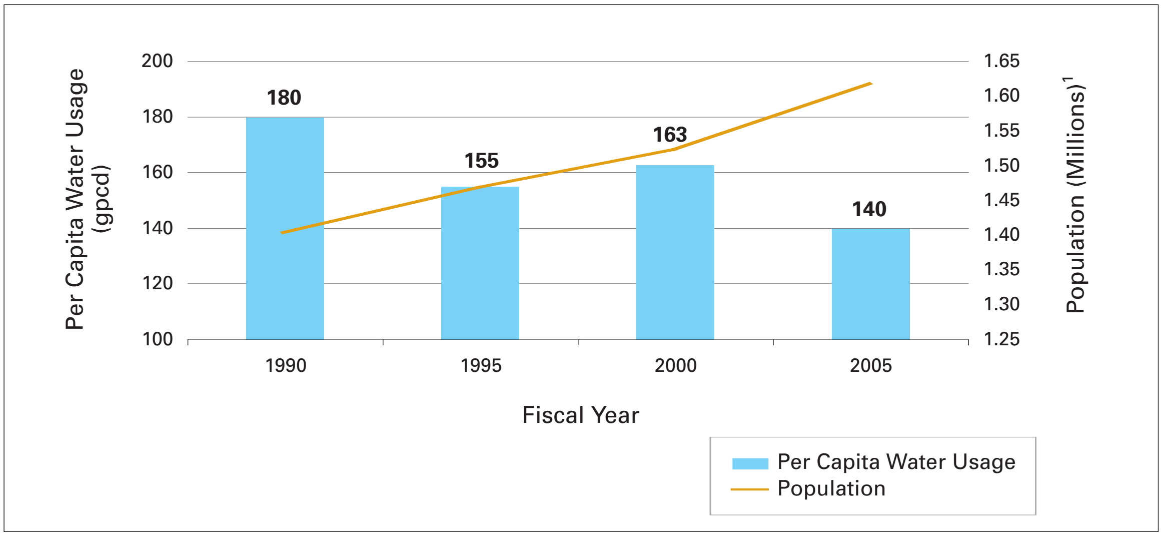
[1] The 2005 demands are based on the 2004-05 year, which is also considered one of the "wettest" years on record.
[2] Includes groundwater production from the Central and Main San Gabriel Basins (est. 42,000 AF).
[3] Includes recycled water sales from Central Basin's service area and Cerritos Water Systems.

Figure ES-1
Historical Retail Demand Compared to Population



Source: CBMWD water use database and MWD Demographic Data, 2005.

Figure ES-2
Per Capita Water Usage, 2001 - 2005



Source: CBMWD water use database
[1] Information based on MWD Demographic Data, 2005.

WATER SUPPLY

Central Basin currently relies on approximately 90,600 AFY of imported water from the State Water Project (SWP) and the Colorado River through MWD to meet the District's retail and replenishment demands. While groundwater supplies remain a significant source of water (68%) for customer agencies in the Central Basin service area, imported water supplements this resource (22%) and assists to mitigate the over-pumping of the groundwater basin. Recycled water is added to the supply mix, serving up to 2% of the area's demands, while conservation rounds out the equation at 8%.

Table ES-2 shows current (2005) and projected (2030) supplies within Central Basin's service area, with imported and recycled water being provided by Central Basin.

PLANNING FOR INCREASED DIVERSIFICATION

Given the critical importance of water to the region's growth, economic health and quality of life, the desirable quantity and mix of supply must be planned well in advance of the actual need. Implementing water projects and changing behavior and attitudes regarding water usage are lengthy and complex endeavors. While the UWMP Act requires a 20-year planning horizon for water reliability, Central Basin has used a 25-year planning horizon to ensure a minimum 20-year planning period each year until the next 5-year update of the District's UWMP.

Although implementation of supply targets is challenging, Central Basin's approach is straightforward: continue to reduce the risk of future shortage by distributing the responsibility for supply among several, well-balanced options. Central Basin's projected supply portfolio for 2030, as compared to the current mix, is shown in Figure E-3 on page ES-6.

Central Basin's diversification plan includes expansion of the District's recycled water system, increased conservation efforts and groundwater storage opportunities. The District's future dependence on traditional sources of water (groundwater and imported) will continue to decrease with the expansion of these alternative resources. During the next 25 years, conservation is expected to have a significant dampening effect on retail water demand, lowering projected water use by roughly 58,400 AF in 2030.

Central Basin's ambitious 2030 target for conservation will be directed by a Conservation Master Plan (completion in 2006) that will identify the programs, strategies and actions that will guide policy development and commitment of resources in the future.

Likewise in 2006, Central Basin will complete the update of its Recycled Water Master Plan. This effort will provide the basis for completion of the recycled water distribution system and the fulfillment of its full potential to offset the use of imported water. The future Southeast Water Reliability Project will connect the existing Rio Hondo and Century systems across the northern portion of the service area. The project will increase flow and pressure in many areas not adequately served today, reach a large new customer base in several cities

Table ES-2
Current and Projected Water Supplies
(In Acre-Feet)

District Water Supplies	2005[1]	2030
Groundwater	186,549	202,000
Imported Water	61,033	82,535
Recycled Water	5,217	17,900
Total	**252,799**	**302,435**
Conservation	21,100	58,400
Total	**273,899**	**360,835**

[1] The 2005 demands are based on the 2004-05 year, which is also considered one of the "wettest" years on record.

within the service area and enable new partnerships with neighboring agencies that wish to extend Central Basin's system into their service areas.

WATER SUPPLY RELIABILITY

During consecutive dry years, southern California has historically seen demands increase by as much as 20% while supplies have decreased. Prior to recent significant improvements in water reliability, most cities and agencies were forced to mandate conservation efforts and restrict water use in some cases in order to maintain an adequate supply. Enormous strides made by MWD, Central Basin and the entire water supply community in southern California to increase locally-developed supplies and conservation as well as imported water storage and transfers during the past decade have increased the overall supply reliability during extended dry periods.

MWD's 2005 Regional UWMP demonstrates reliability of supply in all hydrologic conditions through the year 2030. In fact, the plan shows a surplus of supply in nearly all conditions. MWD planning initiatives to ensure water supply reliability include the IRP, the Water Surplus and Drought Management Plan (WSDM Plan) and local resource investments. These initiatives provide a framework for MWD and its member agencies to manage their water resources to meet growing demands.

Through its investments into supply diversification, support of the region's IRP and the collaborative efforts with MWD, Central Basin projections show that supplies will adequately meet service area demands in normal, single-dry and multiple dry-year scenarios as well as other water shortage emergencies.

Regionally, alternative water supplies are being explored, studied and in some cases, implemented to enhance the area's water supply reliability. In addition to recycled water, alternative water supply projects include conjunctive use groundwater storage, water transfers and exchanges, and ocean and groundwater desalination. Central Basin supports the ongoing efforts of these programs.

WATER CONSERVATION

Since the drought of the 1990s, Central Basin has been a leader implementing aggressive water conservation programs to help limit water demand in its service area. District programs have included a strong emphasis on education and the distribution of rebate incentives and plumbing retrofit hardware. The results of these programs, in conjunction with passive conservation measures such as modifications to the plumbing and building codes, have resulted in significant reductions in water use. By current estimates, demand management conservation saves more than 6.9 billion gallons of imported water every year. This represents the average water use of almost 30,000 families in southern California.

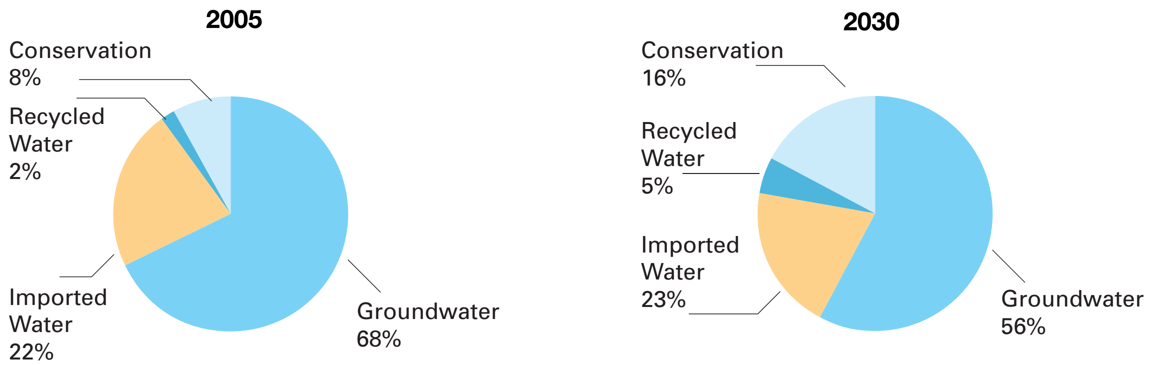
Central Basin water conservation programs follow the recommended 14 Best Management Practices (BMPs) according to the California Urban Water Conservation Council. For fiscal year 2005-06, Central Basin will complete a Conservation Master Plan that will guide the District to meet or exceed the goals of the BMPs and MWD's Conservation Strategy Plan. The plan will assess the conservation potential and incorporate local stakeholder input into a group of actions and strategies for achieving long-term targets for conservation.

RECYCLED WATER

Recycled water is one of the cornerstones of Central Basin's efforts to augment local supplies and reduce dependence on imported water. Since the initial planning and construction of Central Basin's water recycling in the early 1990s, Central Basin has become a leader in producing and marketing recycled water. This new supply of water assists in meeting the demand for non-potable applications such as landscape irrigation, commercial and industrial processes, and seawater intrusion barriers. With more than 200 site connections, Central Basin is projected to deliver 5,000 AF both inside and outside of the District's service area in fiscal year 2005-06.

In addition to Central Basin, other agencies distribute recycled water within the District's service area. These agencies include the City of Cerritos, City of Lakewood and WRD. WRD uses recycled water to help replenish the groundwater basin and halt sea-

Figure ES-3
Comparison of Water Supply Portfolio
2005 vs. 2030



water intrusion. Central Basin purchases recycled water from both the Los Coyotes and San Jose Creek Water Reclamation Plants (WRPs) for distribution within its service area. The WRPs together produce approximately 137 MGD of tertiary-treated effluent, nearly 40% of which Central Basin and agencies within the service area reused in 2000.

Central Basin's recycling program includes the E. Thornton Ibbetson Century Recycled Water Project (Ibbetson Century Project) and the Esteban E. Torres Rio Hondo Recycled Water Project (Torres Project). Both projects deliver recycled water for landscape irrigation and industrial uses.

The Ibbetson Century Project began delivering recycled water in 1992 and now delivers tertiary-treated recycled water from the Los Coyotes WRP, serving 11 cities. In 1994, the recycled water system extension, the Torres Project, reached into the northern portion of Central Basin's service area. The Torres Project delivers tertiary-treated recycled water from San Jose Creek WRP and serves eight cities.

Central Basin anticipates recycled water use sales to increase in the future as more customers switch from potable water to recycled water due to the reliability of the supply and the economic incentives associated with the conversion. Table ES-3 summarizes the current and projected demands for recycled water within Central Basin.

Central Basin's Water Recycling Master Plan Update, slated for completion in 2006, will include future potential sites and users and help secure the alignment for the proposed Southeast Water

Table ES-3
Projected Recycled Water Used within Central Basin Service Area
(In Acre-Feet)

	2005[1]	2010	2015	2020	2025	2030
Central Basin						
Century/Rio Hondo Projects	3,150	10,500	11,750	13,000	14,250	15,500
Total	**3,150**	**10,500**	**11,750**	**13,000**	**14,250**	**15,500**
Other Programs within Central Basin						
City of Cerritos	1,714	1,950	1,950	1,950	1,950	1,950
City of Lakewood	352	450	450	450	450	450
WRD (Replenishment Spreading)	50,000	50,000	50,000	50,000	50,000	50,000
Total	**52,067**	**52,400**	**52,400**	**52,400**	**52,400**	**52,400**
Central Basin's Service Area Total	**55,217**	**62,900**	**64,150**	**65,400**	**66,650**	**67,900**

[1] The 2005 demands are based on the 2004-05 year, which is also considered one of the "wettest" years on record.

Reliability Project (SWRP). This project will "loop" the overall system and connect the Rio Hondo and Century projects and benefit an additional six cities. When operational in 2009, the SWRP will ultimately serve an additional 5,500 AFY of recycled water.

WATER QUALITY

Water quality regulations are an important factor in Central Basin's water management activities. Imported water quality is the responsibility of MWD to comply with State and Federal drinking water regulations. Purveyors that Central Basin sells imported water to are responsible for ensuring compliance in their individual distribution systems and at the customer tap. MWD maintains a rigorous water quality monitoring program and is also proactive in protecting its water quality interests in the SWP and the Colorado River through active participation. Imported water meets or exceeds all drinking water standards set by the California Department of Health Services.

Water quality of the Basin is continually monitored by both Central Basin and WRD. Challenges to water quality include potential contamination from adjacent basins, the Basin's susceptibility to seawater intrusion and the migration of shallow contamination into deeper aquifers. WRD and Central Basin have several active programs to monitor, evaluate and mitigate water quality issues.

Central Basin actively assists retail agencies in its service area in meeting drinking water standards through its Cooperative Basin-Wide Title 22 Groundwater Quality Monitoring Program. Central Basin offers this program to water agencies for wellhead and reservoir sample collection, water quality testing and reporting services.

Another potential water quality concern for the Basin is the presence of perchlorate, trichloroethylene and perchloroethylene in the San Gabriel Valley aquifer. In accordance with the plan to "clean up" the contaminated groundwater before it migrates to the Central Groundwater Basin, Central Basin has completed and is successfully operating extraction and treatment facilities that not only protect the local Basin but also recover potable water for distribution to retail agencies in the vicinity.

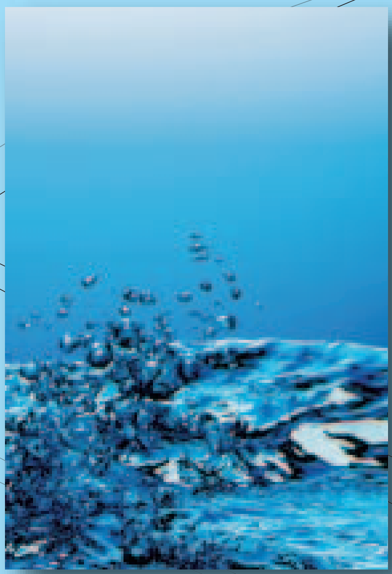
Recycled water meets Title 22 standards through tertiary treatment. Central Basin relies on the Sanitation District of Los Angeles County to meet all applicable State and Federal water quality regulations for recycled water it purchases and distributes through its two systems.

WATER RATES AND CHARGES

In 2002, MWD adopted a new rate structure to support its strategic planning vision as a regional provider of services, incentivize the development of local supplies like recycled water and conservation, and encourage long-term planning for imported water demand. To achieve these objectives, MWD called for voluntary purchase orders from its member agencies, unbundled its water rates, established a tiered supply rate system and added a capacity charge. In all, these new rate structure components have provided a better opportunity for MWD and its member agencies to manage their water supplies.

MWD's 2002 rate structure changes were passed through to Central Basin's customer agencies in a manner that preserved the water management benefits while minimizing financial impacts. With the purchase order and tiered supply rate elements, Central Basin has successfully implemented a conservation-based structure that encourages agencies to stay within their annual water budget and uses revenue from agencies that exceed their water budget to fund service-area wide conservation studies and programs. Central Basin also assesses a capacity charge at the retail level designed to recover the cost of MWD's capacity charge. In addition to the pass-through elements of MWD's rate structure, Central Basin's rates include a volumetric administrative surcharge and a fixed water service charge.

Since 1992, Central Basin has encouraged the maximum use of recycled water through the economic incentive of its rates and charges. Central Basin recycled water commodity rates cover the operation, maintenance, labor and power costs associated with the delivery of recycled water. These rates are set up in a declining tiered structure and are maintained at a significant reduction to imported water so they may further encourage the use of recycled water.



Section 1

Introduction

1
Introduction

1.1 PURPOSE AND UWMP SUMMARY

An Urban Water Management Plan (UWMP or Plan) prepared by a water purveyor is to ensure the appropriate level of reliability of water service sufficient to meet the needs of its various categories of customers during normal, single dry or multiple dry years. The California Urban Water Management Planning Act of 1983 (Act), as amended, requires urban water suppliers to develop an UWMP every five years in the years ending in zero and five.

The legislature declared that waters of the state are a limited and renewable resource subject to ever increasing demands, that the conservation and efficient use of urban water supplies are of statewide concern, that successful implementation of plans is best accomplished at the local level, that conservation and efficient use of water shall be actively pursued to protect both the people of the state and their water resources, that conservation and efficient use of urban water supplies shall be a guiding criterion in public decisions and that urban water suppliers shall be required to develop water management plans to achieve conservation and efficient use.

Central Basin Municipal Water District's (District) 2005 UWMP has been prepared in compliance with the requirements of the Act, as amended to 2005[1] (Appendix A), and includes the following:

- *Water Wholesale Service Area*
- *Water Demands*
- *Water Sources and Supplies*
- *Water Reliability Planning*
- *Water Quality Information*
- *Water Demand Management Measures*
- *Water Shortage Contingency Plan*
- *Water Recycling*

1.2 URBAN WATER MANAGEMENT PLAN UPDATE PREPARATION

The District's 2005 UWMP revises the 2000 UWMP prepared by the District and incorporates changes enacted by legislation, including SB 610 (2001), AB 901 (2001), SB 672 (2001), SB 1348 (2002), SB 1384 (2002), SB 1518 (2002), AB 105 (2004) and SB 318 (2004). The UWMP also incorporates water use efficiency efforts the District has implemented or is considering implementing pursuant to the Memorandum of Understanding Regarding Urban Water Conservation in California (MOU).[2] The District was one of the first agencies to become signatory to the MOU in September 1991.

The sections in this Plan correspond to the outline of the Act, specifically Article 2, Contents of Plans, Sections 10631, 10632 and 10633. The sequence used for the required information, however, differs slightly in order to present information in a manner reflecting the unique characteristics of the District. The Department of Water Resources Review for Completeness form has been completed, which identifies the location of Act requirements in this Plan and is included as Appendix B.

1.2.1 PLAN ADOPTION

The 2005 UWMP was adopted by a resolution of the District's Board of Directors in December 2005, following a public hearing. The Plan was submitted to the California Department of Water Resources within 30 days of Board approval. Copies of the Notice of Public Hearing and the Resolution of Plan

[1] California Water Code, Division 6, Part 2.6; §10610, et. seq. Established by Assembly Bill 797 (1983).

[2] The Memorandum of Understanding Regarding Urban Water Conservation in California (MOU) was adopted in September 1991 by a large number of water suppliers, public advocacy organizations and other interested groups. It created the California Urban Water Conservation Council and established 16 Best Management Practices (BMPs) for urban water conservation, recently refined to 14 BMPs. The District became signatory to the MOU in September 1991.

Table 1-1
Coordination with Appropriate Agencies

	Participated in UWMP Development	Commented on the Draft	Attended Public Meetings	Provided Assistance	Received Copy of Draft	Sent notice of intention to adopt
Regional Water Agency	Metropolitan Water District of Southern California	✔	✔		✔	✔
Customer Agencies	Bellflower-Somerset Mutual Water Co	✔	✔	✔	✔	✔
	California American Water Company			✔	✔	✔
	California Water Service Company	✔		✔	✔	✔
	City of Bell Gardens*				✔	✔
	City of Cerritos	✔	✔	✔	✔	✔
	City of Commerce	✔		✔	✔	✔
	City of Downey	✔		✔	✔	✔
	City of Huntington Park		✔	✔	✔	✔
	City of Lakewood	✔	✔	✔	✔	✔
	City of Lynwood			✔	✔	✔
	City of Montebello	✔		✔	✔	✔
	City of Norwalk	✔		✔	✔	✔
	City of Paramount		✔	✔	✔	✔
	City of Pico Rivera			✔	✔	✔
	City of Santa Fe Springs	✔	✔	✔	✔	✔
	City of Signal Hill*				✔	✔
	City of South Gate			✔	✔	✔
	City of Vernon			✔	✔	✔
	City of Whittier			✔	✔	✔
	County of Los Angeles-Rancho Los Amigos			✔	✔	✔
	La Habra Heights County Water District*				✔	✔
	Maywood Mutual Water Co. #1*				✔	✔
	Maywood Mutual Water Co. #2*				✔	✔
	Maywood Mutual Water Co. #3*				✔	✔
	Montebello Land & Water Co.			✔	✔	✔
	Orchard Dale Water District	✔		✔	✔	✔
	Park Water Company	✔	✔	✔	✔	✔
	Pico Water District			✔	✔	✔
	San Gabriel Valley Water Company			✔	✔	✔
	South Montebello Irrigation District			✔	✔	✔
	Southern California Water Company	✔	✔	✔	✔	✔
	Suburban Water Systems			✔	✔	✔
	Walnut Park Mutual Water Company*				✔	✔
	Water Replenishment District*	✔	✔		✔	✔

* Agencies were not required to do a 2005 Urban Water Management Plan.

Adoption are included in Appendix C. Copies of the Plan were made available to the public within 30 days following Board approval.

1.2.2 AGENCY COORDINATION

A notice of preparation for the 2005 UWMP Update was prepared and sent to the Metropolitan Water District of Southern California (MWD), the County of Los Angeles and all of the District's various cities and customer agencies, as shown in Table 1-1. The Notice of Preparation is included in Appendix D.

Development of this Plan was performed by District staff in coordination with its water purveyors and the MWD. District staff has met with many of its customer agencies to discuss the UWMP, answer questions related to the UWMP and/or projects occurring throughout the service area, and provide assistance when requested. Staff provided many of its agencies with conservation data that they were able to use in their conservation section of the UWMP.

The District is a water wholesaler and is fully dependent on MWD for its imported water supplies to its service area. This UWMP details the specifics as they relate to the District and its service area and will refer to MWD throughout the document. The District held two UWMP workshops, one in January 2005 for the public, in coordination with MWD and the California Urban Water Conservation Council, and the other in June 2005 for the District's water purveyors. Further, MWD held multiple UWMP information meetings for stakeholders and the public throughout its service area during the months of June and July 2005. On August 24, 2005, MWD held an additional Public Information Meeting at the Southern California Water Dialogue monthly forum. The Southern California Water Dialogue participants meet voluntarily to explore water-related issues of vital interest to the Southern California region.

The UWMP is intended to serve as a general, flexible and open-ended document that periodically can be updated to reflect changes in the region's water supply trends as well as conservation and water use efficiency policies. This Plan, along with the District's other planning documents, will be used by District staff to guide the service area's water use and management efforts through the year 2010, when the UWMP is required to be updated.

1.3 THE DISTRICT'S SERVICE AREA

1.3.1 BACKGROUND

The District was established by a vote of the people in 1954 to help mitigate the overpumping in the Central Groundwater Basin (Basin). Central Basin's founders realized they would have to curtail the use of pumping by providing the region with imported water. Therefore, Central Basin joined MWD to purchase, on a wholesale level, potable water imported from the Colorado River and the SWP and then sell it to the local municipalities, investor-owned and mutual water companies and districts. As a water supplier, MWD provides the Southern California region with a reliable supply of imported water. Central Basin remains one of the largest member agencies in MWD's family of wholesalers.

Today, Central Basin wholesales potable water to 24 cities, mutual water companies, investor-owned utilities, water districts and private companies in the region. In addition, the District supplies recycled water to the region for municipal, commercial and industrial use. Central Basin supplies imported and recycled water to its customer agencies to help reduce their reliance on groundwater supplies.

Central Basin is governed by a five member elected Board of Directors from within the service area of the District. Each Director serves a four-year term once elected. The Board of Directors guides the mission and policy of the District. Also, Central Basin's Board of Directors appoints two representatives to serve on the 37-member MWD Board of Directors. Central Basin's representation on the MWD Board is critical to shaping a regional voice on water issues.

1.3.2 DISTRICT'S SERVICE AREA

Central Basin's service area covers approximately 227 square miles and includes 24 cities and several unincorporated areas in Los Angeles County. Approximately 1.61 million people are served within Central Basin's service area. The cities and their associated divisions include:

Division 1:
Bell Gardens, Downey, Montebello, Norwalk and Vernon

Division 2:
La Habra Heights, La Mirada, Pico Rivera, Santa Fe Springs and Whittier

Division 3:
Bell, Commerce, Huntington Park, Maywood, portions of Monterey Park and areas of unincorporated East Los Angeles

Division 4:
Portions of Carson and Cudahy, Lynwood, South Gate, Florence-Graham and Willowbrook

Division 5:
Artesia, Bellflower, Cerritos, Hawaiian Gardens, Lakewood, Paramount and Signal Hill

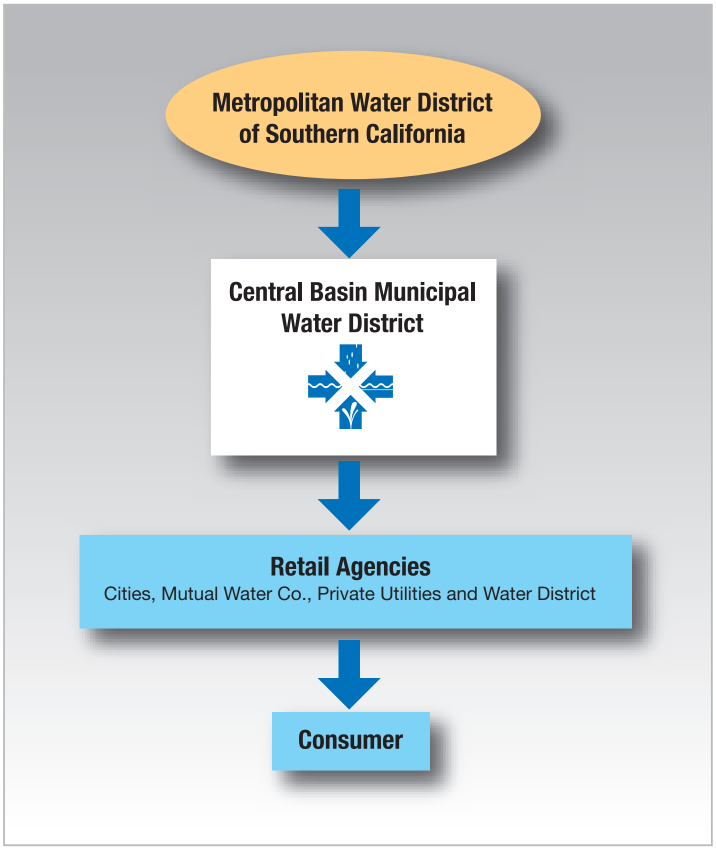
1.3.3 RELATIONSHIP TO METROPOLITAN WATER DISTRICT

Realizing that the Basin could not meet the overlying demand for water in the early 1950s, the cities' leaders and residents formed the District to petition for annexation to the MWD family in order to receive supplemental imported water.

The District plays an important role in managing the imported supplies for the region. Through various programs and projects, the District ensures that its residents have a safe and reliable supply of water.

Figure 1-1 shows the supply chain, which illustrates the relationship the District plays to its customer agencies. The District is the voice and representative of its customers to MWD. As such, the District takes great pride in knowing that its retailers are receiving a safe and reliable supply of drinking water.

Figure 1-1
Imported Water Supply Chain



Section 2

Water Demand

2

Water Demand

This section describes current and future water demand trends within Central Basin's service area

2.1 OVERVIEW

Today, the total water demand for the 1.61 million people living within Central Basin's service area is approximately 280,400 acre-feet (AF) with replenishment demand making up 27,600 AF. One acre-foot equals 326,000 gallons and serves the annual water needs of two families. In 1980, Central Basin's population was 1.22 million and the service area's water demand was 260,960 AF. In those 25 years, Central Basin's retail water demand has grown 7.4% while population has grown 30%. One of the contributing factors to this low growth in demand has been in large part because of conservation and education efforts by the water community.

In the last five years, Central Basin's water demand has increased by only 1% while population has increased by more than 5%. This gradual increase in water usage is attributed to Central Basin's efforts in education and promotion of water conservation as well as incentives for people to retrofit their homes and businesses with more efficient water use devices.

Despite the flattening demand trend, water use will continue to increase. However, projections show that Central Basin's water usage is expected to increase roughly 0.5% per year during the next 25 years, as illustrated in Table 2-5 on page 2-8.

This section will explore in greater detail Central Basin's population trends and historical and current water demands as well as offer some insight into expected future water demands for the next 25 years.

2.2 CLIMATE CHARACTERISTICS

Central Basin's service area lies in the heart of Southern California's coastal plain. The climate is Mediterranean, characterized by typically warm, dry summers and wet, cool winters with an average precipitation level of approximately 14.9 inches per year[1]. The combination of mild climate and low rainfall makes the area a popular residential destination, creating a challenge for water agencies in meeting for increasing water demands with a limited water supply.

Areas with low precipitation, such as Southern California, are typically vulnerable to droughts. Historically, Central Basin has experienced some severe dry periods (Droughts of 1977-78 and 1989-92) and until recently the Los Angeles region had the five driest years on record (1999-2004). In fact, anything less than the average yearly rainfall causes concern for water agencies. Central Basin has been actively pursuing and accomplishing these water saving techniques for the last 15 years to ensure adequate future water reliability.

Table 2-1 illustrates the climate characteristics for the Los Angeles region, taken at both the Long Beach Station and the Montebello Station, for the period between 1979 and 2004 (25 years) including standard monthly average ETo[2] (Long Beach Station), the average rainfall (Montebello Station) and the average temperature (Montebello Station). In comparison to other cities with an abundant supply of precipitation each year, the low rainfall in this region invariably challenges Central Basin to provide sufficient, reliable, quality water to meet the area's increasing water needs. The average precipitation for the last 25 years is approximately 16.02 inches, indicating the need for water conservation in an area with a water demand that will continue to grow as urban infiltration continues to rise.

1 According to the National Weather Service

2 Evapotranspiration is the water lost to the atmosphere by two processes-evaporation and transpiration. Evaporation is the loss from open bodies of water, such as lakes and reservoirs, wetlands, bare soil and snow cover; transpiration is the loss from living-plant surfaces.

Table 2-1
Climate Characteristics - Los Angeles Region
Period 1/1/1979 to 12/31/2004

	Jan	Feb	Mar	Apr	May	June
Standard Monthly Average Eto[1]	1.65	2.15	3.59	4.77	5.12	5.71
Average Rainfall (inches)[2]	3.71	4.07	3.19	0.94	0.24	0.07
Average Temperature (Fahrenheit)[2]	69.4	71.1	72.7	77.8	79.4	83.7

	July	Aug	Sept	Oct	Nov	Dec	Annual
Standard Monthly Average Eto	5.93	5.91	4.39	3.22	2.18	1.68	**46.3**
Average Rainfall (inches)	0.02	0.02	0.20	0.32	1.28	1.96	**16.02**
Average Temperature (Fahrenheit)	88.6	89.7	87.9	82.6	75.4	70.9	**79.1**

[1] Data taken from the California Irrigation Management Information System (CIMIS) at the Long Beach Station for the Los Angeles Region for Calendar Year 2004: http://www.cimis.water.ca.gov/cimis/welcome.jsp
[2] Data taken from the Western Regional Climate Center's web site at the Montebello Station: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?camont

2.3 DEMOGRAPHICS

Central Basin's service area encompasses 227 squares miles in southeast Los Angeles County, including 24 cities, water agencies, publicly-owned mutual water companies and publicly regulated utilities. This service area includes some of the most densely populated areas in the County. According to the 2000 U.S. Census Report and the Metropolitan Water District of Southern California's (MWD) demographics data, Central Basin has grown from 1.4 million people in 1990 to 1.61 million people today.

Based on MWD's demographic projections, population is expected to increase an average of 3.01% every five years for the next 25 years, or 0.64% annually. By 2030, Central Basin's population is expected to grow by more than 258,000 people. Table 2-2 displays the demographic projections for the next 25 years.

Table 2-2 also displays Central Basin's total households, which are expected to increase 19% by 2030, especially in the Multi-family category where households will increase by 48,000 people. As it relates to water demand, the availability of more households increases the demand on water supplies. As for employment, Central Basin is expected to see a 25% increase by 2030. As urban employment grows, so does the demand on water supplies.

2.4 HISTORICAL AND CURRENT WATER DEMANDS

The key factors that affect water demands are growth in population, increases in land use development, industrial growth and hydrology. However, since the end of the 1989-1992 drought, retail water demands in Central Basin's service area have remained fairly consistent. As illustrated in Figure 2-1, the Central Basin region has not seen significant increases in water demands during the past 15 years despite population growth at an average rate of 10,350 persons per year and continued in-fill development in the service area. Central Basin's FY 2004-05 retail water demand was 252,800 AF.

Total water use, or demand, within Central Basin's service area includes retail demand and groundwater replenishment. Retail demand is defined as all municipal (residential, firefighting, parks, etc.) and industrial uses, and represents the population's total direct water consumption. Replenishment uses, including deliveries to the saline barriers (Alamitos) or to the spreading grounds (Montebello), are not directly delivered to the public but enable continued groundwater production to help satisfy retail demand.

Table 2-2
Demographic Projections for Central Basin's Service Area[1]

Year	2005	2010	2015	2020	2025	2030
Population	**1,614,400**	**1,655,200**	**1,712,300**	**1,768,000**	**1,821,200**	**1,872,500**
Single-family	291,200	300,200	301,800	311,400	320,500	323,800
Multi-family	124,900	132,600	147,000	153,400	160,200	172,900
Total Household	**416,100**	**432,800**	**448,800**	**464,800**	**480,700**	**496,700**
Persons per Household	3.84	3.78	3.78	3.77	3.75	3.74
Employment	591,700	659,700	682,600	702,600	720,500	736,900

[1] Information based on MWD Demographic Data, 2005.
Note: All units are rounded to the nearest hundred; totals may not sum exactly due to rounding.

Figure 2-1 displays Central Basin's total retail water demand from FY 1990 to 2005. As previously discussed, retail demands have remained fairly consistent since 1995 following several years of increasing demands after the drought. The average retail demand for the past 15 years is 260,468 AF.

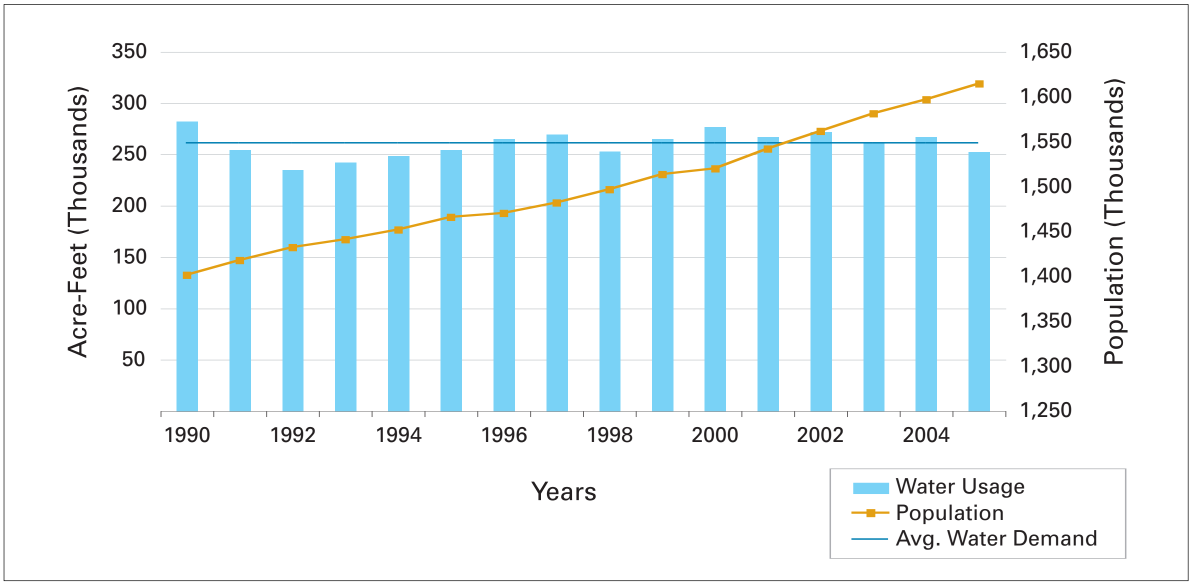
The District averaged 264,167 AF for the past five years, which is only 1.4% above the 15 year average.

Central Basin's service area is using the same amount of water as it did 10 years ago, despite the addition of 148,560 people. This indicates that water conservation and education has significantly affected the manner in which Central Basin's residents are using water today. We can further verify this by reviewing Central Basin's water usage per person in "Per Capita Water Usage."

2.4.1 HISTORICAL PER CAPITA WATER USAGE

According to the Pacific Institute[3], the State's total water usage is equivalent to 183 gallons per capita

Figure 2-1
Central Basin's Historical Total Retail Water Demand[1] vs. Population



[1] Information based on MWD Demographic Data, 2005.

3 Pacific Institute, Waste Not, Want Not: The Potential for Urban Water Conservation in California, 2003. pg. 4 per day (gpcd) for the nearly 34 million people living in California. Through conservation measures such as Ultra-Low-Flush Toilets (ULFT), High Efficiency Clothes Washers, low-flow showerheads, new technologies in water irrigation and education programs, Central Basin has gradually reduced Per Capita water usage.

For the last five years the usage has decreased to an average of 152 gallons per day gpcd. Figure 2-2 illustrates the retail water usage per capita for the last five fiscal years comparative to population in Central Basin's service area.

As displayed below, population has been steadily increasing in the last five years while Per Capita water usage decreased to 140 gpcd, verifying the notion that the District's current water resources efforts are meeting the growing water demands of today.

2.4.2 REPLENISHMENT DEMANDS

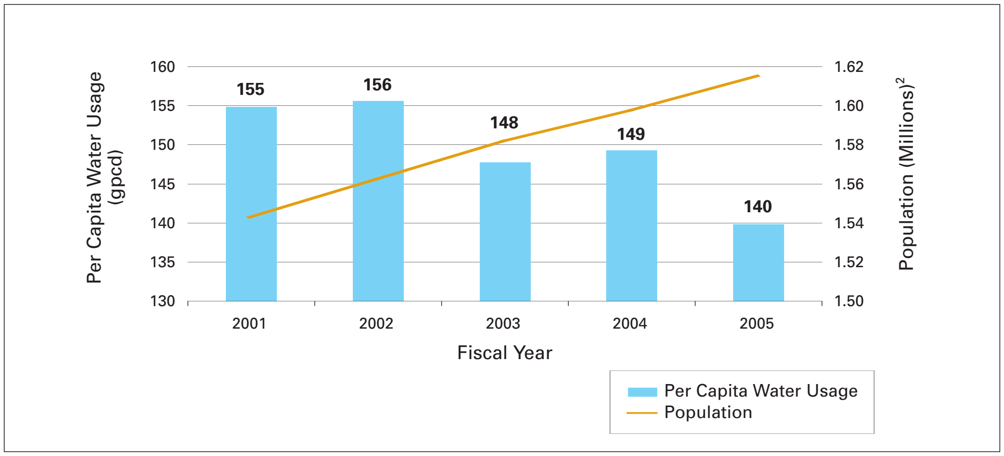
Replenishment water is defined as water that is used to refill or protect the groundwater basin. The Water Replenishment District of Southern California (WRD) is the entity responsible for maintaining and replenishing the West Coast and Central Groundwater Basins. WRD is a special district created by the State and governed by a five-member elected body to replenish and protect these groundwater basins with imported water and recycled water.

Spreading Demands

As groundwater is extracted annually beyond the natural level of replenishment known as basic yield, WRD purchases supplemental water to refill the basin and replenish the amount that is extracted above the basin yield. This replenishment water is a combination of allowable deliveries of recycled water and the purchases of untreated imported water.

As the imported wholesaler, Central Basin sells untreated imported water to WRD to be conserved at the Rio Hondo and San Gabriel River Spreading Grounds (Spreading Grounds) in the Montebello Forebay. Demands at the Spreading Grounds have varied year to year. As shown in Figure 2-3 on the opposite page, imported spreading purchases can range from 45,000 AF to 0 AF in any given year. The cause for variation can be the result of available seasonal water from MWD or operations, maintenance and construction activities at the

Figure 2-2
Historical Per Capita Retail Water Usage[1]



[1] Retail water usage includes groundwater, imported water and recycled water.
[2] Information based on MWD Demographic Data, 2005.

spreading grounds, or unpredictable replenishment needs of the Basin. For example, spreading water deliveries were limited in 1997-98 due to the "El Nino" effect, which brought on heavy rains that met the replenishment needs for the Basin. By contrast, the drought conditions in the region in 1990 increased the need for replenishment deliveries to reach more than 50,000 AF. Nevertheless, WRD's purchases average 27,000 AFY of imported water per year.

Rio Hondo Spreading Grounds. Courtesy of WRD.

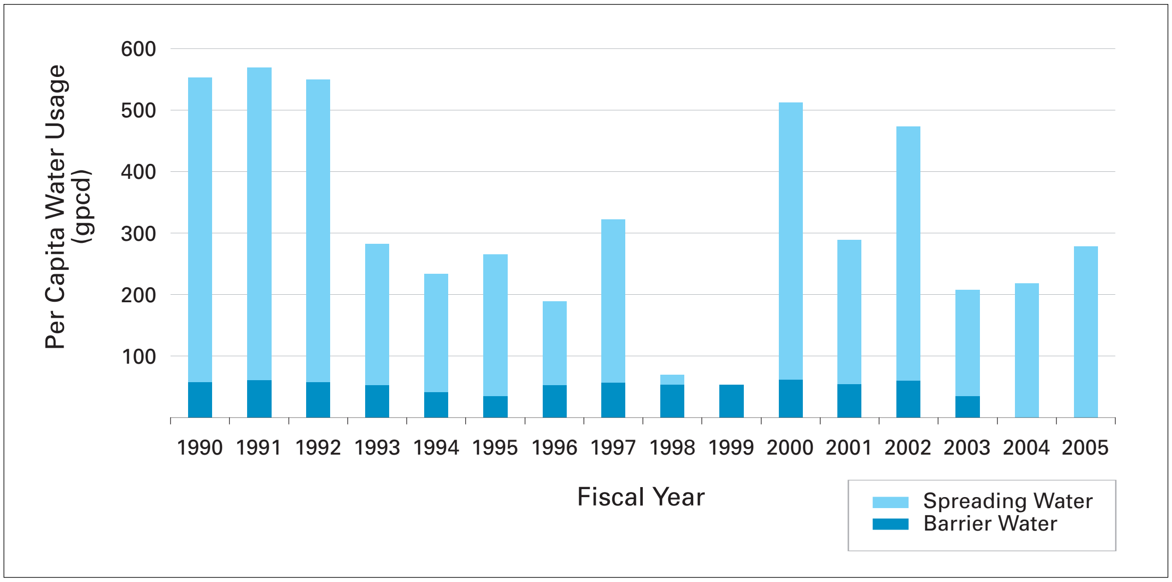
Barrier Demands

Unlike the Spreading Grounds, the demands at the Alamitos Barrier (Barrier) are mostly consistant year to year. This is mainly due to the required regular injection of imported water needed to prevent seawater intrusion from entering into the Basin. For the last 10 years, the average demand at the Barrier has been about 5,300 AF. However, in 2003 the City of Long Beach took over the connection that serves the Barrier with imported water, and Central Basin no longer supplies water to meet those demands. Looking forward, WRD plans to reduce imported demands at the Barrier by 3,000 AF, replacing it with the delivery of highly treated recycled water through WRD's new Leo J. Vander Lans Advanced Water Treatment Center located in Long Beach.

2.4.3 RETAIL WATER DEMAND BY CUSTOMER AGENCY

As mentioned above, Central Basin, as a wholesaler, has not seen significant increases in water demands for the past 10 years. However, local retail customer agencies have experienced

Figure 2-3
Replenishment Demands in Central Basin's Service Area



Source: Central Basin Wateruse Database, 2005

Table 2-3
Total Water Demand Per Central Basin Customer Agency
FY 1990-1995 vs. FY 2000-2005
(In Acre-Feet)

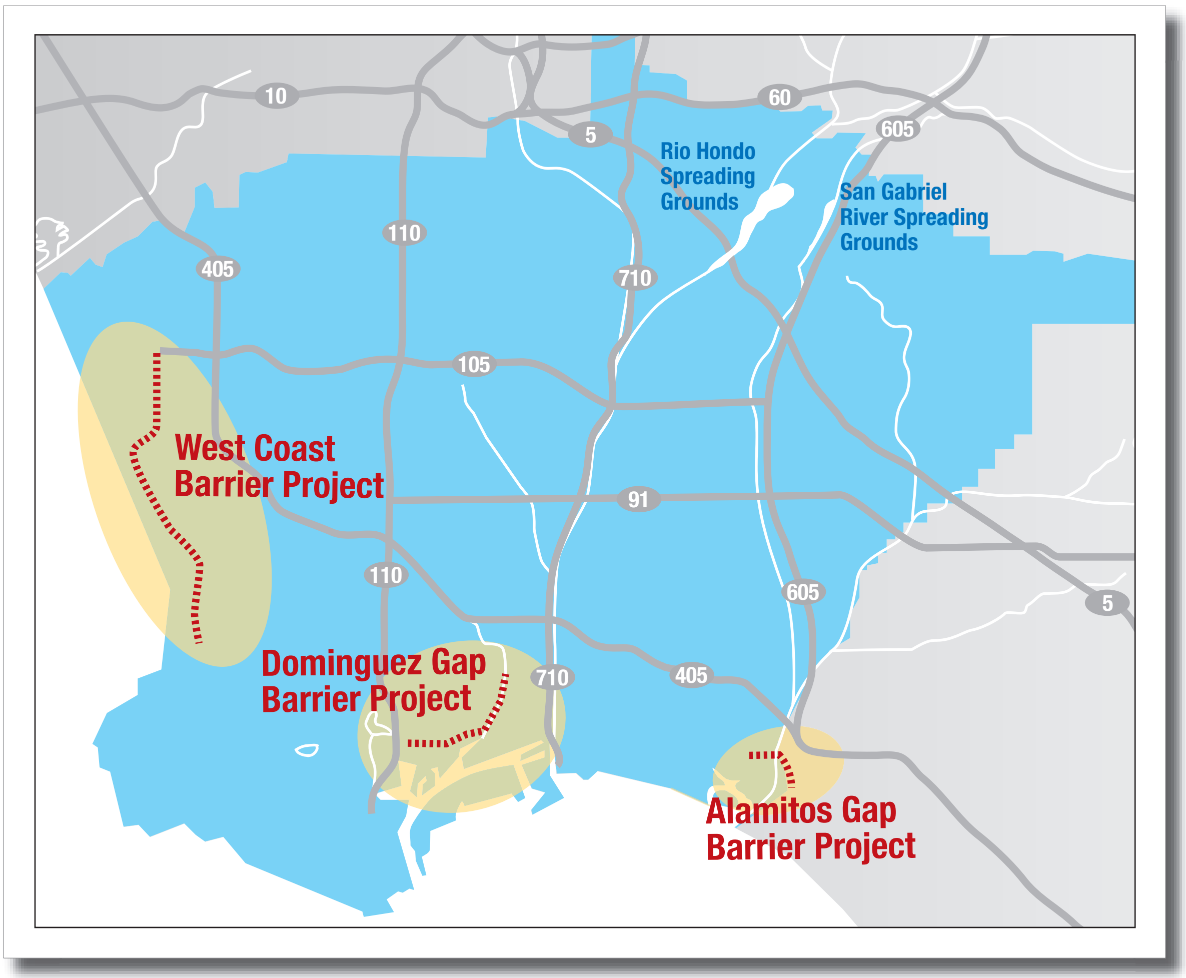
Customer Agency	1990-1995 Average Total Water Use	2000-2005 Average Total Water Use	% Increase/ (Decrease)
Bellflower- Somerset MWC	8,102	6,465	(20.2%)
Cal-Water- East LA	20,500	21,098	2.9%
Cal-Water- Commerce	2,663	2,689	1.0%
City of Bell Gardens	1,204	1,252	4.0%
City of Cerritos	12,239	14,644	19.7%
City of Downey	16,263	18,297	12.5%
City of Huntington Park	5,746	5,826	1.4%
City of Lakewood	8,733	9,545	9.3%
City of Lynwood	6,710	6,850	2.1%
City of Montebello	1,594	1,627	2.1%
City of Norwalk	1,358	1,564	15.2%
City of Paramount	7,407	7,923	7.0%
City of Santa Fe Springs	8,549	8,462	(1.0%)
City of Signal Hill	1,908	2,295	20.3%
City of South Gate	9,368	11,281	20.4%
City of Vernon	8,941	11,729	31.2%
LA Co. - Rancho Los Amigos	947	880	(7.1%)
La Habra Heights Water District	2,331	2,824	21.1%
Maywood MWC No.1	884	941	6.4%
Maywood MWC No.2	1,461	1,318	(9.8%)
Maywood MWC No.3	1,478	1,518	2.7%
Orchard Dale Water District	2,276	2,448	7.6%
Park Water Company	10,928	14,043	28.5%
San Gabriel Valley WC	5,255	3,555	(32.4%)
Southern California WC	30,256	29,998	(0.9%)
Suburban Water System	15,743	15,441	(1.9%)
Walnut Park Mutual WC	1,491	1,567	5.1%
Total	**194,335**	**206,080**	

changes in their overall water demand since 1990. Table 2-3, on the opposite page, illustrates the changes, either increases or decreases, in each retail customer agencies' average water usage during two different five-year periods since 1990.

Although some agencies have seen some dramatic shifts in water demand usage during the past 15 years, the overall average per customer agency saw a 5.5% increase in water demand. Some of the significant changes among customer agencies may be attributed to reductions and/or expansions in service area, an increase or decrease in industrial customers and/or further land use development.

2.5 PROJECTED WATER DEMANDS

One of the objectives of this Plan is to provide some insight into Central Basin's expected water demands for the next 25 years. The predictability of water usage is an important element in planning future water supplies. The methodology used to determine demand forecasting is a combination of historical water use analysis, population growth and commercial and residential development. Central Basin, with the assistance of MWD's forecasting model known as MWD-MAIN (Municipal and Industrial Needs) Water Use Forecasting System, is able to develop some well formulated water demand projections.



Courtesy of WRD.

Water Replenishment District service area and locations of spreading grounds and seawater intrusion barriers

The MWD-MAIN forecasting model determines expected urban water usage for the next 25 years. This model incorporates Census data, industrial growth, employment and regional development from regional planning agencies, such as SCAG (Southern California Association of Governments), to project water demands. It also features demands in sectors such as single family, multi-family, industrial, commercial and institutional usage for the region. MWD also takes into account current and future water management efforts, such as water conservation Best Management Practices (BMPs) and education programs.

Table 2-4 illustrates the current and projected retail water demands to the year 2030 for Central Basin under normal demand conditions.

As displayed below, the retail demand in Central Basin is expected to grow approximately 0.5% each year. Groundwater will remain consistent, due to the limited amount of extractable pumping rights within the basin, with imported and recycled water meeting the growth during the next 25 years.

2.5.1 PROJECTED PER CAPITA

As discussed previously, water demand is determined by the water usage per person. The future Per Capita usage shows how water demand is growing at a modest pace.

Table 2-5 shows a gradual decrease in Per Capita usage at a time when water has become a scarce commodity in a region where population is projected to increase. Although the total retail water usage continues to increase, the amount of water used per person will decline during the next 25 years. Essentially, more people are using less water.

Table 2-5
Projected Per Capita Retail Water Usage in Central Basin's Service Area

Year	Estimated Population[1] (Millions)	Retail Water Usage[2] (AF)	Per Capita (GPCD)
2010	1.655	273,991	148
2015	1.712	281,122	147
2020	1.768	287,400	145
2025	1.821	294,650	144
2030	1.873	301,900	144
		Average	**146**

[1] Information based on MWD Demographic Data, 2005.
[2] Retail Water Usage includes recycled water but does not include replenishment sales.

2.5.2 PROJECTED REPLENISHMENT DEMAND

Future replenishment demands are difficult to project because of the variation in operational changes and replenishment needs. WRD expects reduced deliveries of imported water at the Barrier with increased deliveries of recycled water.
Furthermore, there are projects currently being studied to increase the amount of storm and recycled water at the Spreading Grounds within the Central Basin. Any one of these projects can affect

Table 2-4
Central Basin's Current and Projected M&I Water Demand
(In Acre-Feet)

District Water Demands	2005[1]	2010	2015	2020	2025	2030
Retail Municipal & Industrial Use						
Groundwater[2]	186,549	202,000	202,000	202,000	202,000	202,000
Imported Water	61,033	59,091	64,691	70,462	76,409	82,535
Recycled Water[3]	5,217	12,900	14,150	15,400	16,650	17,900
Total	**252,799**	**273,991**	**280,841**	**287,862**	**295,059**	**302,435**

[1] The 2005 demands are based on the 2004-05 year, which was considered one of the "wettest" years on record.
[2] Includes groundwater production from the Central and Main San Gabriel Basins (est. 42,000 AF).
[3] Includes Recycled Water sales from Central Basin's service area and Cerritos Water Systems.

the projections of replenishment water demands. Below are the estimated replenishment demands during the next 25 years under normal conditions. Although replenishment demands may fluctuate year to year, the overall demand should stay relatively the same because groundwater production within the Central Basin is limited according to the allowable pumping rights each producer is allocated in the Central Basin. Furthermore, groundwater production is at or around its maximum amount; therefore, replenishment demands should not significantly increase.

Table 2-6
Projected Replenishment Demands
(In Acre-Feet)

District Water Demands	2005	2010	2015	2020	2025	2030
Replenishment						
Imported Water[1]	27,600	27,600	27,600	27,600	27,600	27,600
Recycled Water[2]	50,000	50,000	50,000	50,000	50,000	50,000
Total	**77,600**	**77,600**	**77,600**	**77,600**	**77,600**	**77,600**

[1] Imported water demands are based on the Water Replenishment District's projected estimate needs, although they may adjust depending upon groundwater production.
[2] Recycled water is limited to 50,000 AF according to the California Department of Health Service's permit which allows a maximum of 150,000 AF over three years.

Section 3

Water Supply

3

Water Supply

This section discusses the current and future water supply within Central Basin's service area

3.1 OVERVIEW

It is Central Basin's mission to ensure a safe, adequate and reliable supply of water for the region it serves. However, with a limited supply and growing demand for water, the task of meeting this mission is becoming increasingly challenging.

Sixty years ago the average customer agency in Central Basin relied completely on groundwater. Today, however, it relies on a more diverse mix of water resources: 68% groundwater, 22% imported, 2% recycled water (only M&I) and 8% conservation efforts. It is projected that by 2030, the resource mix on average will be 56% groundwater, 23% imported and 5% recycled water, with conservation meeting the remaining 16%. Diversification of water supplies has become one of the District's answers to ensuring a reliable supply of water for its service area.

This section provides an overview of the current and future water supplies needed to meet the expected demands of Central Basin, including a review of the District's current and projected water supply mix, a description of each water source on which Central Basin's customer agencies currently rely and expected future supplies that Central Basin is planning and/or developing to meet its region's future demands.

3.2 CENTRAL BASIN'S WATER SUPPLY PORTFOLIO

Since its formation in 1952, Central Basin has fulfilled its responsibility of providing its customer agencies with supplemental supplies to ensure reliability. Today, diversification is the key to an ample future supply of water throughout its service area. As illustrated in Figure 3-1, Central Basin's supply portfolio has changed through the years.

Similar to creating a balanced investment portfolio to reduce risk, the District plans to further diversify the water resource mix during the next 25 years with the expansion of the District's recycled water system, increased conservation efforts and groundwater storage opportunities. The District's dependence on traditional sources of water (groundwater and imported) will continue to decrease with the expansion of these alternative resources. Figure 3-1 and Table 3-1 show the historical, current and projected water supply portfolio that the District is anticipating meeting by the year 2030.

Figure 3-1
Historical, Current & Projected Water Supplies

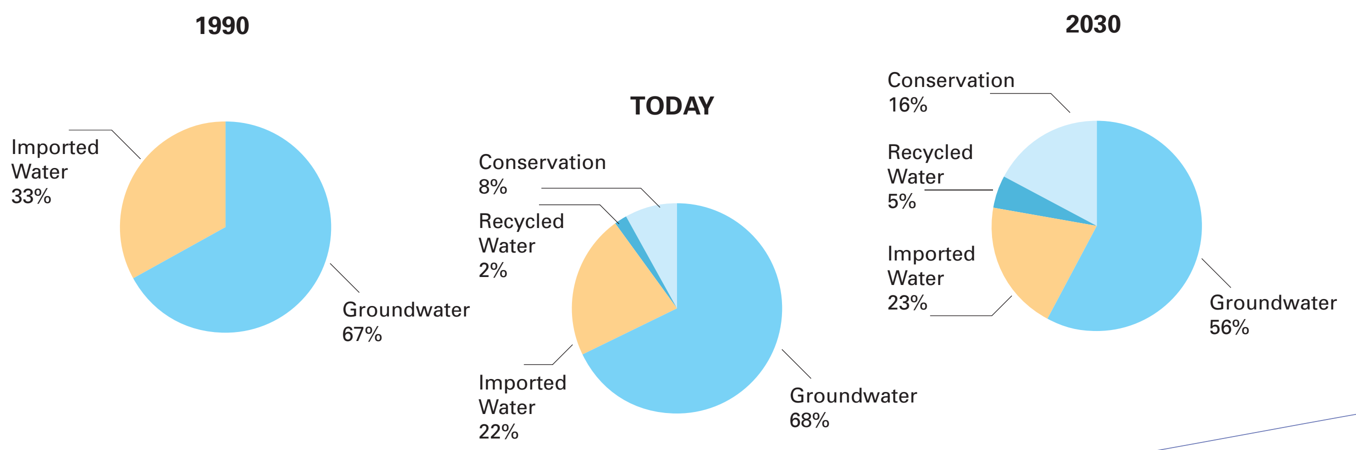


Table 3-1
Historical, Current & Projected Retail Water Supplies
(In Acre-Feet)

Type of Water		FY 1990	Today[1]	2030
Groundwater[2]		187,931	186,549	202,000
Imported Water[3]		94,059	61,033	82,535
Recycled Water[4]		-	5,217	17,900
	Total	**281,989**	**252,799**	**302,435**
Conservation[5]		-	21,100	58,400
	Total	**281,989**	**273,899**	**360,835**

[1] Sales based upon FY 2004-05.
[2] Groundwater production within Central Basin service area only, including imported groundwater production from Main San Gabriel Basin (Avg 42,000 AFY).
[3] Imported retail use only; does not include replenishment deliveries (i.e. Spreading or Barrier).
[4] Recycled retail use only; does not include replenishment deliveries (i.e. Spreading or Barrier).
[5] Conservation consists of active and passive savings according to the District's projected estimates.

3.3 CENTRAL BASIN'S WATER SOURCE

3.3.1 IMPORTED WATER SUPPLY

Central Basin relies on approximately 90,600 acre-feet per year (AFY) of imported water from the Colorado River and SWP to meet the District's retail and replenishment demands. MWD receives this supply from these two major water systems that supplies a majority of the Southern California region.[1]

Colorado River

MWD was established to develop a supply from the Colorado River. Its first mission was to construct and operate the Colorado River Aqueduct (CRA), which can deliver roughly 1.2 million acre-feet (MAF) per year. Under its contract with the federal government, MWD has a basic entitlement of 550,000 AF per year of Colorado River water. MWD also holds a priority for an additional 662,000 AF per year. MWD can obtain water under this priority when the U.S. Secretary of the Interior determines that either one or both of the following exists:

- surplus water; and/or
- water is apportioned to but unused by Arizona and/or Nevada.

MWD and the State of California have acknowledged that they could obtain less water from the Colorado River in the future than they have in the past, but the lack of clearly quantified water rights hindered efforts to promote water management projects. The U.S. Secretary of Interior asserted that California's users of Colorado River water had

1. *A third aqueduct to Southern California, the Los Angeles Aqueduct, supplies imported water from the eastern Sierra Nevada region to the City of Los Angeles.*

to limit their use to a total of 4.4 MAF per year, plus any available surplus water. The resulting plan, known as "California's Colorado River Water Use Plan" or the "California Plan," characterizes how California would develop a combination of programs to allow the state to limit its annual use of Colorado River water to 4.4 MAF per year plus any available surplus water. The Quantification Settlement Agreement (QSA) among the California agencies is the critical component of the California Plan. It establishes the baseline water use for each of the agencies and facilitates the transfer of water from agricultural agencies to urban uses.

In the context of the QSA, MWD has identified a number of storage and transfer programs that could be used to achieve long-term development targets for a full CRA and it has entered into or is exploring agreements with a number of agencies.

State Water Project

California's State Water Project (SWP), MWD's second main source of imported water, is the nation's largest state-built water and power development and conveyance system. It includes facilities-pumping and power plants, reservoirs, lakes and storage tanks, and canals, tunnels and pipelines that capture, store and convey water from the Lake Oroville watershed in Northern California to 29 water agencies in Central and Southern California. Planned, designed, constructed and now operated and maintained by the California Department of Water Resources (DWR), this unique facility provides water supplies for 23 million Californians and for 755,000 acres of irrigated farmland.

The original State Water Contract called for an ultimate delivery capacity of 4.2 MAF, with MWD holding a contract for 2,011 MAF. More than two-thirds of California's drinking water, including all of the water supplied by the SWP, passes through the San Francisco- San Joaquin Bay-Delta (Bay-Delta). For decades, the Bay-Delta system has experienced water quality and supply reliability challenges and conflicts due to variable hydrology and environmental standards that limit pumping operations.

In 1999, MWD's Board of Directors set new goals for the SWP with the adoption of its CALFED Policy Principles. These goals committed MWD to water quality objectives, the development of 0.65 MAF minimum dry-year supply from the SWP by 2020 and average annual deliveries of 1.5 MAF (excluding transfers and storage programs along the SWP). To achieve these goals while minimizing impacts to the Bay-Delta ecosystem, MWD would maximize deliveries to storage programs during wetter years, implement a number of source water qualities and supply reliability improvements in the Delta, remove operational conflicts with the Central Valley Project (CVP) and better coordinate planning and operations between the SWP and CVP.

Types of Imported Supplies

MWD offers different types of imported water to its member agencies depending on the ultimate use. Among them, Central Basin has delivered Non-Interruptible Water (treated full-service), Seasonal Treated Replenishment Water and Seasonal Untreated Replenishment Water.

Non-Interruptible Water is the treated firm supply that is available all year round. Central Basin delivers an average of 63,000 AFY of non-interruptible water annually. It is used as the main supplemental supply of cities and water agencies and has historically been used as the main supply for the Alamitos Barrier; however, the City of Long Beach now provides water for that barrier.

Seasonal Treated Replenishment Water, also known as the "In-Lieu" water, is delivered to customer agencies that are eligible to offset groundwater production with imported water. This program incentivizes customer agencies to take imported surplus water which indirectly replenishes the groundwater basin. This surplus water is purchased at a discount rate in exchange for leaving groundwater in the basin for no less than a year so that it can be used subsequently during dry years.

Seasonal Untreated Replenishment Water, better known as "Spreading" water, is delivered to the replenishment spreading grounds in the Montebello Forebay. Spreading water does not require treatment and is generally provided during the seasonal months (October through April), which allows for it to be purchased at a discounted rate. WRD is the sole purchaser of spreading water, and the amount varies year to year depending on replenishment needs of the Basin, with the long term average being approximately 27,600 acre-feet per year.

3.3.2 GROUNDWATER SUPPLY

Groundwater has for many years been the primary supply of water within Central Basin's service area. In fact, it was the sole source of water supply until the Central Groundwater Basin (Basin) was overdrafted in the late 1940s. Today, the average customer agency in Central Basin relies on groundwater production for 62% of its water supply, although there still remain a few agencies in the District's service area that rely exclusively on groundwater to meet all current water needs.

Ultimately, the extensive overpumping of the Basin through the years led to critically low groundwater levels. This overpumping of the Basin resulted in a legal judgment, or adjudication, that limited the allowable extraction that could occur in any given year and assigned water rights to basin pumpers. The adjudicated water rights were greater than the Basin yield; therefore, the Basin was operating with an annual overdraft. In order to address this overdraft, imported and recycled water sources and a means to purchase these sources were required. The groundwater producers (pumpers) in the area, which are members of the Central Basin Water Association, led the creation of the Water Replenishment District of Southern California (WRD), which manages the replenishment of the groundwater basin.

In 1959, the State Legislature enacted the Water Replenishment Act, enabling the water associations for the Basin to secure voter approval for the formation of the "Central and West Basin Water Replenishment District" (now referred to as the Water Replenishment District of Southern California or "WRD") to be the permanent agency in charge of replenishing the Basin. The State Legislature has vested in WRD the statutory responsibility to manage, regulate, replenish and protect the quality of the groundwater supplies within its boundaries for the beneficial use of the approximately 3.5 million residents and water users who rely upon those groundwater resources to satisfy all or a portion of their beneficial water needs.

Although the water rights have been bought, sold, exchanged or transferred through the years, the total amount of allowable extraction rights within the entire groundwater basin has remained virtually the same. The adjudicated pumping rights available within Central Basin's service area totaled 163,960 AF. However, not all of these water right holders are water retail agencies. Many of these holders are nurseries, businesses, cemeteries and private entities that make up approximately 23% (37,287 AF) of the total water rights. Shown in Table 3-2 are all of the water retailers' adjudicated groundwater rights in Central Basin's service area for fiscal year 2003-04.

Although most of the groundwater supply is extracted from the Central Basin, there are a number of water retailers that retain groundwater rights within the Main San Gabriel Basin that are extracted and imported within their Central Basin service area. The Main San Gabriel Basin underlies most of the San Gabriel Valley, above Central Basin. It is bounded by the San Gabriel Mountains to the north, San Jose Hills to the east, Puente Hills to the south and by the Raymond Fault and a series of other hills to the west.

Table 3-2
Groundwater Pumping Rights 2003-2004

Central Basin Retail Agencies	Adjudicated Pumping Rights in Central Basin
Bellflower- Somerset MWC	4,313
California Water Service Company- East LA	11,774
California Water Service Company- Commerce	5,081
City of Bell Gardens	1,914
City of Cerritos	4,680
City of Downey	16,553
City of Huntington Park	3,853
City of Lakewood	9,423
City of Lynwood	5,337
City of Montebello	387
City of Norwalk	1,267
City of Paramount	5,883
City of Santa Fe Springs	4,036
City of Signal Hill	2,022
City of South Gate	11,183
City of Vernon	8,039
County LA- Rancho Los Amigos	490
La Habra Heights County Water District	2,498
Maywood Mutual Water Company No.1	741
Maywood Mutual Water Company No.2	912
Maywood Mutual Water Company No.3	1,407
Orchard Dale Water District	1,107
Park Water Company	1
San Gabriel Valley Water Company	2,616
Southern California Water Company	16,439
Suburban Water System	3,721
Walnut Park Mutual Water Company	996
Non-Retail Water Agencies[1]	37,287
Total	**163,960**

Source: Central Basin Watermaster Report, 2004
[1] Water right holders that are not water retail agencies; i.e. nurseries, cemeteries, industries, etc.

The total amount of water extracted from the Main San Gabriel Basin and imported within Central Basin service area totals approximately 42,000 AFY. Table 3-3 displays the water retailers and the amount produced from this adjoining basin for the past five fiscal years.

As illustrated in Table 3-4, the total amount of groundwater produced through the past five years in the Central and Main San Gabriel Basins has remained fairly consistent. The amount of groundwater produced ranges from 94% to 98% of the total groundwater supply available.

The total amount of groundwater projected to be extracted during the next 25 years will be fairly consistent due to the adjudication in both basins. The economic costs to pump groundwater versus the purchases of imported water will pressure water retailers to maximize their groundwater rights. Therefore, the total amount of groundwater produced is projected to range in the 98% percentile of available supply, as illustrated in Table 3-5 on the next page.

Groundwater Recharge

For the past 42 years, WRD has replenished the Basin through "Spreading Grounds" and prevented further seawater intrusion by injecting recycled and imported water into the Alamitos Barrier, which were created by the Los Angeles County Flood Control District (LACFCD) and owned and operated by the Los Angeles County Department of Public Works.

WRD assesses a groundwater production fee, known as their "Replenishment Assessment," to pumpers in the Basin. This assessment provides funds that WRD uses to purchase and produce water for both spreading and injection to replace groundwater pumped as well as hydrological barriers to seawater intrusion. The available supply of replenishment water to physically recharge the basins can be classified as follows:

Table 3-3
Amount of Groundwater Pumped from Main San Gabriel Basin
(In Acre-Feet)

Water Retailer	2000	2001	2002	2003	2004
California Domestic Water Co.	19,886	18,603	21,204	21,338	21,233
San Gabriel Valley Water Co.	279	300	1,500	1,454	1,450
Suburban Water Systems	13,570	12,885	13,773	11,497	12,353
City of Whittier	8,952	8,107	8,116	7,411	8,021
Total	**42,687**	**39,895**	**44,593**	**41,700**	**43,057**

Source: Central Basin Watermaster Report

Table 3-4
Total Amount of Groundwater Pumped
(In Acre-Feet)

Basin Name	2000	2001	2002	2003	2004
Central Groundwater Basin[1]	158,516	153,242	157,036	152,802	151,785
Main San Gabriel Basin[2]	42,687	39,895	44,593	41,700	43,057
Total	**201,203**	**193,137**	**201,629**	**194,502**	**194,842**
% of Total Water Supply	98%	94%	98%	94%	95%

[1] Includes Central Basin's service area groundwater production.
[2] Water Production from Main San Gabriel Basin and imported into Central Basin's service area.

Table 3-5
Total Amount of Groundwater Projected to Be Pumped
(In Acre-Feet)

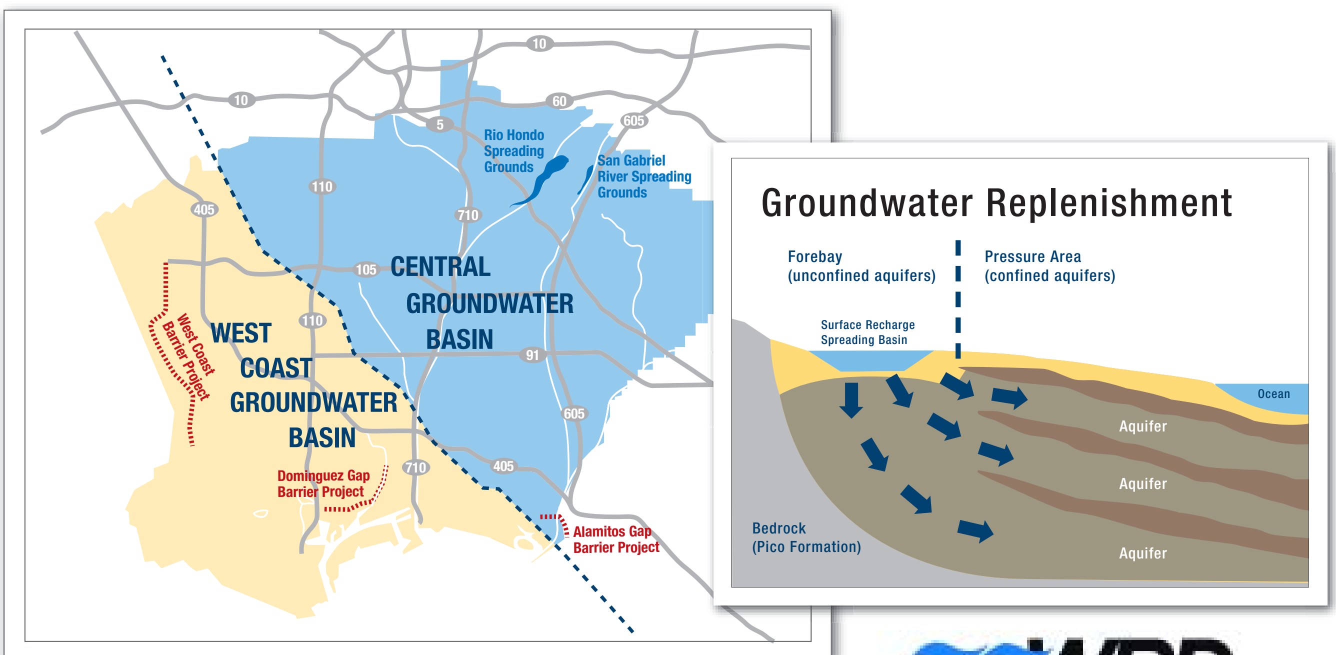
Basin Name	2010	2015	2020	2025	2030
Central Groundwater Basin[1]	160,000	160,000	160,000	160,000	160,000
Main San Gabriel Basin[2]	42,000	42,000	42,000	42,000	42,000
Total	**202,000**	**202,000**	**202,000**	**202,000**	**202,000**
% of Total Water Supply	98%	98%	98%	98%	98%

[1] Includes Central Basin's service area groundwater production.
[2] Water Production from Main San Gabriel Basin and imported into Central Basin's service area.

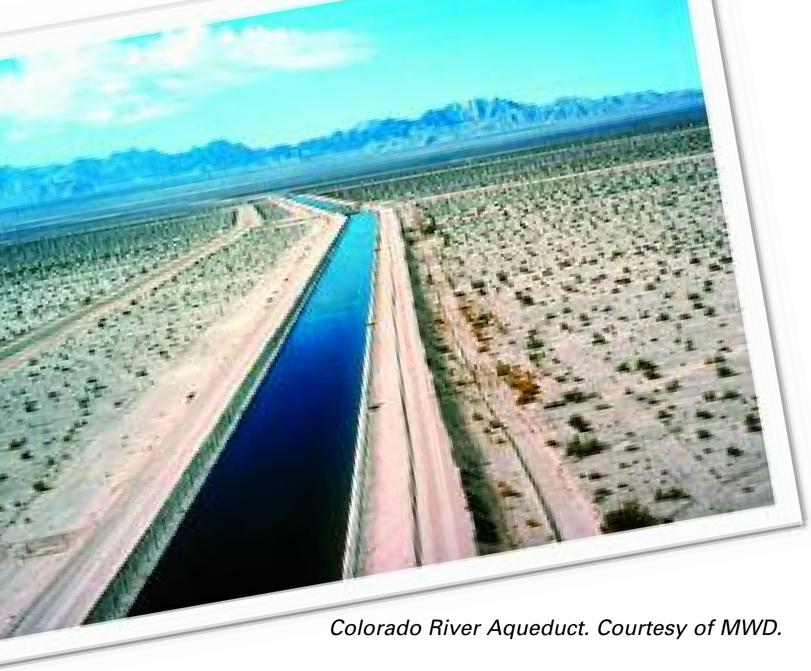
- **Local water**
  Storm flows from the San Gabriel River, Rio Hondo and other waterways within the San Gabriel Valley and flow obligations under the San Gabriel River Judgment with the Upper Area of the Central Basin, defined as "Make-up Water."

- **Recycled water**
  Recycled water purchased from the County Sanitation Districts of Los Angeles County for deliveries at the Montebello Forebay Spreading Grounds or highly treated water for injection into the Alamitos seawater barrier.

- **Imported water**
  Purchased untreated imported water from Central Basin for deliveries at the Montebello Spreading Grounds or treated imported water from the City of Long Beach for injection into the Alamitos seawater barrier.



Courtesy of WRD.



Colorado River Aqueduct. Courtesy of MWD.

WRD also encourages in-lieu replenishment of the Basin. Under the In-Lieu program, pumpers are encouraged through a financial incentive to purchase surplus imported water from Central Basin "in-lieu" of pumping groundwater.

Table 3-6 summarizes the historical amounts of imported water purchased to replenish the Basin at both the Spreading Grounds and at the Alamitos Barrier.

3.3.3 RECYCLED WATER SUPPLY

Recycled water is one of the cornerstones of Central Basin's efforts to augment local supplies and reduce dependence on imported water. Since the planning and construction of Central Basin's water recycling system in the early 1990s, Central Basin has become a leader in producing and marketing recycled water. This new supply of water assists in meeting the demand for non-potable applications such as landscape irrigation, commercial and industrial processes, and seawater barriers. Recycled water is a resource that is reliable and environmentally beneficial to the region. It is only limited by the infrastructure needed to deliver this source of water. With approximately 201 site connections, Central Basin has delivered an average of 3,800 AF per year both inside and outside of the District's service area. This upcoming fiscal year, the District anticipates recycled water sales to reach 5,000 AF.

Table 3-6
Historical Imported Water Replenishment Deliveries
(In Acre-Feet)

Fiscal Year	Spreading Water	Barrier Water[1]	Total
1990	49,531	5,756	**55,287**
1991	50,785	6,168	**56,953**
1992	49,229	5,757	**54,986**
1993	22,987	5,261	**28,248**
1994	19,239	4,145	**23,384**
1995	23,008	3,496	**26,504**
1996	13,693	5,269	**18,962**
1997	26,440	5,739	**32,179**
1998	1,562	5,336	**6,898**
1999	0	5,330	**5,330**
2000	45,037	6,169	**51,206**
2001	23,451	5,398	**28,849**
2002	41,268	6,062	**47,330**
2003	17,297	3,479	**20,776**
2004	21,788	0	**21,788**
2005	27,785	0	**27,785**

Source: Central Basin Wateruse Database, 2005
[1] Barrier supplies transferred to the City of Long Beach in 2003.

In addition, the City of Cerritos has its own recycled water system that currently treats and supplies within its City's boundaries and its neighbor, the City of Lakewood, a total of 2,400 AF per year. Together, both these recycled water programs plan to offset potable supplies by 7,400 AF this next fiscal year.

Recycled water deliveries within Central Basin are projected to reach 10,500 AF by year 2010. Refer to a more detailed description of Central Basin's water recycling program in Section 8 of this Plan.

Recycled water effluent from San Jose Creek Plant.

3.4 ALTERNATIVE WATER SUPPLY PROJECTS

3.4.1 CONJUNCTIVE USE GROUNDWATER STORAGE

Conjunctive Use can be defined as the coordinated management of surface and groundwater supplies to increase the yield of both supplies and enhance water supply reliability in an economic and environmentally responsible manner. Central Basin sees the development of Conjunctive Use Storage Programs as part of the District's core responsibility to ensure a reliable supply of water for its service area. If done in a publicly responsible manner, groundwater storage can be viewed as an additional source in diversifying our water resource supply portfolio.

The potential benefits of a Conjunctive Use program include:

- Operational flexibility for groundwater production;
- Increased yield of the basin;
- More efficient use of surplus surface water during wet years;
- Financial benefits to groundwater users;
- Better distribution of water resources and
- Increased measures of reliability.

At this time there are programs available for water retailers to create groundwater storage both within and outside of the Basin judgment. Included is the availability for a District-sponsored storage program with MWD in which retail agencies with imported water connections could partake. The size of such a program would depend on retailers' total demand and the amount that they could realistically shift of groundwater to imported water.

3.4.2 WATER TRANSFERS & EXCHANGES

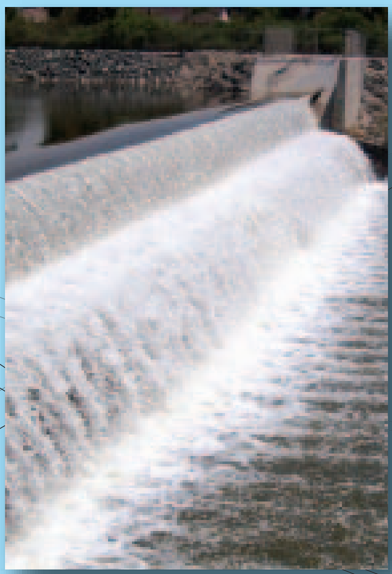
Water transfers and exchanges are management tools to address increased water needs in areas of limited supply. Although they do not generate a new supply of water, they do better distribute water from where it is abundant to where it is limited.

MWD, in recent years, has played an active role statewide in securing water transfers and exchanges as part of their IRP goals. Although Central Basin is a member of MWD, there has not been a compelling reason or opportunity to pursue transfers directly.

3.4.3 DESALINATED WATER

Desalination is viewed as a way to develop a local, reliable source of water that assists agencies in reducing their demand on imported water, reducing groundwater overdraft and in some cases make unusable groundwater available for municipal uses. Although Central Basin currently has not identified any projects for desalination of seawater or impaired groundwater, the District is a strong supporter of the endeavor. This additional source of water supply would provide greater water reliability for the District.

In 2005, the District passed a resolution supporting the efforts of its sister agency, West Basin Municipal Water District (West Basin), in the development of a seawater desalination project. West Basin has been operating a desalination pilot project since May 2003 to identify optimal performance conditions and evaluate the water quality of the water produced. The project is located at the El Segundo Power Plant and processes 40 gallons per minute.



Section 4

Water Reliability

4

Water Reliability

This section discusses Central Basin's plan of maintaining a reliable source of water

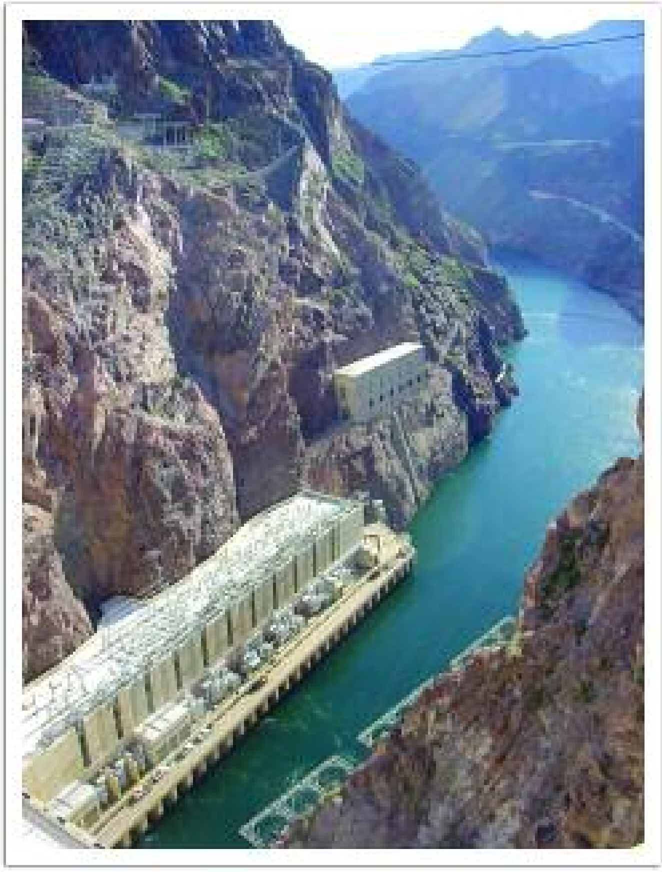
4.1 OVERVIEW

Among the future challenges of continued urbanization in Southern California is the question of water reliability. In other words, can Southern California meet the necessary water demands of the region during times of drought? During consecutive dry years, Southern California has historically seen demands increase by as much as 20% while supplies have decreased. Prior to recent significant improvements in water reliability, most cities and agencies were forced to mandate conservation efforts and restrict water use in some cases in order to maintain an adequate supply.[1]

This section will discuss how the regional supplier, MWD, in partnership with its member agencies such as Central Basin, plans on ensuring future reliability through water management measures, long-term planning and investment in local resources, Central Basin's projections for meeting its service area's future demands during single and multiple dry-year conditions and, finally, a review of the District's Water Shortage Contingency Plan in the event MWD limits deliveries.

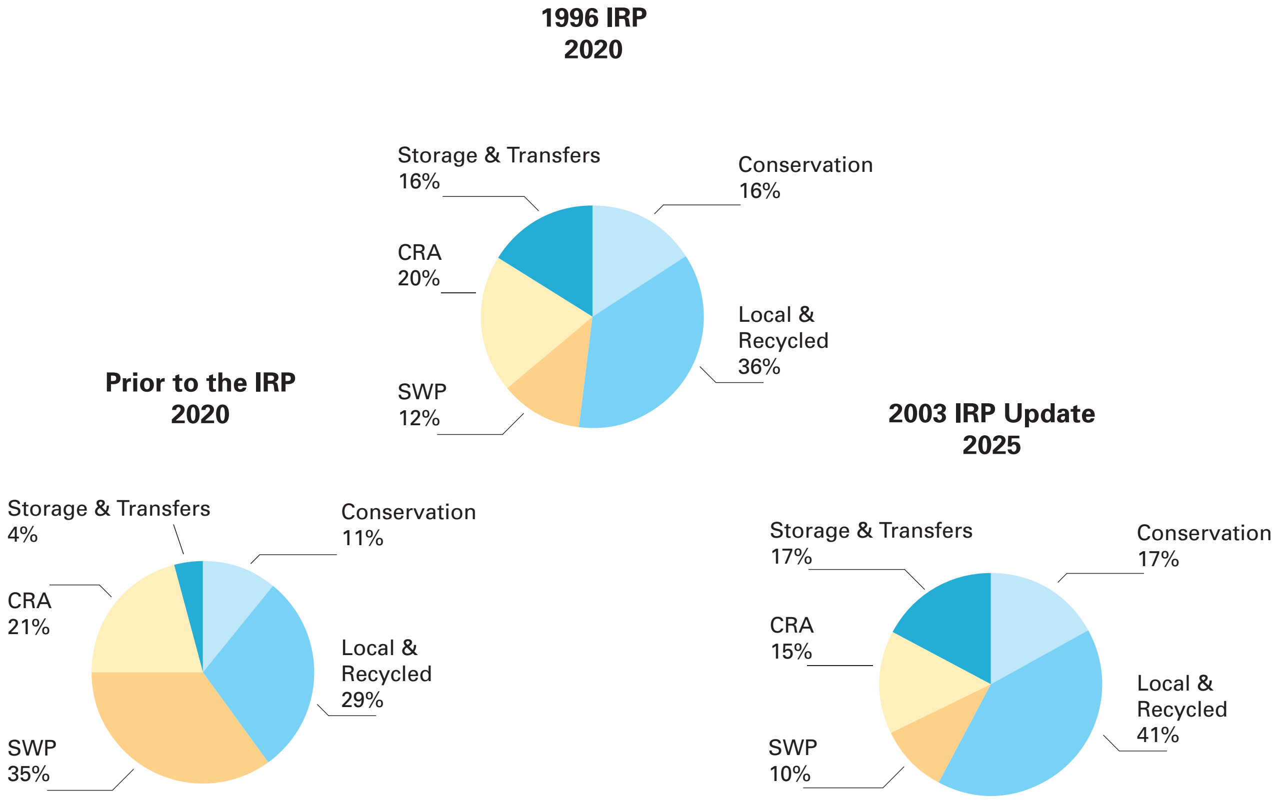
4.2 MWD WATER SUPPLY RELIABILITY

With the experience of the droughts of 1977-78 and 1989-92, MWD has undertaken a number of planning initiatives to ensure water supply reliability. Included among them are the Integrated Resources Plan (IRP), the Water Surplus and Drought Management Plan (WSDM Plan) and local resource investments. Together, these initiatives have provided the policy framework for MWD and its member agencies to manage their water resources in such a way to meet a growing population even under recurrences of the worst historical hydrologic conditions locally and in the key watersheds that supply Southern California. Below is a brief description of each water management initiative MWD has undertaken to ensure 100% reliability during the next 20 years.



Colorado River water at Hoover Dam in Nevada.

1 By contrast, the loss of a large portion of our Colorado River supply in 2004 during an extended dry period in Southern California did not cause hardship or require any drastic return on the part of the general population. This was a tribute to planning and investments made into water reliability during the past decade.



4.2.1 MWD INTEGRATED RESOURCE PLAN

To meet the challenges of the supply shortages on the State and Colorado River Aqueducts under increases in population and growing State and Federal regulatory requirements, MWD's Board of Directors called for the development of an IRP in 1996. The IRP's objective was to determine the appropriate combination of water resources to provide 100% reliability for full service demands during the next 20 years. With the support of its member agencies, MWD developed a preferred supply mix that includes conservation, local supplies (recycled, brackish, desalination), SWP supplies, CRA supplies, groundwater banking and water transfers that could meet projected water demands under severe shortage conditions. The IRP identifies supply targets for each supply option and has become the blueprint for guiding investment and policy decisions for decades to come.

By design, the IRP is also subject to revision when conditions and opportunities change through time. In 2003, MWD completed its first update to the IRP, which included revised projected demands and an updated resource supply mix. MWD has three clear objectives for the IRP update: (1) to review the goals and achievements of the 1996 IRP, (2) to identify changed conditions for water resource development and (3) to update the resource targets through 2025.

Among the most significant findings from the updated IRP was the increased participation of local agencies in developing local supplies such as recycled water and brackish groundwater desalination as well as promoting savings from conservation. The result revealed a greater source of local supply reliability than anticipated among MWD member agencies. However, it also identifies the limitations expected on the Colorado River and the need for local infrastructure improvements to provide the flexibility to manage and overcome supply risks.

Overall, the 2003 IRP Update revealed a decrease in the region's reliance on Colorado River and SWP supplies compared to the 1996 IRP, while continuing to provide 100% reliability through the year 2025.

4.2.2 MWD WATER SURPLUS AND DROUGHT MANAGEMENT PLAN

In order for MWD to be 100% reliable in meeting all non-discounted non-interruptible demands in the region, MWD adopted the WSDM Plan in 1999. The WSDM Plan provides the policy guidance to manage the region's water supplies to achieve the reliability goals of the IRP. This is achieved by integrating the operating activities of surplus and shortage supplies through a series of stages and principles.

Those principles include water management actions to secure more imported water during times of drought by promoting efficient water usage, increasing public awareness and seeking additional water transfers and banking programs. Should supplies become limited to the point where imported supplies are truncated, the WSDM Plan would allocate water through a calculation on the basis of need as opposed to any historical purchases through MWD. MWD and its member agencies have not yet decided on a formula for the allocation calculation.

4.2.3 MWD LOCAL RESOURCE INVESTMENTS

A key element within MWD's IRP objectives to ensure regional reliability is to further enhance local resources. In addition to the traditional supplies of imported water and groundwater, MWD has looked to invest in numerous local resources projects including recycled water, conservation, groundwater, surface water storage and even ocean water desalination to meet future demands.

Since 1982, MWD has provided financial assistance to more than 75 projects in the areas of water recycling and groundwater recovery totaling approximately $124 million and $41 million, respectfully.

MWD has already invested more than $290 million in water conservation, which has produced significant water savings for the past 15 years.

One of MWD's most significant investments is Diamond Valley Lake. Built in the saddle of two mountains, Diamond Valley Lake, Southern California's newest and largest reservoir, is a vital link in the regional system that has brought water to Southern California for the past 60 years. The lake nearly doubled the region's surface water storage capacity and provides additional water supplies for drought, peak summer and emergency needs. This newly created reservoir, located in southwestern Riverside County, holds enough water to meet the region's emergency and drought needs for six months and is an important component in MWD's plan to provide a reliable supply of water to the 18 million people in Southern California who rely on this water. Water began pouring into the reservoir in November 1999 and the lake was filled by early 2002. Diamond Valley Lake holds 800,000 AF, or 260 billion gallons, of water. By comparison, Lake Havasu on the Colorado River holds just 648,000 acre-feet, or 201 billion gallons. The lake nearly doubled the area's surface water storage capacity and provides additional water supplies for drought, peak summer and emergency needs.

Diamond Valley Lake. Courtesy of MWD.

4.3 CENTRAL BASIN'S WATER SUPPLY RELIABILITY

Along with MWD's reliability initiatives, Central Basin has also taken important steps during the past decade to reduce the District's vulnerability to extended drought or other potential threats. The District's investments in recycled water to replace imported water for non-potable uses and the implementation of conservation devices and education have resulted in more self-reliance.

Courtesy of MWD.

Colorado River Aqueduct traverses 240 miles of desert to Southern California.

Based on the District's current water supply portfolio, as illustrated in Table 4-1, Central Basin provides an adequate supply for the single dry-water year and multiple dry-water year scenarios. The "Normal Water Year" used in this plan is based on the average rainfall year - FY 2000-01. According to the National Weather Service, the recorded rainfall in FY 2000-01 was 17.94 inches - one of the closest years to the historical average of 16.42 inches. The "Single Dry Year" is based on the lowest rainfall year - FY 2001-02. The recorded rainfall in FY 2001-02 was at 4.42 inches - the lowest recorded year in more than 100 years. The three "Multiple Dry-Water Years" used below were based upon the most recent multiple dry-year period - FY 2001-02, 2002-03, and 2003-04.

Groundwater is shown constant in all scenarios due to the Basin's adjudication, which limits the total amount that each customer within Central Basin's service area is able to extract. Recycled water, which includes both Central Basin and the City of Cerritos systems, is also constant in all scenarios because the availability of recycled water is not subject to hydrologic variation. This leaves imported water as the only supply currently that can fluctuate under different hydrological scenarios.

The supply reliability scenarios described in this section focus exclusively on municipal and industrial usage within the District's service area. It does not include replenishment water.

Looking forward, Central Basin will continue to evaluate opportunities to increase its water supply portfolio within its service area. These opportunities include the expanded use of recycled water, brackish water recovery and additional conservation programs as well as the exploration of investments in groundwater storage through Conjunctive Use programs.

Table 4-1
Central Basin Municipal Water District
Retail Supply Reliability
(In Acre-Feet)

Supplies	Normal Water Year	Single Dry-Water Year	Multiple Dry-Water Years		
	FY 2000-01	FY 2001-02	FY 2001-02	FY 2002-03	FY 2003-04
Groundwater[1]	205,960	205,960	205,960	205,960	205,960
Imported Water	63,000	68,000	68,000	59,308	64,816
Recycled Water[2]	7,400	7,400	7,400	7,400	7,400
Total Supply	**276,360**	**281,360**	**281,360**	**272,668**	**278,176**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Spreading water
[1] Based upon the total allowable pumping allocation (APA) for each customer agency within Central Basin's service area plus the average amount produced and imported from Main San Gabriel Basin, according to the 2004 DWR Central Basin Watermaster Report.
[2] Includes the available supply of recycled water system for both Central Basin and the City of Cerritos.

4.3.1 NORMAL-YEAR RELIABILITY COMPARISON

As discussed in Section 2.0 Water Demand, Central Basin's normal demands are projected to increase modestly during the next 25 years. Increases in recycled water use during the 25-year planning period equate to a corresponding reduction in the need for imported water.

4.3.2 SINGLE DRY-YEAR RELIABILITY COMPARISON

Central Basin's projected single dry-year water supply is expected to call for additional imported supplies from MWD. According to historical demands, the total water demands in a single dry-year are projected to be 3.5% greater than normal year projections. Table 4-3 compares the dry-year supply and demand projections for the Central Basin MWD service area.

Table 4-2
Projected Normal Water Year Supply and Demand
(In Acre-Feet)

Supplies	2005	2010	2015	2020	2025	2030
Groundwater[1]	205,960	205,960	205,960	205,960	205,960	205,960
Imported Water	63,000	59,091	64,691	70,462	76,409	82,535
Recycled Water[2]	7,400	12,900	14,150	15,400	16,650	17,900
Total Supply	**276,360**	**277,951**	**284,801**	**291,822**	**299,019**	**306,395**
Total Demand[3]	**252,799**	**273,991**	**280,841**	**287,862**	**295,059**	**302,435**
Surplus/(Shortage)	**23,561**	**3,960**	**3,960**	**3,960**	**3,960**	**3,960**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Spreading
[1] Based upon the total allowable pumping allocation (APA) for each customer agency within Central Basin's service area plus the average amount produced and imported from Main San Gabriel Basin, according to the 2004 DWR Central Basin Watermaster Report.
[2] Includes the available supply of recycled water system for both Central Basin and the City of Cerritos.
[3] Total Demand includes Projected Groundwater within Central Basin's service area, Imported and Recycled M&I Demands.

Table 4-3
Projected Single Dry-Year Water Supply and Demand
(In Acre-Feet)

Supplies	2005	2010	2015	2020	2025	2030
Groundwater[1]	205,960	205,960	205,960	205,960	205,960	205,960
Imported Water	68,000	68,000	70,560	76,577	82,776	89,160
Recycled Water[2]	7,400	12,900	14,150	15,400	16,650	17,900
Total Supply	**281,360**	**286,860**	**290,670**	**297,937**	**305,386**	**313,020**
Total Demand[3]	**261,647**	**283,581**	**290,670**	**297,937**	**305,386**	**313,020**
Surplus/(Shortage)	**19,713**	**3,279**	**0**	**0**	**0**	**0**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Spreading
[1] Based upon the total allowable pumping allocation (APA) for each customer agency within Central Basin's service area plus the average amount produced and imported from Main San Gabriel Basin, according to the 2004 DWR Central Basin Watermaster Report.
[2] Includes the available supply of recycled water system for both Central Basin and the City of Cerritos.
[3] Total Demand includes Projected Groundwater within Central Basin's service area, Imported and Recycled M&I Demands.

4.3.3 MULTIPLE DRY-YEAR RELIABILITY COMPARISON

Under the multiple dry-year water scenarios, Central Basin is projected to meet demands by continuing to implement conservation and water recycling. Tables 4-4 through 4-8 illustrate the projected water supplies and demands within multiple dry-year reliability comparisons for the next 25 years.

Table 4-4
Projected Water Supply and Demand during Multiple Dry-Year 2008-2010
(In Acre-Feet)

Supplies	2008	2009	2010
Groundwater[1]	205,960	205,960	205,960
Imported Water	68,000	59,308	64,816
Recycled Water[2]	10,900	11,400	12,900
Total Supply	**284,860**	**276,668**	**283,676**
Total Demand[3]	**281,484**	**269,302**	**270,888**
Surplus/(Shortage)	**3,376**	**7,366**	**12,788**

Table 4-5
Projected Water Supply and Demand during Multiple Dry-Year 2013-2015
(In Acre-Feet)

Supplies	2013	2014	2015
Groundwater[1]	205,960	205,960	205,960
Imported Water	68,000	59,308	64,816
Recycled Water[2]	13,650	13,900	14,150
Total Supply	**287,610**	**279,168**	**284,926**
Total Demand[3]	**283,128**	**270,875**	**277,661**
Surplus/(Shortage)	**4,482**	**8,293**	**7,265**

Table 4-6
Projected Water Supply and Demand during Multiple Dry-Year 2018-2020
(In Acre-Feet)

Supplies	2018	2019	2020
Groundwater[1]	205,960	205,960	205,960
Imported Water	69,346	59,308	64,816
Recycled Water[2]	14,900	15,150	15,400
Total Supply	**290,206**	**280,418**	**286,176**
Total Demand[3]	**290,206**	**277,647**	**284,602**
Surplus/(Shortage)	**0**	**2,771**	**1,574**

Table 4-7
Projected Water Supply and Demand during Multiple Dry-Year 2023-2025
(In Acre-Feet)

Supplies	2023	2024	2025
Groundwater[1]	205,960	205,960	205,960
Imported Water	75,351	62,228	69,108
Recycled Water[2]	16,150	16,400	16,650
Total Supply	**297,461**	**284,588**	**291,718**
Total Demand[3]	**297,461**	**284,588**	**291,718**
Surplus/(Shortage)	**0**	**0**	**0**

Table 4-8
Projected Water Supply and Demand during Multiple Dry-Year 2028-2030
(In Acre-Feet)

Supplies	2028	2029	2030
Groundwater[1]	205,960	205,960	205,960
Imported Water	81,538	68,094	75,150
Recycled Water[2]	17,400	17,650	17,900
Total Supply	**304,898**	**291,704**	**299,010**
Total Demand[3]	**304,898**	**291,704**	**299,010**
Surplus/(Shortage)	**0**	**0**	**0**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Spreading
[1] Based upon the total allowable pumping allocation (APA) for each customer agency within Central Basin's service area plus the average amount produced and imported from Main San Gabriel Basin, according to the 2004 DWR Central Basin Watermaster Report.
[2] Includes the available supply of recycled water system for both Central Basin and the City of Cerritos.
[3] Total Demand includes Projected Groundwater within Central Basin's service area, Imported and Recycled M&I Demands.

4.4 WATER SHORTAGE CONTINGENCY PLAN

The State requires that each urban water supplier should provide a water shortage contingency analysis within its urban water management plan. Below is a brief description of the District's plan for water shortage according to the state's water code requirements.

4.4.1 MINIMUM SUPPLY

Currently, the District's water supplies are groundwater, imported water and recycled water. As it relates to the estimated minimum supply available during a severe drought, the District's groundwater supply, as stated in Section 3, is not affected by hydrology because the Basin is adjudicated. The available supply for each groundwater producer (Allowable Production Allocation), set by the Judgment, remains the same regardless of the Central Basin service area's rainfall. The same relates to recycled water, where the supply is not affected by hydrology but rather through the number of service connections and production capacity. The benefit of recycled water is that it is drought-proof and the supply of recycled water remains available regardless of the rainfall. Imported water, on the other hand, is the only supply affected by hydrology. As the wholesaler of imported water to the region, the District's minimum imported water supply is based upon the recent historical demand of imported water during a dry-year sequence of fiscal years 2001-02 to 2003-04; rainfall for these three years range among the lowest on record. The estimated minimum supplies during the next three years for the District is shown in Table 4-9.

Table 4-9
Three-year Estimated Minimum Water Supply
(In Acre-Feet)

Supplies	2006	2007	2008
Groundwater[1]	205,960	205,960	205,960
Imported Water	68,000	59,308	64,816
Recycled Water[2]	7,400	9,400	10,900
Total Supply	**281,360**	**274,668**	**281,676**
Total Demand[3]	**278,690**	**266,629**	**273,375**
Surplus/(Shortage)	**2,670**	**8,039**	**8,301**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Spreading
[1] Based upon the total allowable pumping allocation (APA) for each customer agency within Central Basin's service area plus the average amount produced and imported from Main San Gabriel Basin, according to the 2004 DWR Central Basin Watermaster Report.
[2] Includes the available supply of recycled water system for both Central Basin and the City of Cerritos.
[3] Total Demand includes Projected Groundwater within Central Basin's service area, Imported and Recycled M&I Demands.

4.4.2 STAGES OF ACTION TO REDUCE IMPORTED DELIVERIES

As the area's wholesaler of MWD imported water, the District's stages for reduction are subject to MWD's WSDM Plan, which guides the management of water supplies for the region during shortages conditions.

According to MWD's WSDM Plan, an array of water resource management measures would take place prior to any supply reductions. Through a series of seven shortage stages, MWD will seek the steps to encourage more efficient water usage with its member agencies. Not until the last stage, under an extreme shortage condition, will MWD discontinue imported water deliveries according to an allocation formula. Currently, however, MWD has not determined the shortage allocation methodology to complete the WSDM Plan. Conversely, MWD's 2005 Regional UWMP demonstrates 100% reliability in multiple dry years through 2030. Nevertheless, given the resources described in MWD's IRP, MWD fully expects to be reliable, under the most extreme supply shortage scenarios, during the next 10 years.

However, if imported water supplies were discontinued according to MWD's WSDM Plan, the District would consider reducing supplies through a series of action stages, which would include an allocation methodology similar to MWD. Once MWD determined such an allocation, the District would work with each of its customer agencies to set a specific allocation level to cumulatively meet the District's allocation from MWD. The following page shows a four step stage rationing plan that the District would implement to reduce imported deliveries up to 50%.

Central Basin Municipal Water District Stages of Action

Minimum Shortage - The District would request for a voluntary effort among its customers to reduce imported water deliveries. In addition, the District would pursue an aggressive Public Awareness Campaign to encourage residents and industries to reduce their usage of water.

Moderate Shortage - In addition to the stage above, the District would work with its customer agencies to promote and adopt water waste prohibitions and ordinances to discourage unnecessary water usage.

Severe Shortage - In addition to the two stages above, the District would seek to adopt a rate structure that penalizes increased water usage among its customer agencies.

Extreme Shortage - In addition to all the stages above, the District would call for the discontinuance of imported water based upon an allocation methodology similar to MWD for each of its customer agencies.

Since these action stages are contingent upon MWD's WSDM Plan's allocation methodology and such a formula has yet to be determined, the District's shortage stages will remain in draft form. Until MWD completes the WSDM formula, the District's implementation of any rationing stage will be subject to a variety of conditions, among them the severity of the drought, the District allocation level and the current water supply mix available to each customer agency before the Board would apply any action stage listed above.

Once the Board determines action is necessary, the Board would adopt, by resolution, the appropriate stage of action, which would take effect immediately and the District customer agencies would be notified. A draft resolution is included in Appendix E.

4.4.3 PROHIBITIONS, PENALTIES AND CONSUMPTION REDUCTION METHODS

Through the years the District has developed strong relationships with its customer agencies to promote community awareness of water conservation. Should water reductions become necessary, the District will work with each city and water agency within its service area to encourage the adoption of water waste prohibition measures that establish mandatory water use restrictions. Moreover, the District will provide the necessary assistance and information to apply the best suited water reducing practice(s) for each customer agency.

Additionally, the District will encourage behavioral change through the adoption of an appropriate water rate structure. As part of MWD's WSDM Plan, the District will pass through additional charges, where MWD will enforce water reductions by setting a minimum amount per AF for any deliveries exceeding a member agency's allotment up to 102%, once an allocation plan is determined. Any deliveries exceeding 102% will be assessed a surcharge equal to three times MWD's full-service rate. The District will impose MWD's penalties for excess use to its customer agencies that exceed their allocation.

4.4.4 IMPACTS TO REVENUE

The District will seek to recover the shortfall of revenue caused by water reductions from its Rate Stabilization Fund as well as from any surplus revenues collected from excess penalties. Moreover, the District will closely monitor its revenue and expenditure impacts on a monthly basis, and respond with any rate adjustments needed at each action stage.

Through the District's imported water invoices per connection, the District will measure each customer agencies' actual performance on a monthly basis.

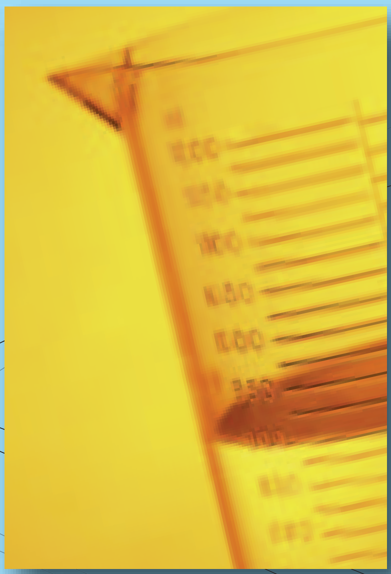
4.4.5 CATASTROPHIC SUPPLY INTERRUPTION

In the event imported water supplies are interrupted from a catastrophic event, the District, through coordination with MWD, can respond at both a regional and a local level.

In the event that an emergency such as an earthquake, system failure or regional power outage, etc. affected the entire Southern California region, MWD would take the lead and activate its Emergency Operation Center (EOC). The EOC coordinates MWD's and the District's responses to the emergency and concentrates efforts to ensure the system can begin distributing potable water in a timely manner.

If circumstances render the Southern California's aqueducts to be out of service, MWD's Diamond Valley Lake can provide emergency storage supplies for its entire service area's firm demand for up to six months. With few exceptions, MWD can deliver this emergency supply throughout its service area via gravity, thereby eliminating dependence on power sources that could also be disrupted. Furthermore, should additional supplies be needed, MWD also has surface reservoirs and groundwater conjunctive use storage accounts that can be draw upon to meet additional demands. The WSDM plan guides MWD's management of available supplies and resources during an emergency to minimize the impacts of a catastrophic event.

Locally, the District has the Member Agency Response System (MARS) to immediately contact its customer agencies and MWD during an emergency about potential interruption of services and the coordination of critical resources to respond to the emergency, also known as mutual aid. The MARS is a radio communication system developed by MWD and its member agencies to provide an alternative means of communication in extreme circumstances. The District is currently in the process of enhancing its communication system in order to provide a more rapid response.



Section 5

Water Quality


ml.
1200
1150
1100
1050
1000
950
900
850
800

5

Water Quality

This section discusses the Water Quality within Central Basin's service area

5.1 OVERVIEW

Water quality regulations are an important factor in Central Basin's water management activities. MWD is responsible for complying with State and Federal drinking water regulations on imported water sold to Central Basin. Purveyors to which Central Basin sells imported water are responsible for ensuring compliance in their individual distribution systems and at the customer tap.

For groundwater quality, Central Basin assists purveyors in its service area in meeting drinking water standards through its Cooperative Basin-Wide Title 22 Groundwater Quality Monitoring Program. Title 22 is in reference to the California Code of Regulations section pertaining to both domestic drinking water and recycled water standards. Central Basin offers this program to water agencies for wellhead and reservoir sample collection, water quality testing and reporting services. Sampling is conducted for compliance with the Federal Safe Drinking Water Act and Title 22 regulations. Twenty-nine agencies in Central Basin's service area participate in the monitoring program. Results are compiled in a published annual report.

In March 1999, Governor Gray Davis signed an executive order requiring the use of MTBE (methyl tertiary-butyl ether), a gasoline oxygenate, be phased out by January 1, 2003. This deadline was later postponed to January 1, 2004. Central Basin has been monitoring its groundwater wells since 1996 for MTBE; to date it has not been detected in any wells.

In another development, the California Department of Health Services (CDHS) recommended that drinking water wells be tested for the rocket fuel component perchlorate. Central Basin began monitoring for perchlorate voluntarily in 1997 as part of the Title 22 Monitoring program. CDHS required all water purveyors in the State to monitor for perchlorate under the 2001 Unregulated Contaminant

GAC vessels at Central Basin's Water Quality Protection Project.

Monitoring Rule. To date, perchlorate has been detected in nine separate wells. Furthermore, the presence of perchlorate in the San Gabriel Basin could impact water quality in Central Basin's service area. In response, the Central Basin Board of Directors has supported a plan to clean up the contaminated groundwater before it migrates into the Central Basin. The "San Gabriel Basin Restoration Fund" was created, and 11 firms agreed to pay $200 million to construct treatment facilities throughout the San Gabriel Valley to remove contaminants and restore the groundwater basin.

5.2 QUALITY OF EXISTING WATER SUPPLIES

A number of issues are considered when evaluating alternative water supply options. Of primary consideration is a project's ability to provide a safe, reliable and cost-effective drinking water supply. Providing a safe drinking water supply to Central Basin's customers is a task of paramount importance. All prudent actions are taken to ensure that water delivered throughout the service area meets or exceeds drinking water standards set by the State's primary water quality regulatory agency, the CDHS. MWD is also proactive in its water quality efforts, protecting its water quality interests in the State Water Project and Colorado River through active participation in processes that would provide for the highest water quality from both sources.

5.2.1 IMPORTED WATER

Central Basin's imported water comes from the State Water Project and Colorado River via MWD pipelines and aqueducts. MWD tests its water for microbial, organic, inorganic and radioactive contaminants as well as pesticides and herbicides. Protection of MWD's water system is a top priority. In coordination with its 26 member agencies, MWD added new security measures in 2001 and continues to upgrade and refine procedures. Changes have included an increase in the number of water quality tests conducted each year (more than 300,000) as well as contingency plans that coordinate with the Homeland Security Office's multicolored tiered risk alert system. MWD also has one of the most advanced laboratories in the country where water quality staff performs tests, collects data, reviews results, prepares reports and researches other treatment technologies. Although not required, MWD monitors and samples elements that are not regulated but have captured scientific and/or public interest.

MWD performs more than 300,000 water quality tests annually.

MWD has a strong record of identifying those water quality issues that are most concerning and have identified necessary water management strategies to minimize the impact on water supplies. Part of its strategy is to support and be involved in programs that address water quality concerns related to both the SWP and Colorado River supplies. Some of the programs and activities include:

- **CALFED Program –** This program coordinates several SWP water feasibility studies and projects. These include:

  1. A feasibility study on water quality improvement in the California Aqueduct.

  2. The conclusion of feasibility studies and demonstration projects under the Southern California-San Joaquin Regional Water Quality Exchange Project. This exchange project was discussed earlier as a means to convey higher quality water to MWD.

  3. DWR's Municipal Water Quality Investigations Program and the Sacramento River Watershed Program. Both programs address water quality problems in the Bay-Delta and Sacramento River watershed.

- **Delta Improvement Package –** MWD in conjunction with DWR and U.S. Geologic Survey have completed modeling efforts of the Delta to determine if levee modifications at Franks Tract would reduce ocean salinity concentrations in water exported from the Delta. Currently, tidal flows trap high saline water in the tract. By constructing levee breach openings and flow control structures, it is believed saline intrusion can be reduced. This would significantly reduce total dissolved solids and bromide concentrations in water from the Delta.

- **Source Water Protection –** In 2001, MWD completed a Watershed Sanitary Survey as required by CDHS to examine possible sources of drinking water contamination and identify mitigation measures that can be taken to protect the water at the source. CDHS requires the survey to be completed every five years. MWD also completed a Source Water Assessment (December 2002) to evaluate the vulnerability of water sources to contamination. Water from the Colorado River is considered to be most vulnerable to contamination by recreation, urban/storm water runoff, increasing urbanization in the watershed, wastewater and past industrial practices. Water supplies from SWP are most vulnerable to urban/stormwater runoff, wildlife, agriculture, recreation and wastewater.

5.2.2 GROUNDWATER

Groundwater in the Central Basin is continually monitored for the quality of the water because of its susceptibility to seawater intrusion, potential contamination from adjacent basins and migration of shallow contamination into deeper aquifers. The Alamitos Barrier, located in the southwest portion of Central Basin's service area, provides a buffer between the groundwater basin and seawater intrusion. The available supply of replenishment water to physically recharge the Basin includes local and imported water. The local water that recharges the groundwater basin comes from storm flows from the San Gabriel Valley and flow obligations under the San Gabriel River Judgment with the Upper Area of the Central Basin. This water is defined as "Make-Up Water." Imported Water is purchased from MWD to be used for surface spreading at the Montebello Forebay and for seawater barrier injection at the Alamitos Barrier. Recycled water is purchased from the County Sanitation Districts of Los Angeles County for spreading and injection.

As a voluntary service to its purveyors, the District's Water Quality staff coordinates wellhead testing at approximately 150 groundwater wells within the service area to ensure high quality of local supply.

Dual Pump System. Courtesy of WRD.

By outsourcing laboratory services for complex analytical tests, Central Basin helps purveyors save time and money while providing a valuable service for public safety. Due to the mixture of imported and natural groundwater in the Central Basin, testing of the water ensures that the water is safe for drinking purposes.

Water Replenishment District Programs

As the regional groundwater management agency for the Central and West Coast Groundwater Basins, WRD has several active programs to monitor, evaluate and mitigate water quality issues.

Under its Groundwater Quality Program, WRD continually evaluates current and proposed water quality compliance in agency production wells, monitoring wells and recharge/injection waters of the groundwater basins. If non-compliance is identified, WRD staff develops a recommended course of action and associated cost estimates to address the problem and to achieve compliance. WRD also monitors and evaluates the impacts of pending drinking water regulations and proposed legislation.

WRD's Regional Groundwater Monitoring Program consists of a network of about 200 WRD and USGS-installed monitoring wells at 45 locations throughout the District. Monitoring well data is supplemented with information from production wells to capture the most accurate information available. WRD staff, comprised of certified hydrogeologists and registered engineers, provides the in-house capability to collect, analyze and report groundwater data. This information is stored in the District's GIS and provides the basis to better understand the characteristics of the Central and West Coast Groundwater Basins.

WRD's Safe Drinking Water Program (SDWP) is intended to promote the cleanup of groundwater resources at specific well locations. Through the installation of wellhead treatment facilities at existing production wells, the District hopes to remove contaminants from the underground supply and deliver the extracted water for potable purposes. Projects implemented through the program are accomplished through direct input and coordination with well owners. The current program focuses on the removal of volatile organic compounds (VOCs) and offers financial assistance for the design and equipment of the selected treatment facility.

More information regarding these and other groundwater management programs can be found in the current WRD Engineering and Survey Report and Regional Groundwater Monitoring Report.

5.2.3 RECYCLED WATER

Tertiary recycled water meeting Title 22 standards can be used for a wide variety of industrial and irrigation purposes where high-quality, non-potable water is needed.

Central Basin relies on the County Sanitation Districts of Los Angeles County (CSDLAC) to meet all applicable State and Federal water quality regulations for recycled water it purchases and distributes through its two systems. Central Basin purchases recycled water from CSDLAC's San Jose Creek Water Reclamation Plant and Los Coyotes Water Recycling Plant (WRP). These two plants together produce approximately 120 MGD of tertiary-treated effluent. Recycled water from CSDLAC's reclamation plants not reused is discharged to the ocean directly and through major flood control channels.

Settling Basin at San Jose Creek Water Reclamation Plant.

5.3 EFFECTS ON WATER MANAGEMENT STRATEGIES

Poor water quality makes a water source unreliable, affects overall supply and increases the cost of serving water to the public. A water source that fails drinking water regulations must be taken out of service. The source can be restored through treatment or other management strategies.

Groundwater can become impaired through leaching of contaminants into an aquifer, or by excessive concentrations of naturally-occurring constituents that impact quality, such as arsenic. Surface water sources become contaminated from human activities in the watershed or deliberate contamination.

5.4 EFFECTS ON SUPPLY RELIABILITY

The District assists the purveyors in meeting new State and Federal drinking water standards and guidelines. The District also manages research and development projects to find effective solutions to improve water treatment for non-potable use.

As part of a voluntary service offered by the District, the staff coordinates regular wellhead testing through a contract laboratory at approximately 160 groundwater wells in Central Basin's service area. Analytical reports are sent to Central Basin’s purveyors and the CDHS. This voluntary service saves purveyors time and money while ensuring high quality of local groundwater supply.

The quality of recycled water is regularly monitored for process control, regulatory compliance and customer development. Through special sampling and testing, customers can have the confidence of knowing that they are receiving the quality of recycled water needed for their use.

5.5 WATER QUALITY PROTECTION PROJECT

In the early 1980s, the San Gabriel Valley aquifer was discovered to have contaminants including trichloroethylene (TCE) and perchloroethylene (PCE) in the water supply. Based on the contamination level, the Environmental Protection Agency (EPA) declared the area as a superfund site. As the contamination plume moved south toward the Central Groundwater Basin during the next 20 years and threatened the local groundwater supplies, Central Basin developed a containment plan known as the Water Quality Protection Project (WQPP).

By taking necessary steps to ensure removal of the contaminants, it prevented any further migration of contamination from the San Gabriel Valley into the Central Groundwater Basin, preventing the contamination from reaching the spreading grounds. The cleanup of the aquifer at no cost to Central Basin produces a safe and reliable supply of potable water to participating producers without affecting water rates and minimizes the impact of rising energy costs to participating producers. Central Basin obtained necessary Federal funds for the implementation of the WQPP with the objective of preventing the further migration of contaminants into the Central Groundwater Basin. Funding legislation was enacted in December 2000 with congressional support.

Central Basin's Water Quality Protection Project.

The $10 million project consists of the construction of two extraction wells with a collector pipeline and treatment facility. The extraction wells will pump out the contaminated groundwater with a combined rate of approximately 3,600 gallons per minute and convey it via the collector pipeline to the central treatment facility for purification. To ensure service while saving costs, Central Basin entered into an agreement with the City of Whittier to co-locate components of the WQPP with Whittier's existing water facilities. Whittier's facilities are utilized to distribute the treated groundwater to purveyors.

Section 6

Water Conservation

6

Water Conservation

This section discusses the Water Conservation efforts within Central Basin's service area

6.1 OVERVIEW

Since the drought of the 1990s, Central Basin has been a leader implementing aggressive water conservation programs to help limit water demand in its service area. District programs have included a strong emphasis on education and the distribution of rebate incentives and plumbing retrofit hardware. The results of these programs, in conjunction with passive conservation measures such as modifications to the plumbing and building codes, have resulted in significant reductions in retail water use within Central Basin's service area. By current estimates, demand management conservation saves more than 4.5 billion gallons of imported water every year. This represents the average water use of almost 30,000 families in Southern California.

Central Basin's conservation programs are made up of a wide array of cost-effective programs that contribute to conserving water, improving water quality, reducing imported water needs and increasing the region's water supply reliability.

Central Basin prides itself in the partnerships it has created with Federal, State and local entities to offer these programs. By developing integrated programs with its partners, Central Basin has been able to leverage funding and resources to provide effective programs throughout its region.

This section will present the past and current water conservation efforts Central Basin has undertaken for the past 15 years, provide a detailed analysis of Central Basin's water conservation programs, according to the California Urban Water Conservation Council's (CUWCC) recommended Best Management Practices (BMPs), and give a brief description of Central Basin's upcoming conservation efforts and its Conservation Master Plan to promote additional water savings for the service area by the year 2030.

Water Conservation is made of two main elements: Active and Passive. Below is a brief description of these two.

Active Conservation:
Water savings produced from incentive based programs: Rebates, Free Devices, Retrofits, etc.

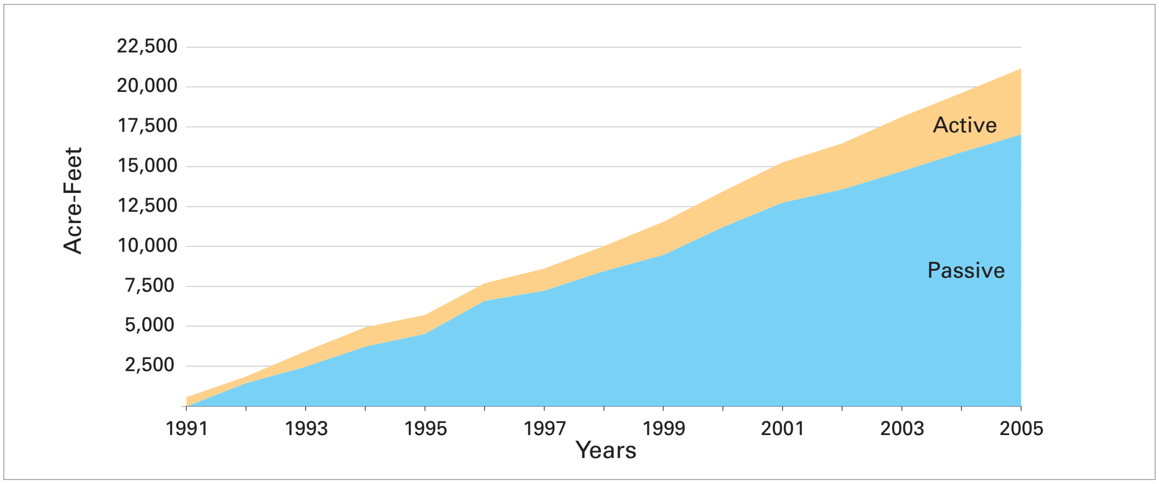
Passive Conservation:
Water savings produced from building and plumbing codes, consumer behavioral changes and price responses.

6.2 CENTRAL BASIN'S PAST AND CURRENT WATER CONSERVATION EFFORTS

Today, Central Basin's conservation programs are made up of a wide array of cost-effective programs as shown below.

- Zero Water Consumption Urinal Program
- Ultra-Low-Flush Toilets
- High Efficiency Clothes Washer Rebate Program
- Commercial, Industrial and Institutional Rebates
- Commercial Clothes Washers
- Water Brooms
- Cooling Towers Conductivity Controllers
- Pre-Rinse Spray Nozzles
- X-Ray Machine Recirculating Devices
- Landscape Conservation Programs
- Weather-Based Irrigation Controller
- Landscape Classes
- School Education Programs
- Public Outreach

Figure 6-1
Central Basin Conservation Water Savings
From 1990 to 2005

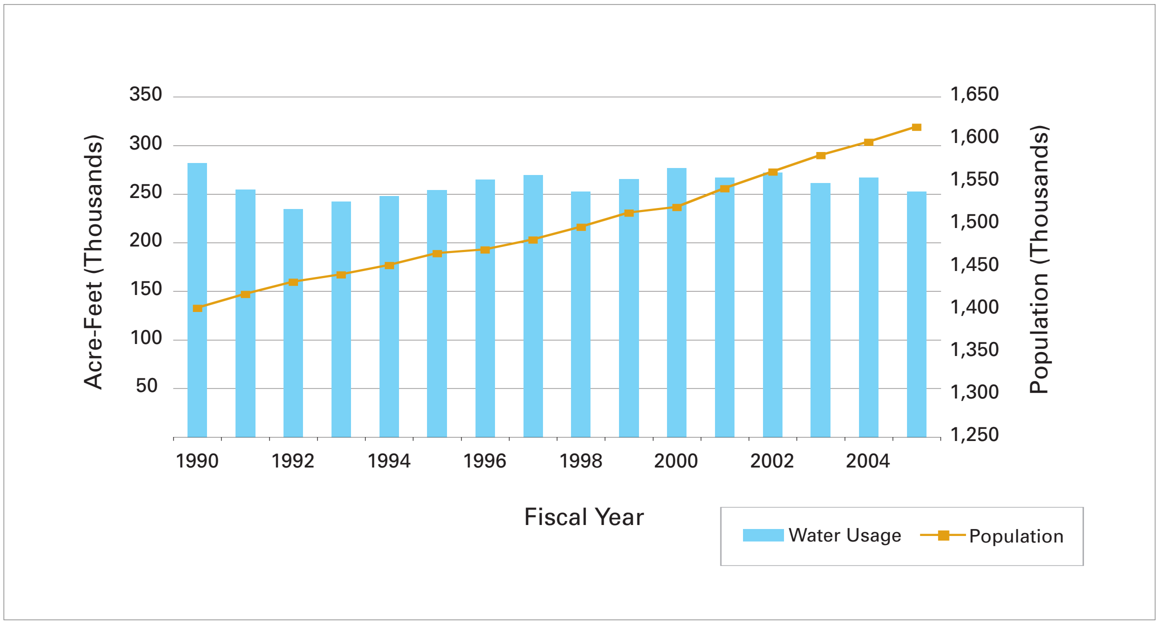


Source: Estimated total water savings from conservation from MWD-MAIN Model 2004.

It is estimated that Central Basin has distributed and installed more than 327,100 devices from 1990 to 2003. As a result, it is estimated that Central Basin currently saves, from active and passive conservation combined, more than 21,100 AF (6.8 billion gallons), or 8% percent annually, of Central Basin's total water demand. The total cumulative savings to date since 1990 is more than 158,900 AF.

Conservation savings can further be verified by comparing Central Basin's water usage versus population. As shown in Figure 6-2, water usage has remained relatively consistent while population has escalated an average of 1% annually.

Figure 6-2
Central Basin Service Area
Total Water Demand vs. Population Growth
From 1990 to 2005



Source: Central Basin's water use database and MWD Demographic Data, 2005.

6.2.1 METROPOLITAN WATER DISTRICT'S CONSERVATION GOAL

MWD, in adopting its 2004 IRP Update, is committed to an aggressive conservation goal. MWD's IRP Update set water supply targets for Southern California through 2025, which includes a conservation target of 1.1 MAF during the next 20 years. MWD's strategy and approach for meeting the conservation targets is outlined in a "Conservation Strategy Plan." The Strategy Plan emphasizes three main areas of incentive based conservation: Residential, Landscape and Commercial, Industrial and Institutional (CII), and provides Board policy guidelines and action plans for the implementation of conservation under MWD's Conservation Credit Program.

6.3 CALIFORNIA URBAN WATER CONSERVATION COUNCIL

In 1991, the CUWCC was created to increase water use efficiency by integrating urban water conservation BMPs into the planning and management of California water agencies. It is a partnership of agencies and organizations concerned with water supply and conservation of natural resources in California.

To encourage water use efficiency, the CUWCC asked water agencies and organizations to sign a Memorandum of Understanding (MOU) regarding urban water conservation in California, which committed participating urban water suppliers to use their "good faith efforts" to implement the CUWCC's 14 BMPs.

Central Basin was one of the first urban water suppliers to become signatory to the CUWCC's MOU. In addition, Central Basin has submitted a Best Management Practices Wholesaler Water Agency Report to the CUWCC every other year that details Central Basin's progress in implementing the 14 BMPs as currently specified in the MOU. In Appendix F, the District has attached its 2003-04 Agency Report.

The BMPs are becoming increasingly important as benchmarks of agency conservation efforts throughout the State. This UWMP, for example, requires agencies that are not members of the CUWCC to describe current and future implementation efforts for all 14 BMPs (referred to as Demand Management Measures, or DMMs). Eligibility for grant funding from State agencies, such as DWR, is now contingent upon satisfactory completion of the UWMPs and the conservation reporting within them.

6.3.1 BEST MANAGEMENT PRACTICES (BMPS)

The BMPs are a list of recommended conservation measures that have been proven to provide reliable savings to a given urban area. There are currently 14 BMPs that a signatory member is committed to implement. Table 6-1 below, lists the 14 existing BMPs.

Table 6-1
List of Best Management Practices for California Urban Water Conservation Council

1. Residential Water Surveys Indoor and outdoor audits of residential water use and distribution of water-saving devices
2. Residential Plumbing Retrofits Distribution or installation of water-saving devices in pre-1992 residences
3. System Water Audits Unaccounted for water calculated annually and distribution system audits as required
4. Metering with Commodity Rates Metering of consumption and billing by volume
5. Large-Landscape Conservation ET-based water budget for large landscape irrigators
6. High Efficiency Clothes Washers Rebates for efficient washing machines
7. Public Information Public information to promote water conservation

(Table continues on next page.)

(Table 6-1 continued from previous page.)

8. School Education Provision of education materials and services to schools
9. Commercial, Industrial and Institutional Conservation (CII) Programs to increase water use efficiency in CII sectors
10. Wholesale Agency Assistance Support by wholesalers for conservation programs of retail water suppliers
11. Conservation Pricing Uniform or increasing block rate structure, volume related water charges and service cost recovery
12. Conservation Coordinator Designation of staff coordination of agency conservation programs
13. Water Waste Prohibition Enforced prohibition of wasteful use of water
14. Residential Ultra-Low-Flush Toilet Replacement Programs promoting replacement of high-water-using toilets with Ultra-Low-Flush Toilets

As a signatory to the MOU, Central Basin currently implements the wholesaler BMPs, which are BMPs #3, 7, 8, 10, 11 and 12. Although only certain BMPs apply to a wholesaler, Central Basin also provides additional support to its cities and water retailers (customers) through BMP #10. As a water wholesaler representing 24 cities throughout southeast Los Angeles County, Central Basin also supports its customers with BMPs #5, 6, 9 and 14. In order to enhance the programs, Central Basin offers partnership opportunities to its customers who can add additional funding and resources in order to increase the size of the programs or rebates, which increases participation and water savings.

6.4 CENTRAL BASIN'S CONSERVATION PROGRAMS

Central Basin's mission is to ensure a safe and reliable supply of water to its service area. Since the drought of the 1990s, Central Basin has strived to expand its role in water use efficiency. Not only is water conservation and education a method for public outreach but it's an essential part of Central Basin's water resources portfolio to drought-proof the region.

Although Central Basin is required to meet only the wholesaler BMPs, Central Basin is committed to assisting its customer agencies with their conservation efforts. Described below are Central Basin's efforts in each of the 14 BMPs.

6.4.1 BMP #1 - WATER SURVEY PROGRAMS FOR SINGLE-FAMILY RESIDENTIAL AND MULTI-FAMILY CUSTOMERS

Residential surveys look to all the water using devices inside the home such as toilets, faucets, showerheads, etc. A trained surveyor checks for leaks and tests the flow indoors and outdoors. Once the survey is completed, recommendations are provided for retrofitting certain water use devices, and educational materials are also supplied to the resident.

Because Central Basin is a water wholesaler and does not have direct access to single- or multi-family customer account data, Central Basin can only provide support to the water retailers. MWD currently provides funding for residential survey devices, and if requested, Central Basin will act as the liaison to MWD and provide retailers with funding available through MWD. It is anticipated that Central Basin will review the market strategy for promoting residential water use surveys within the Conservation Master Plan.

Residential surveys provide cities and water retailers with a great opportunity to provide their customers with a program that offers customer outreach opportunities.

Table 6-2
Residential Plumbing Retrofit Devices

	1990-2000		2000-2005		Total	
Devices	**# units**	**AF**	**# units**	**AF**	**# units**	**AF**
Faucet Aerators	1,154	3.6	0	0	**1,154**	**3.6**
Low-Flow Showerheads	237,049	1,115	7,500	35	**244,549**	**1,150**

6.4.2 BMP #2 - RESIDENTIAL PLUMBING RETROFIT

This BMP recommends the distribution and retrofit of low-flow showerheads, Ultra-Low-Flush Toilets and faucet aerators as well as the adoption of enforceable ordinances.

Since 1990, it is estimated that Central Basin has distributed the following number of faucet aerators and low-flow showerheads, shown in Table 6-2.

6.4.3 BMP #3 - SYSTEM WATER AUDITS, LEAK DETECTION, AND REPAIR

In 1996, Central Basin and its sister agency, West Basin Municipal Water District, partnered with the United States Bureau of Reclamation (USBR) and hired a consultant to develop and provide a Water Audit and Leak Detection Program (Program). The Program was offered to 40 water purveyors. Of the 40, only 10 participated in the audit, and of the 10, only three agencies found their unaccounted for water to be above 10%.

According to BMP #3, water retailers shall complete an annual pre-screening system audit of its potable water system to determine the need for a full-scale system audit.

This BMP is geared more toward a water retailer, but Central Basin has provided support in the past. As part of its Conservation Master Plan, Central Basin will seek input from its water retailers regarding support for this program.

6.4.4 BMP #4 - METERING WITH COMMODITY RATES FOR ALL NEW CONNECTIONS AND RETROFIT OF EXISTING CONNECTIONS

Since Central Basin is a water wholesaler, this BMP does not directly apply. However, every water agency within Central Basin's service area bills their retail customers according to meter consumption. This BMP requires that agencies identify intra- and inter-agency disincentives and barriers to retrofitting mixed use commercial accounts with dedicated landscape meters and conduct a feasibility study to assess the merits of a program that provides incentives to switch mixed use accounts to dedicated landscape meters.

By encouraging the installation of dedicated landscape meters, agencies will be able to recommend the appropriate irrigation schedules through future landscape programs.

6.4.5 BMP #5 - LARGE LANDSCAPE CONSERVATION PROGRAMS AND INCENTIVES

Despite the urbanization of Southern California, the region is dotted with large turf areas that require year-round irrigation to keep them green. Large turf areas include city and county parks, golf courses, schools, cemeteries and street medians.

South Gate Park outfitted with irrigation controllers.

Central Basin is reducing demand for imported water for irrigation purposes by providing recycled water in its service area. Virtually anywhere potable water is used to irrigate, recycled water can, and should, replace it. However, in areas where recycled water cannot reach or be applied to large landscape areas, Central Basin provides other programs to conserve water. Below is a list of the programs Central Basin is currently implementing.

Irrigation Controller Programs

In 2004, MWD was awarded a Proposition 13 grant for a new Weather-Based Irrigation Controller (CBIC) Program. MWD and its member agencies developed a Project Advisory Committee (PAC) to work on developing the program, which includes marketing, reporting, databasing and implementing. MWD allocated a limited amount of funding to each member agency for this program. Central Basin has been working with the PAC to develop the program. Central Basin recognizes the water savings potential and is beginning to test weather-based irrigation controllers in sites that use potable imported water. The plan is to use the new controllers in areas where recycled water cannot reach. The funding incentives provided vary on the number of stations and acreage at each site. The funding is used to help pay for the hardware and to help motivate cities, parks and schools to participate in the program.

Irrigation controllers can save between 20-50 percent of outdoor water use.

Protector Del Agua Irrigation Program

Central Basin also partners with MWD on the "Protector Del Agua" or "Protector of Water" landscape classes. In partnership with cities, classes are offered to residents as a way to teach them about various topics that help conserve water and reduce urban runoff. Residents learn about gardening with native plants and using weather-based irrigation controllers to conserve water and reduce runoff.

More than 50% of the potable water used in Southern California goes to maintain landscaping; therefore, offering these classes is an ideal way to reduce outdoor water waste. By educating the public on properly maintaining the irrigation system and trouble-shooting problems, such as over-watering, that are simple yet difficult to address, can be solved without spending additional funding.

Wireless Irrigation Controllers

Central Basin, along with its partners, submitted and received Proposition 50 funding for a research project to test how wireless irrigation controllers can be used to conserve water in outdoor landscaping. Central Basin will partner with cities and water retailers to offer wireless irrigation controllers to schools, parks, businesses and other large landscape areas that are currently using older hydraulic-type irrigation systems. By providing wireless irrigation controllers, sites will have the ability to inexpensively retrofit their current irrigation systems. Wireless irrigation controllers use weather data to irrigate and can save between 20- 50% of outdoor water use and also reduce urban runoff by up to 70%. This research program will be implemented in 2006.

6.4.6 BMP #6 - HIGH-EFFICIENCY WASHING MACHINE REBATE PROGRAMS

Beginning in 1999, Central Basin participated with MWD in a pilot program with Southern California Edison (Edison) to offer rebates to residents who replaced their existing clothes washer with a high efficiency model. The rebate from Edison varied according to the model purchased (which was tied into the total energy savings), but the amount offered by Central Basin and MWD at the time was capped at $35 per washer. That pilot program ended in September 1999.

In 2003, Central Basin again partnered with MWD on a new program. MWD received funding from CALFED and provided a higher rebate incentive. Central Basin developed the program and offered residents a $100 rebate.

The CALFED portion of the funding expired, but the program was so successful that, at the request of the MWD member agencies, MWD continued to provide funding at the current level. The High-Efficiency Clothes Washer (HECW) Program has exceeded all expectations and continues to be one of Central Basin's more successful programs. When the HECWs first hit the market, they were quite expensive. But market demand has helped to drive the price down. The new HECWs cost twice as much as regular inefficient models, but by providing a $100 rebate (along with other utility/store incentives), consumers are purchasing the new HECWs. In addition to saving 50% water, the HECWs also have other benefits: they save 60% electricity and use less detergent. Consumer acceptance has been very positive.

In 2004, the MWD Board of Directors, along with the support of Central Basin, approved additional funding to continue the program through 2005. At the same time, MWD applied for Proposition 50 funding in an effort to maintain the program at the higher incentive level through 2006. MWD was successful in its Prop. 50 application and was awarded roughly $1.6 million from the California Department of Water Resources for the High-Efficiency Clothes Washer Rebate Program. This funding will allow MWD and Central Basin to continue offering its $100 rebate to residents in an effort to encourage the purchase of high-efficient clothes washers with a Water Factor (WF) of 6.0 or less.

Table 6-3
High-Efficiency Washing Machine

	2003	2004	Total
$ per Rebate	$100	$100	**n/a**
# of Rebates	541	758	**1,299**
Water Savings (AF)	8	11	**19**

The Water Factor of a clothes washer can range from 13.5 to 3.6, with the lower number being more efficient. A complete list of qualifying washers can be obtained at MWD's web site, www.bewaterwise.com, or by calling the District's program vendor at 1-877-732-2830.

In 2003, the Governor of California signed Assembly Bill 1561 that would require clothes washer manufacturers to only manufacture and provide residential washers with a WF of 8.5 in 2007 and 6.0 by 2010. The legislation was adopted by the California Energy Commission and was submitted to the Federal Government for approval. The Federal Government must approve this legislation before the new standards can be applied. This process is anticipated to take 1–2 years.

As long as funding is available, MWD and Central Basin will continue offering its $100 rebate to residential customers for clothes washers with a WF of 6.0 or less. Table 6-3 illustrates the number of rebates Central Basin has distributed during the past two years.

In an effort to continue the successful washer rebate program, MWD along with its member agencies, applied for and received Proposition 50 funding from DWR in the amount of $1,660,000. This funding will allow Central Basin to continue its rebate program through 2006.

6.4.7 BMP #7 - PUBLIC INFORMATION PROGRAMS

Public information is a very broad term with various meanings. Since Central Basin operates a strong outreach program, public information about Central Basin and its mission, programs and events are constantly disseminated to many interested parties. The method by which the public receives this information is important.

- The first significant method is the Public Information Committee (PIC), formed several years ago. The Committee is made up of Public Information and Public Affairs Officers from cities and water agencies within Central Basin's service area. The purpose is to share information on a variety of topics that would be of interest to customers.

- Central Basin, in cooperation with MWD, also provides inspection tours of the Colorado River Aqueduct and the State Water Project to legislators, local elected officials, retail agency staff and the general public on various dates throughout the year. The purpose of the three-day trips is to give local decision-makers a better understanding and appreciation of the water supply throughout the State.

- Central Basin, through its Speaker's Bureau, provides speakers to local community groups, service clubs and schools when requested. In addition, Central Basin operates a very successful and aggressive school education program that promotes the importance of conservation and recycled water.

- Central Basin is also active in the California Water Awareness Campaign (CWAC), which is an association formed several years ago to coordinate efforts throughout the state during "May is Water Awareness Month." With this effort, water agencies throughout the State, large and small, can tap into a large pool of knowledge and materials to promote a water awareness message not only in May but throughout the year.

- Central Basin maintains a strong link with the local news media through press releases on important subjects and periodic meetings with newspaper editorial boards.

Children are encouraged to participate in the education programs that Central Basin offers.

6.4.8 BMP #8 - SCHOOL EDUCATION PROGRAMS

Water and environmental education continue to be critical components of Central Basin's outreach strategy. Therefore, Central Basin offers a variety of elementary through high school programs free of charge to all schools within its service area. The following is a list of Central Basin's current and future education programs. Descriptions of every program can be found in Section 6.5.

- *Planet Protector Water Explorations*
- *Think Earth It's Magic*
- *Conservation Connection*
- *Think Earth Curriculum Kits*
- *Water Is Life Poster Contest*
- *Water Wanderings: A Journey Through Water*
- *SEWER SCIENCE*

6.4.9 BMP #9 - CONSERVATION PROGRAMS FOR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL (CII) ACCOUNTS

Central Basin, in partnership with MWD, participates in MWD's region-wide CII rebate program. Central Basin helps promote these rebates to the businesses, schools and facilities throughout its service area. Rebates are offered for commercial clothes washers, waterbrooms, cooling tower conductivity controllers, pre-rinse spray nozzles, x-ray machine recirculating devices and commercial toilets and urinals.

In 2002, the CUWCC pursued and received a $2.3 million grant from the California Public Utilities Commission (CPUC) to purchase and install restaurant pre-rinse spray nozzle valves. The new nozzles use 1.6 gpm compared to 2 - 6 gpm valves. These valves conserve water and heating costs and reduce wastewater discharge. Central Basin supported CUWCC's efforts in marketing the program. The nozzles and installations were provided free of charge to the food services sector.

In 2003, Central Basin applied for and received a $780,000 Proposition 13 grant for the purchase and installation of 2,600 Waterfree Urinals. Waterfree urinals can save an average of 40,000 gallons of water per year. Central Basin is currently working with cities, water purveyors, schools, businesses and other facilities to install the devices.

In 2005, Central Basin entered into a 10-year agreement with MWD to help support the on-going regional marketing efforts of the CII rebate program. As a way to increase the success of this program, Central Basin offers the cities and water purveyors partnering opportunities to increase the rebate amounts. Through the years, agencies have partnered to provide higher rebate incentives in an effort to increase program participation of their customers.

6.4.10 BMP #10 - WHOLESALE AGENCY PROGRAMS

The programs provided by Central Basin are done in partnership with and benefit the retail water agencies that are located within the 24 cities serviced by Central Basin.

Among the 14 BMPs Central Basin provides assistance for are:

- **BMP #3** - System Audits
- **BMP #5** - Landscape Programs
- **BMP #6** - Washing Machines
- **BMP #7** - Public Information
- **BMP #8** - School Education
- **BMP #9** - CII Rebates
- **BMP #10** - Wholesaler Incentives
- **BMP #12** - Water Conservation Coordinator
- **BMP #14** - ULFT Replacement

Since 2000, Central Basin has acquired more than $1 million from State and local grant funding sources for program development and implementation. Furthermore, Central Basin markets, designs and implements a majority of the BMPs within its service area. Central Basin has also invested more than $1 million to provide conservation programs that help increase water supply reliability for the region.

School children enjoy Think Earth It's Magic Program.

Central Basin plans on expanding its conservation programs and the support it provides to cities and water retailers in their conservation program efforts.

6.4.11 BMP #11 - CONSERVATION PRICING

In 2003, Central Basin passed through MWD's two-tiered rate structure to its customer agencies to promote water conservation and regional water supply reliability. This rate structure called for customer agencies, in coordination with Central Basin, to develop a reasonable budget for their Tier 1 annual maximum limit for imported water. Through voluntary purchase agreements, these customers will pay a higher price (Tier 2) for purchases that exceed their Tier 1 allotment.

To help assist agencies from exceeding their Tier 1 allocation limits, Central Basin works with agencies to enhance conservation, education and expand recycled water use.

6.4.12 BMP #12 - WATER CONSERVATION COORDINATOR

As the regional wholesaler, Central Basin has a water conservation coordinator that not only promotes Central Basin's conservation programs and devices but also works with cities and water agencies to enhance their conservation efforts. This close collaboration between Central Basin's conservation coordinator and the customer agencies' staff provides for a successful execution of the BMPs. In addition, Central Basin's conservation coordinator represents the service area at regional and statewide workshops and organizations.

Central Basin's conservation coordinator also seeks Federal, State and local funding to develop new programs that cities and water purveyors can partner on and provide additional benefits to the end-users.

6.4.13 BMP #13 - WATER WASTE PROHIBITION

Central Basin encourages its customer agencies to adopt water waste prohibition ordinances. Central Basin can also assist local cities and agencies to develop ordinances that will reduce water wasting in the area.

6.4.14 BMP #14 - RESIDENTIAL ULTRA-LOW-FLUSH TOILET (ULFT) REPLACEMENT PROGRAMS

One of Central Basin's more successful programs has been its free ULFT distribution program. Since 1991, Central Basin has provided more than 80,000 ULFTs to the public "free of charge" in an effort to conserve water. These devices have proven water savings and have contributed to the overall water reduction through the years.

In 2004, Central Basin partnered with MWD on a joint project to identify the existing opportunity within Central Basin's service area for this device. Data shows that there are still many inefficient toilets that need to be replaced. Within Central Basin, there is a 30-40% saturation level in many of its cities. The saturation levels and program performance will continue to be evaluated. For the time being, Central Basin plans on continuing to provide ULFTs and rebates as long as funding is available, programs continue to be cost-effective and a significant saturation level has not been met.

Due to the large areas of high density and numerous multi-family facilities, there are still many older toilets that need replacing. Central Basin will continue to partner with cities and water purveyors in order to implement these programs. In addition, Central Basin will continue to offer its $50 rebate for the purchase and installation of ULFTs.

ULFT giveaway event in La Mirada.

Table 6-4
ULFT Rebate Program

	2000	2001	2002	2003	2004	Total
$ per Rebate	$50	$50	$50	$50	$50	**n/a**
# of Rebates	662	895	619	493	649	**3,318**
Water Savings (AF)	19	26	18	14	18	**95**

Table 6-5
ULFT Replacement Program (Free ULFT Distributions to the Public)

	2000	2001	2002	2003	2004	Total
# of Devices	7,250	5,975	3,650	2,574	2,608	**22,057**
Water Savings (AF)	211	174	106	74	75	**640**

Central Basin also provides a $70 rebate for the purchase and installation of dual-flush toilets. These new toilets have the capability of flushing at either 0.8 gallons for liquids and 1.6 gallons for solids; they average 1 gallon per flush. Also, new 1 gallon per flush High-Efficiency Toilets (HET) are beginning to enter the market place. Advances in technology continue to create new conservation devices that are more water efficient than today's products.

Tables 6-4 and 6-5 illustrate the ULFT Rebate Program and the ULFT Replacement Program for the last five years.

6.4.15 ADDITIONAL CONSERVATION PROGRAMS

Central Basin is very active in working with MWD to develop new conservation programs that are included in the CUWCC BMPs. In 2005, MWD implemented several new programs that Central Basin supports, including:

Synthetic Turf Program
MWD, in partnership with the USBR, developed and provided funding to test the effectiveness of using synthetic turf. Central Basin helped promote the program by issuing press releases and forwarding information to cities, water purveyors, non-profit organizations and others.

City Makeover Program
Central Basin continues to support MWD's City Makeover Program. Through a competitive application process, MWD provides funding for development of new water efficient landscapes that promote California native plants and water efficient techniques. More information about this program can be found on MWD's web site, www.mwdh2o.com.

Community Partnering Program
MWD, in cooperation with the Member Agencies, accepts applications from nonprofit organizations and public agencies that promote discussions and educational activities for regional water quality, conservation and reliability issues. This program provides support for the following types of programs:

- after-school water education
- community water festivals
- watershed education outreach
- environmental museum exhibits
- library water resources education book drives

Local residents inspect high efficiency toilet.

- public policy water conferences
- other projects that directly support water conservation or water quality education

6.5 CURRENT AND FUTURE EDUCATION PROGRAMS

6.5.1 CURRENT PROGRAMS

Planet Protector Water Explorations
Now in its 10th year of operation, Planet Protector Water Explorations is a collaborative water education field trip program between Central Basin and the Roundhouse Marine Lab and Aquarium in Manhattan Beach. The Roundhouse is operated by Oceanographic Teaching Stations, a non-profit organization, and is affiliated with the Los Angeles County Office of Education.

The objectives of Planet Protector Water Explorations are:

1. To increase the awareness of water as a valuable and limited resource.
2. To encourage water conservation efforts.
3. To introduce the concept of water recycling.
4. To introduce the concept of ocean water desalination.

Think Earth It's Magic
School Education Program.

5. To increase the awareness of urban runoff pollution.
6. To teach about local marine life.
7. To promote the concept of stewardship of the environment and its resources.

By the end of the 2004-2005 school year, more than 25,000 students will have experienced Planet Protector Water Explorations since the program began in September 1995. Table 6-6 displays the number of students that have been educated through the Plant Protector Water Exploration program from fiscal year 2000-01 to fiscal year 2004-05. Beginning in fiscal year 2004-05, additional programs have become available to students, therefore increasing the number of students that are educated through the various programs.

Think Earth It's Magic
Through Central Basin's membership as part of the Think Earth Environmental Education Foundation, Think Earth It's Magic is a collaborative program between Central Basin, the CSDLAC and MWD. Think Earth It's Magic combines Think Earth's award-winning environmental education curriculum, which is designed to promote conservation behaviors and stewardship of the environment, with an environmental magic show that cleverly ties together what students learn in the classroom. By the end of the 2004-2005 school year, more than 500 elementary school students will have participated in Think Earth It's Magic.

Conservation Connection
We turn on the tap and water flows out. We turn on a lamp and light fills the room. We depend on water and energy. We need water and energy to live in this world. But where do we get the water and energy that we use? And will we always have enough to meet our needs?

Conservation Connection answers those questions, showing the connections between California, our water and energy supply, and us. But providing information is only part of Conservation Connection. The goal of the curriculum is to get students actively involved – in their homes and at school – in conserving water and energy. Within the program, students have the opportunity to sur-

Table 6-6
School Education Program
(Number of Students)

Grade Level	FY 2000-01	FY 2001-02	FY 2002-03	FY 2003-04	FY 2004-05[1]	Total
Grades K-3rd	250	110	190	330	1,014[2]	1,894
Grades 4th-6th	1,121	872	830	1,190	1,632	5,645
Grades 7th-8th	140	95	105	60	876	1,276
High School	0	0	0	0	174	174
Total	1,511	1,077	1,125	1,580	3,696	8,989

[1] Program includes Planet Protector Water Exploration in addition to Think Earth It's Magic, Conservation Connection and Think Earth curriculum kits for Fiscal Year 2004-05 only.
[2] Only third graders participate in this program.

vey their family's water and energy use and survey water and energy use at their school.

After gathering data, analyzing their findings and reviewing recommendations, students make, implement and monitor plans to decrease water and energy use. By participating in this action-based curriculum, students will learn to look critically at important environmental issues and take responsibility for finding solutions. By the end of the 2004-2005 school year, more than 500 middle school students will have participated in Conservation Connection.

Think Earth Curriculum Kits
Through Central Basin's membership as part of the Think Earth Environmental Education Foundation, all teachers that participate in Planet Protector Water Explorations receive a grade appropriate Think Earth curriculum unit. Think Earth units are usually distributed each March so that teachers have them prior to Earth Day in April. Each Think Earth unit contains a video, two color posters, a teacher's guide and student booklets. The entire Think Earth curriculum is correlated to the California State Content Standards for the following content areas: language arts, science, social science and mathematics. During the past 10 years more than 25,000 students within Central Basin's service area have participated in Think Earth.

"Water Is Life" Poster Contest
All teachers who have or will participate in Planet Protector Water Explorations during the 2004-2005 school year will be notified in February that their students can participate in the 2005 "Water Is Life"

Winner of the 2005 "Water Is Life" Poster Contest. Fifth-grade student Kimberly Cuchilla from Abraham Lincoln Elementary School in the City of Whittier.

Poster Contest, which is sponsored by Central Basin and MWD. In addition, teachers at each of Central Basin's primary through secondary schools will be notified in February. As in previous years, one grand-prize winner is selected from each District and receives a fully-loaded laptop computer during an award ceremony in June 2005. Each grand-prize winner will also have his or her artwork featured in MWD's "Water Is Life" 2006 Calendar. During the past 10 years more than 25,000 students within Central Basin's service area have had an opportunity to participate in this program.

6.5.2 FUTURE PROGRAMS

Water Wanderings: A Journey Through Water
Water Wonderings is a collaborative classroom visitation program between Central Basin and the S.E.A. Lab in Redondo Beach. This collaborative hands-on classroom program will take fourth graders on a 2 1/2 hour journey through California's water. The program will be correlated to many of the fourth grade State standards for social science and science. Included in the program will also be a "touring tide pool," a van outfitted with touch tanks that will enable students to touch live marine creatures and plants. The program schedule calls for classes to begin October 2005 and last through June 2006 for the 2005-06 fiscal year.

SEWER SCIENCE
Staff is currently partnering with the CSDLAC on this exciting high school science program. SEWER SCIENCE is a hands-on laboratory program that teaches students about wastewater treatment. During a week-long lab, students create wastewater, treat it through the use of tanks employing physical, biological and chemical methods, and apply analytical procedures to test its quality. SEWER SCIENCE is correlated to the California State Content Standards for the following high school sciences: chemistry, physics and microbiology. It is staff's intention to have the program developed by the end of Summer 2005 and then to begin marketing efforts to schedule program dates from September 2005 through June 2006.

6.6 FUNDING PARTNERSHIPS

In addition to partnering with MWD on programs, Central Basin also seeks State funding. In 2004 and 2005, the Department of Water Resources and the State Water Resources Control Board provided funding for programs through various chapters of Proposition 50. As a leader in water conservation, Central Basin, in partnership with its cities and water retailers, developed several conservation programs and applied to the State's grant funding competitive process. If funding is awarded, Central Basin will work with its cities and water purveyors to provide programs to the local communities.

In 2005, the City of South Gate in conjunction with Central Basin received a grant through MWD's City Makeover Program for $6,000 for a demonstration garden at Hollydale Elementary Garden.

6.6.1 PROPOSITION 50 PROGRAMS

In 2005, Central Basin, with support from cities, water retailers and environmental groups, applied for and received Proposition 50 - Chapter 7 - Water Use Efficiency Research Grant in the amount of $164,052. This grant funding from the Department of Water Resources will allow the District to work with its partners to purchase and test wireless irrigation controllers. These controllers will be used to retrofit older hydraulic systems and make them more water efficient. Wireless technology has been proven as an effective way for various devices to communicate and Central Basin, along with its partners, will be using the technology to conserve water in large outdoor landscapes. This program will be implemented in 2006.

Central Basin also applied for the Proposition 50 - Chapter 8 - Integrated Regional Water Management Grant Program. Central Basin partnered with various cities, water purveyors and stakeholders to develop an integrated approach at developing regional programs. Funding is being sought for the purchase and installation of Weather-Based Irrigation Controllers and for the development of landscape workshops and demonstration gardens. If successful, Central Basin will provide education and devices that will conserve water, reduce urban runoff, reduce imported water and increase local water supply reliability.

6.7 CENTRAL BASIN'S CONSERVATION MASTER PLAN

Water Conservation, along with water recycling, will be used to meet a substantial portion of Central Basin's water demands that are gradually increasing. The goal is to minimize Central Basin's need for new imported water sources and enhance this drought-proof resource that has no environmental impacts and is not subject to weather conditions.
Measures such as tiered water pricing, financial incentives for the installation of Ultra-Low-Flush Toilets and water efficient washing machines and large landscape irrigation efficiency programs are just some of the ways Central Basin provides leadership and results in the conservation arena. Conservation is a key component of Central Basin's water resource planning activities and will be implemented to the fullest extent practicable through the long-term.

6.7.1 WATER CONSERVATION MASTER PLAN

Central Basin is in the process of developing its own specific Conservation Master Plan (Plan) to meet and exceed the goals of the BMPs and MWD's Conservation Strategy Plan. The goal of the Plan is to assess the conservation potential within Central Basin's service area and incorporate local stakeholder input into a group of actions and strategies for achieving long-term targets for conservation. The Plan will be launched and completed within the 2005-06 fiscal year.

Section 7

Water Rates & Charges

7

Water Rates & Charges

This section discusses Central Basin's Water Rates & Charges

7.1 OVERVIEW

The residential water bill in Southern California is most likely the least expensive of a typical household's major utility bills. In fact, tap water can be purchased for much less than a penny per gallon–remarkable considering investments by water utilities into regulatory compliance, water use efficiency, infrastructure and other reliability programs. This paradox applies to Central Basin's service area as well, although residential water bills vary from retail water agency to retail water agency depending primarily on the mix of source water purchased and/or produced.

Retail agencies that serve exclusively groundwater, for example, tend to have water rates that are lower than those that serve all imported water or a mix of groundwater and imported water. Imported water purchased from Central Basin and provided by MWD carries not only the cost of acquiring importing, purifying (treating) and distributing the commodity throughout the region but also a long-term action plan for ensuring adequate supplies to meet growing demands through conservation, education and new locally produced supplies.

7.2 MWD RATE STRUCTURE

In 2002, the MWD Board adopted a new rate structure to support its strategic planning vision as a regional provider of services, encourage the development of local supplies such as recycled water and conservation, and ensure a reliable supply of imported water. To achieve these objectives, MWD called for voluntary purchase orders from its member agencies, unbundled its water rates, established a tiered supply rate system and added a capacity charge. In all, these new rate structure components provide a better opportunity for MWD and its member agencies to manage their water supplies and proactively plan for future demands.

7.2.1 PURCHASE ORDERS

One of the important changes in the new rate structure was the call for voluntary purchase orders among MWD's member agencies. The Purchase Order is an agreement between MWD and a member agency, whereby the member agency agrees to purchase a minimum amount (60% of their highest year's delivery of non-interruptible water times 10) of non-interruptible water during a 10-year period - "Purchase Commitment." The economic incentive for a Purchase Commitment is that it entitles the member agency to purchase annually a set amount of non-interruptible water (Tier 1 Annual Maximum) at the lower Tier 1 rate, which is 90% of its highest year's delivery of non-interruptible water.

In the case of Central Basin, the highest delivery of non-interruptible water was 80,700 AF in 1990. As shown below in Table 7-1, Central Basin's Tier 1 Annual Maximum is 72,360 AF with a Purchase Commitment of 482,400 AF by the end of 2013.

Since signing a Purchase Order with MWD, Central Basin has remained below its Tier 1 Annual Maximum and has been on track to meet its Purchase Commitment by the year 2013.

Table 7-1
Central Basin Purchase Order Terms

Initial Base Allocation	Tier 1 Annual Maximum (90% of Base)	Purchase Commitment (60% of Base x 10)
80,400 AF	72,360 AF	482,400 AF

7.2.2 UNBUNDLED RATES AND TIER 1 & 2

In order to clearly justify the different components of the costs of water on a per acre foot basis, MWD unbundled its full service water rate. Among the components MWD established are:

Supply Rate Tier 1 – Reflects the average supply cost of water from the Colorado River and State Water Project.

Supply Rate Tier 2 – Reflects the MWD costs associated with developing new supplies, which is assessed when an agency exceeds its Tier 1 limit of firm deliveries.

System Access Rate – Recovers a portion of the costs associated with the conveyance and distribution system, including capital and operating and maintenance costs.

Water Stewardship Rate – Recovers MWD's cost of providing incentives to member agencies for conservation, water recycling, groundwater recovery and other water management programs approved by the MWD Board.

System Power Rate – Recovers MWD's electricity-related costs, such as the pumping of water through the conveyance and distribution system.

Treatment Surcharge – Recovers the treatment cost and is assessed only for treated water deliveries, whether firm or non-firm.

Recycled water use at Pico Rivera Golf Course.

Table 7-2
Metropolitan Water District Unbundled Water Rate Components Adopted for 2006

Category of Water	$/AF
Supply Rate Tier 1	$73
Supply Rate Tier 2	$169
System Access Rate	$152
Water Stewardship Rate	$25
System Power Rate	$81
Treatment Surcharge	$122
Total Tier 1 Treated Rate	**$453**
Total Tier 2 Treated Rate	**$549**

The unbundled MWD water rates for calendar year (CY) 2006 are displayed in Table 7-2.

7.2.3 REPLENISHMENT SERVICE

Although a majority of the MWD water sold is full service at the Tier 1 rate, there is imported water sold at a discounted rate, better known as Replenishment Service Water. This type of water is used for groundwater storage and/or replenishment. There are two main types of replenishment water – treated and untreated. Because the replenishment water can be interrupted at anytime, MWD has provided a discount to the rates. However, these rates are not tied to the unbundled rate structure illustrated above. These rates are established by MWD to provide the best incentive to replenish the groundwater basins. Replenishment Service rates for 2006 are shown in Table 7-3.

Table 7-3
Metropolitan Water District Replenishment Service Rate Adopted for 2006

Category of Water	$/AF
Replenishment Water Rate Untreated	$238
Treated Replenishment Water Rate	$335

7.2.4 MWD CAPACITY CHARGE

MWD's new rate structure also established a new charge labeled "Capacity Charge." This charge was developed to recover the costs of providing

Table 7-4
Metropolitan Water District Capacity Charge for 2006

	Peak Flow 2002	Peak Flow 2003	Peak Flow 2004	3-Year Max
Central Basin	128.3 cfs	133.4 cfs	149.6 cfs	149.6 cfs

Note: These peak flows are based upon Central Basin's coincident peak of all its MWD connections.

distribution capacity use during peak summer demands. The aim of this new charge is to encourage member agencies to reduce peak day demands during the summer months (May 1 through September 30) and shift usages to the winter months (October 1 through April 30), which will result in more efficient utilization of MWD's existing infrastructure and defers capacity expansion costs. Currently, MWD's Capacity Charge for 2006 is set at $6,800/cubic feet per second (cfs).

The Capacity Charge is assessed by multiplying Central Basin's maximum usage by the rate. The maximum usage is determined by a member agency's highest daily average usage (per cfs) for the past three summer periods, as shown in Table 7-4 above for Central Basin's maximum usage for 2006 – 149.6 cfs.

7.2.5 READINESS-TO-SERVE CHARGE

The Readiness-to-Serve Charge (RTS) recovers a portion of MWD's debt service costs associated with regional infrastructure improvements. The RTS charge is a fixed charge assessed to each member agency regardless of the amount of imported water delivered in the current year. Rather, it is determined by the member agencies' firm imported deliveries for the past 10 years. Central Basin elected to have MWD collect the majority of the RTS obligation through a "Standby Charge" assessed on all parcels within its service area. The remainder is collected as a surcharge on Central Basin's commodity rates.

7.2.6 MWD STANDBY CHARGE

In 1992, the State Legislature authorized MWD to levy a standby charge that recognized that there are economic benefits to lands that have access to a water supply, whether or not such lands are using it. A fraction of the value of the benefit accruing to all landowners in MWD's service territory can therefore be recovered through the imposition of a standby charge. MWD assessed this charge only within the service area of the member agencies that requested such a parcel charge to help fund a member agency's RTS obligation. Within Central Basin, the MWD Standby Charge is currently $10.44 per parcel.

7.3 CENTRAL BASIN'S IMPORTED WATER RATES

As MWD adopted a new rate structure so did Central Basin. In 2003, Central Basin passed through MWD's Purchase Order by offering customer agencies voluntary purchase agreements and assessing MWD's new Capacity Charge. Central Basin also revised the administrative surcharge to be applied uniformly to all classes of imported water sold. Described below are elements of the rate structure that Central Basin applies to the delivery of imported water.

7.3.1 PURCHASE AGREEMENTS

In order to meet the Purchase Order Commitment with MWD, Central Basin established its own purchase contract policy with its customer agencies. Central Basin's Imported Water Purchase Agreements mimic the MWD version in terms of an Annual Tier 1 Maximum and Total Purchase Commitment but offer more flexibility to the customer. Central Basin requires only a five-year commitment, as opposed to a 10-year term. Furthermore, customer agencies have the option to adjust their Tier 1 and Purchase Commitment amounts annually if certain conditions are favorable and can also reduce their commitment amounts by offsetting imported water demand with recycled water purchased from Central Basin. For purchases above the Tier 1 limit, or in the absence of a Purchase Agreement, the customer agency pays the Tier 2 rate (currently $81/AF above the Tier 1 rate).

Out of the 24 cities, water agencies and private water companies that have an imported water connection, seven do not currently have a purchase agreement with Central Basin.

7.3.2 ADMINISTRATIVE SURCHARGE

One of the main revenue sources for Central Basin is the Administrative Surcharge applied to all imported water sold. In 2003, Central Basin revised the Administrative Surcharge to be uniformly applied to all imported water regardless of the type delivered. Revenue from the surcharge recovers Central Basin's administrative costs including planning, outreach and education, and conservation efforts. As of July 1, 2005, Central Basin's Administrative Surcharge is $38/AF.

In 2004, Central Basin and WRD entered into a five-year purchase agreement for untreated replenishment water (Seasonal Spreading). This agreement replaces Central Basin's Administrative Surcharge rate of $37 per acre-foot to an annual fixed payment ($800,000). As a result, this agreement provided Central Basin with a predictable revenue stream and gave WRD a price discount for replenishment purchases above the baseline quantity (21,622 AF).

Central Basin partnered with Upper San Gabriel Valley Municipal Water District to serve recycled water to Rose Hills Cemetery in the City of Montebello.

7.3.3 READINESS-TO-SERVICE SURCHARGE

As described above, MWD levies to Central Basin a RTS charge to recover a portion of its debt service costs, which is covered mostly by the MWD Standby Charge. However, the remaining balance is collected on the commodity rate. This RTS surcharge is added to Central Basin's commodity rates for only non-interruptible water. As of January 1, 2006, Central Basin's RTS surcharge is $8/AF.

7.3.4 WATER SERVICE CHARGE

Water utility revenue structures benefit from a mix of fixed and variable sources. Central Basin's Water Service Charge recovers a portion of the agency's fixed administrative costs but is a relatively small portion of its overall revenue from water rates. As of July 1, 2005, the Water Service Charge is $30/cfs of a customer agency's meter capacity for imported water meters.

7.3.5 CENTRAL BASIN'S CAPACITY CHARGE

This charge, as described in Section 7.2.4, is intended to encourage customers to reduce peak day demands during the summer months, which will result in more efficient utilization of MWD's existing infrastructure. Central Basin has passed through this MWD charge to its customer agencies by mimicking MWD's methodology. Each customer's Capacity Charge is determined from their highest daily average usage (per cfs) for the past three summer periods. However, because MWD assesses Central Basin on the coincident daily peak of all the connections and aggregate of all its customers' daily peak is the non-coincident peak, Central Basin is able to lower the Capacity Charge to its customers from $6,800/cfs to $5,300/cfs.

7.4 RECYCLED WATER RATES

Central Basin's recycled water program is comprised of two distribution systems: the E. Thornton Ibbetson Century Water Recycling Project and the Esteban Torres Rio Hondo Water Recycling Project with more than 70 miles of pipeline and three pump stations. Since 1992, Central Basin has encour-

Recycled water customer
Metro State Hospital in Norwalk.

aged the maximum use of recycled water to industries, cities and landscape irrigation sites through the economic incentive of its rates and charges. Below is a description of Central Basin's recycled water rates and charges.

7.4.1 RECYCLED WATER RATES

Central Basin commodity rates cover the operation and maintenance and labor and power costs associated with the delivery of recycled water. These rates are set up in a declining tiered structure so they may further encourage the use of recycled water. Furthermore, these rates are wholesaled at a significant reduction to imported rates to promote the usage of recycled water. Central Basin's recycled water rates for FY 2005-06 are shown in Table 7-5.

As shown in Table 7-5, the "outside of the Central Basin service area" rate is assessed to customers outside of Central Basin's service boundaries which pay an additional $20/AF for each tier. This additional charge is applied to make up for the recycled water Standby Charge they are not levied on their parcels.

7.4.2 RECYCLED WATER STANDBY CHARGE

In addition to the MWD Standby Charge, there is a recycled water standby charge that is levied by Central Basin to each parcel within the service area. A $10 per parcel charge is administered by Central Basin to provide a source of non-potable water completely independent of drought-sensitive supplies. The revenue collected from this charge is used to pay the debt service obligations on Central Basin's water recycling facilities. Each year the Board holds a public hearing where they adopt Central Basin's Engineer's Report and Resolution to assess this charge.

7.5 FUTURE WATER RATE PROJECTIONS

As the demand for water increases in Southern California so does the cost to administer, treat and distribute imported and recycled water. However, Central Basin has worked diligently to ensure that stable and predictable rates are managed for the future. Below are discussions of imported and recycled water rate trends during the next 10 years.

7.5.1 IMPORTED WATER RATE PROJECTIONS

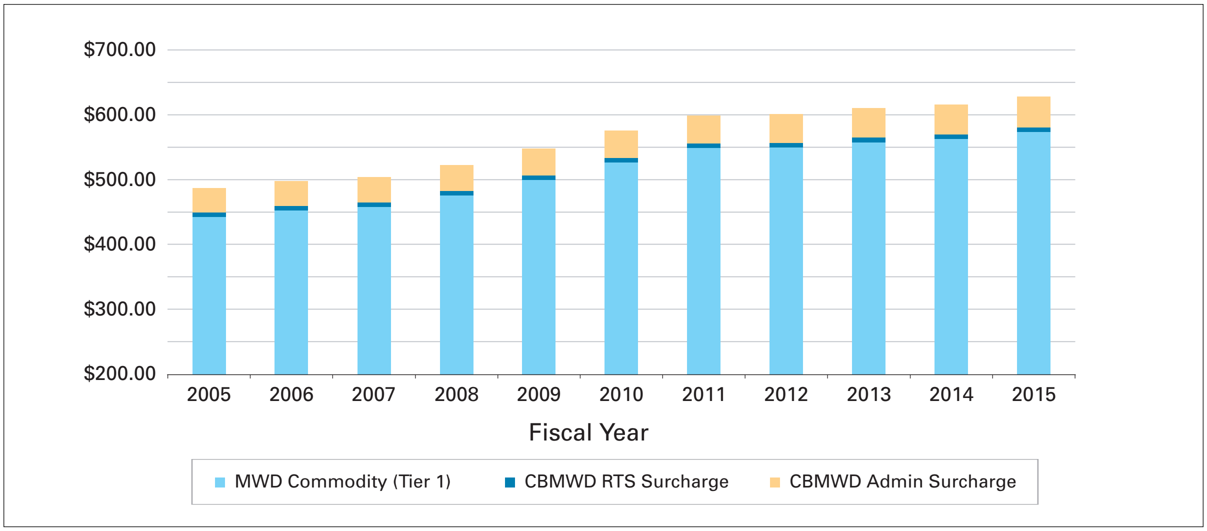
In 2004, the MWD Board adopted its Long Range Financial Plan. This plan was developed to forecast future costs and revenues necessary to support its operations and capital investments. Furthermore, it lays out the financial policy MWD will pursue during the next 10 years. According to projected MWD sales, with investments into local resources, MWD estimates imported water rates will increase 4-6% annually.

Central Basin's Administrative Surcharge is projected to increase at an annual average rate of 3-4%. This increase is determined by Central Basin's Long Range Financial analysis and the budget's revenue requirements.

Table 7-5
Recycled Water Rates
Fiscal Year 2005-06

Volume (AF/month)	Central Basin Service Area	Outside of Central Basin Service Area
0-25	$308/AF	$328/AF
25-50	$286/AF	$306/AF
50-100	$266/AF	$286/AF
100+	$244/AF	$264/AF

Figure 7-1
Central Basin Imported Water Rates
10 Year Projections



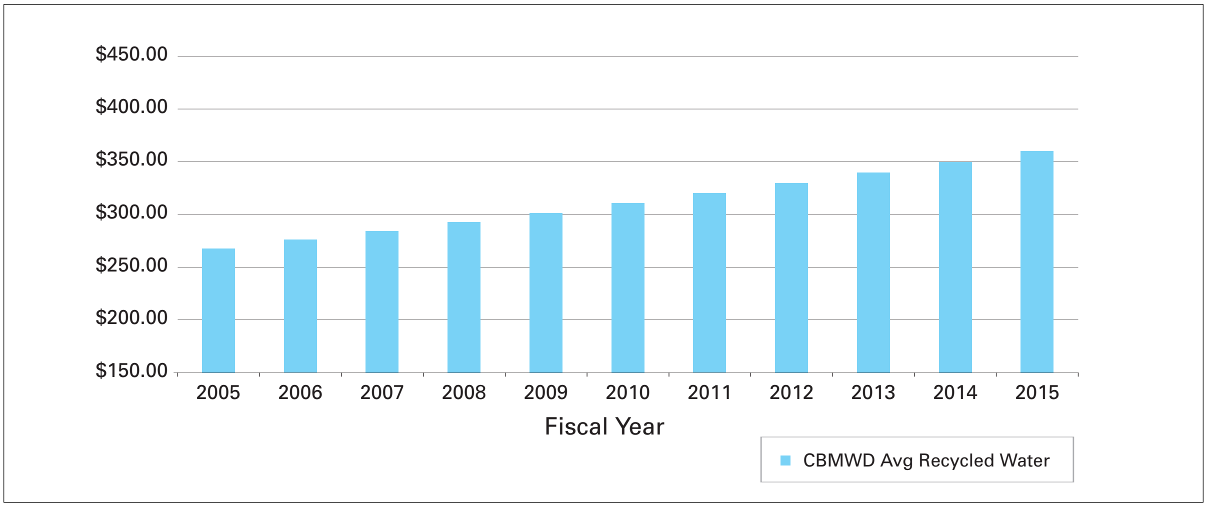
Source: MWD 2004 Long Range Financial Plan & Central Basin's Financial Plan.

Figure 7-1 displays Central Basin's imported water rate projections for the next 10 years.

7.5.2 RECYCLED WATER RATE PROJECTIONS

Similar to imported water rates, recycled water rates are expected to increase because of higher treatment, maintenance and power costs. However, Central Basin believes in setting the rate of recycled water at a competitive level to help offset imported water. In order to achieve this economic incentive, recycled water rates have been projected by Central Basin to increase at a slightly lower level than imported water. The recommended rate increases are projected to be 3% annually. As shown in Figure 7-2, Central Basin's average recycled water rate will be at a competitive level versus imported water rates during the next 10 years.

Figure 7-2
Central Basin Recycled Water Rates
10 Year Projections



Source: Central Basin Financial Plan for the average recycled water rates for within "service area."

Section 8

Water Recycling

8

Water Recycling

This section discusses Water Recycling Efforts within Central Basin's service area

8.1 OVERVIEW

Recycled water is a cornerstone of Central Basin's efforts to augment local supplies and reduce dependence on imported water. Since planning and constructing its recycled water systems in the early 1990s, Central Basin has become an industry leader in water re-use. Recycled water is used for non-potable applications such as landscape irrigation, commercial and industrial processes, and indirect potable use through groundwater replenishment.

In 2005, recycled water M&I deliveries within Central Basin's service area totaled 5,217 AF, representing 2% of the service area's total water supplies. Recycled water sales are projected to reach 17,900 AF by the year 2030, representing 5% of expected total water supplies.

This section provides an overview of the District's water recycling system and water treatment and distribution. In addition, this section includes a discussion of the District's past, current and projected sales as well as the District's system expansion projects and Master Plan. The section concludes with a brief description of the Cerritos, Lakewood and WRD recycled water programs within Central Basin's service area.

8.2 RECYCLED WATER SOURCES AND TREATMENT

8.2.1 SOURCE WATER

The source of Central Basin's recycled water is the County Sanitation Districts of Los Angeles County (CSDLAC). CSDLAC operates one wastewater treatment plant and six water recycling plants in the Los Angeles Basin. These combined systems produce approximately 489 MGD of effluent, of which approximately one-third is available for re-use. Central Basin purchases a portion of this recycled water from two reclamation plants, Los Coyotes and San Jose Creek, located just outside of the District's service area. Both of these plants provide approximately 55 MGD of tertiary-treated (Title-22) water for distribution. Below is a detailed description of the two recycling plants.

San Jose Creek Water Recycling Plant

The San Jose Creek WRP provides tertiary treatment for 100 MGD of wastewater. The plant serves a largely residential population of approximately one million people. Approximately 35 MGD of recycled water is reused at 17 different reuse sites. These include groundwater recharge at the Montebello Spreading Grounds and irrigation of parks, schools and greenbelts. The San Jose Creek WRP was built in the early 1970s as part of Central Basin and West Basin MWD's Joint Outfall System. This system uses six water reclamation plants and the Joint Water Pollution Control Plant to serve a major portion of metropolitan Los Angeles County.

The goal of the CSDLAC is to recycle as much of the reclaimed water from its water reclamation plants as possible. Approximately 35 MGD of the purified water from San Jose Creek WRP is sent to percolation basins for groundwater recharge. In 1994, the San Jose Creek WRP was connected to the E. Thornton Ibbetson Century and Esteban Torres Rio Hondo Water Recycling projects which supply the water recycling needs of more than a dozen cities combined from the Central Basin water recycling distribution system.

The high quality San Jose Creek WRP final effluent meets the National Pollution Discharge Elimination System (NPDES) requirements for water quality. The following discussion includes

San Jose Creek Water Reclamation Plant.

readings of the sampled constituents in 2003.

The Regional Water Quality Control Board (RWQCB) established a new limit for chloride levels through Resolution No. 97-02 in 2002. The Resolution requires monitoring data and assessment reports on chloride by Publicly Owned Treatment Waterworks on an annual basis. During 2003, chloride levels in the final effluent of San Jose Creek WRP were consistently below the limit (180 mg/l).

The daily maximum final effluent turbidity was 3.4 NTU, and the 24-hour composite final effluent turbidity was 1.0 NTU. All the water reused in 2003 was adequately chlorinated to comply with the coliform limit. Also, all water discharged to the San Gabriel River was properly disinfected and dechlorinated.

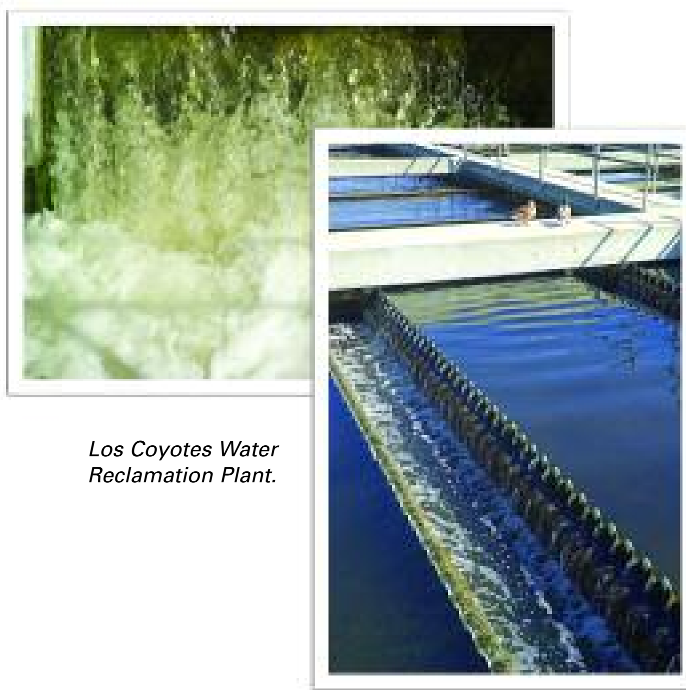
Los Coyotes Water Recycling Plant

The Los Coyotes WRP provides tertiary treatment for 37 MGD of wastewater. The WRP serves a population of approximately 370,000 people. More than 5 MGD of the purified water is reused at more than 200 reuse sites. These include irrigation of schools, golf courses, parks, nurseries and greenbelts and industrial use at local companies for carpet dying and concrete mixing.

Regional water recycling projects such as Century and Rio Hondo are the next step in the evolution of water reuse as the Los Angeles area heads toward a planned basin-wide system linking numerous sanitary agencies and regional and local water purveyors in a highly flexible and reliable reclaimed water distribution system to complement and supplement the precious, limited drinking water supply.

More than 200 reuse sites have been receiving recycled water, which is used for irrigation of parks, golf courses, schools, nurseries, freeway and street medians, and slopes and other greenbelt areas. In addition, various industries, such as the Tuftex Carpet Mill (right), will use recycled water for carpet and textile dyeing, metal finishing, concrete mixing and cooling tower supply.

CSDLAC operates 10 laboratories including the San Jose Creek Water Quality Lab and Treatment Plant Laboratories. These laborato-



Los Coyotes Water Reclamation Plant.

ries have greatly increased the capability to control plant water quality and quality assurances and offer laboratory services in order to monitor the quality of effluent before it reaches the recycled water users.

8.2.2 TREATMENT PROCESS

The wastewater that is recycled at the Los Coyotes and the San Jose Creek plants undergoes tertiary treatment. Tertiary recycled water begins with secondary treated water that undergoes coagulation, flocculation, filtration and disinfection. Tertiary treated water can be used for a wide variety of industrial and irrigation purposes where high-quality, non-potable water is needed. Section 5, Water Quality, of this Plan explains in more detail the wastewater treatment facilities that provide Central Basin with recycled water.

Recycled water undergoes a rigorous, multi-stage treatment process to clarify it to high quality standards. The level of treatment necessary is approved by the California Department of Health Services (CDHS). CDHS requires recycled water to meet California Code of Regulations Title 22 standards (Title 22). Title 22 standards address specific treatment requirements for recycled water and lists approved uses. Approximately 2,000 tests are performed monthly to ensure water quality meets or exceed all State and Federal requirements.

Table 8-1 illustrates the past, current and projected amount of wastewater collected and treated as well as the amount of recycled water delivered by these two plants to the District's distribution system.

The amount of wastewater collected and treated by these two reclamation plants are expected to remain consistent during the next 25 years, despite population increases. According to CSDLAC analysis, these increases are projected not to be significant enough to make it economically feasible to expand these CSDLAC facilities to accommodate an already "Build out" area.

Carpet dyeing with recycled water at Tuftex in Santa Fe Springs.

8.3 CENTRAL BASIN'S RECYCLED WATER SYSTEM

8.3.1 EXISTING SYSTEM

Central Basin's recycling system is comprised of two separate projects: E. Thornton Ibbetson Century Water Recycling Project (Ibbetson Century Project) and the Esteban E. Torres Rio Hondo Water Recycling Project (Torres Project). Both projects deliver recycled water for landscape irrigation and industrial uses throughout the District's service area.

The Ibbetson Century Project began delivering recycled water in 1992. The project currently deliv-

Table 8-1
Wastewater Collected and Treated[1]
(In Acre-Feet)

	2000	2005	2010	2015	2020	2025	2030
Wastewater collected & treated[2]	136,000	103,000	140,000	142,000	145,000	148,000	150,000
Recycled water delivered	32,500	38,000	45,000	47,000	50,000	52,000	55,000

[1] Data supplied by the County Sanitation District of Los Angeles County.
[2] From both the Los Coyotes WRP and the San Jose Creek WRP

ers tertiary-treated recycled water from the CSDLAC's Los Coyotes WRP and serves the cities of Bellflower, Bell Gardens, Compton, Cudahy, Downey, Lakewood, Lynwood, Norwalk, Paramount, Santa Fe Springs and South Gate.

In 1994, the water recycling system was extended into the northern portion of Central Basin's service area. This extension, known as the Torres Project, delivers tertiary-treated recycled water from CSDLAC's San Jose Creek WRP and serves the cities of Bell, Bell Gardens, Commerce, Huntington Park, Montebello, Pico Rivera, Santa Fe Springs and Whittier.

In fiscal year 2004-2005, Central Basin's recycled water system delivered approximately 3,150 AFY to more than 200 sites. It is anticipated, during the next five years that Central Basin will triple its sales with new connections across the northern portion of the service area.

Every year Central Basin connects new customers to recycled water and further reduces demands on potable water.

8.3.2 RECYCLED WATER USE BY TYPE

The types of sites that Central Basin currently serves, as shown in Table 8-2, vary from parks and landscape medians to textile industries and cooling towers.

Table 8-2
Types of Recycled Water Customers

• Landscape	• Textile
• Golf Course	• Median
• Co-Generation (Cooling Tower)	• Nursery
• Cemetery	• Park
• Concrete Mixing	• School (Irrigation)
• Cal-Trans (Irrigation)	• Others

As illustrated in Figure 8-1, the predominated use of recycled water deliveries is landscape irrigation, accounting for almost 66% of the total use. However, in the upcoming years Central Basin plans on increasing its deliveries to the industrial sector. Once the City of Vernon begins receiving

Installation of recycled water pipeline.

recycled water via the Malburg Generating Station and subsequently when the Southeast Water Reliability Project begins operation, the percentage of industrial usage is projected to change significantly during the next 10-15 years.

8.3.3 HISTORICAL AND CURRENT SALES

For the past 10 years, Central Basin has seen its recycled water sales gradually increase each year. With landscape irrigation constituting two-thirds of Central Basin's current recycled water use, there have been years where sales have varied primarily due to weather changes. As shown in Figure 8-2, on the opposite page, there have been years, most notably fiscal years 2000-01 and 2004-05, where total recycled water sales have increased or decreased from projected levels because of rainfall.

Figure 8-1
Central Basin Recycled Water Use
By Type of Site FY 2004-05

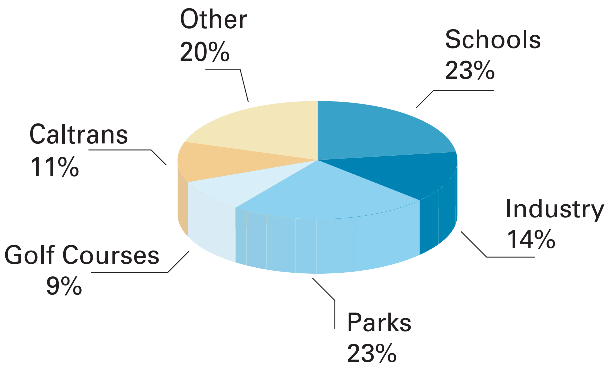
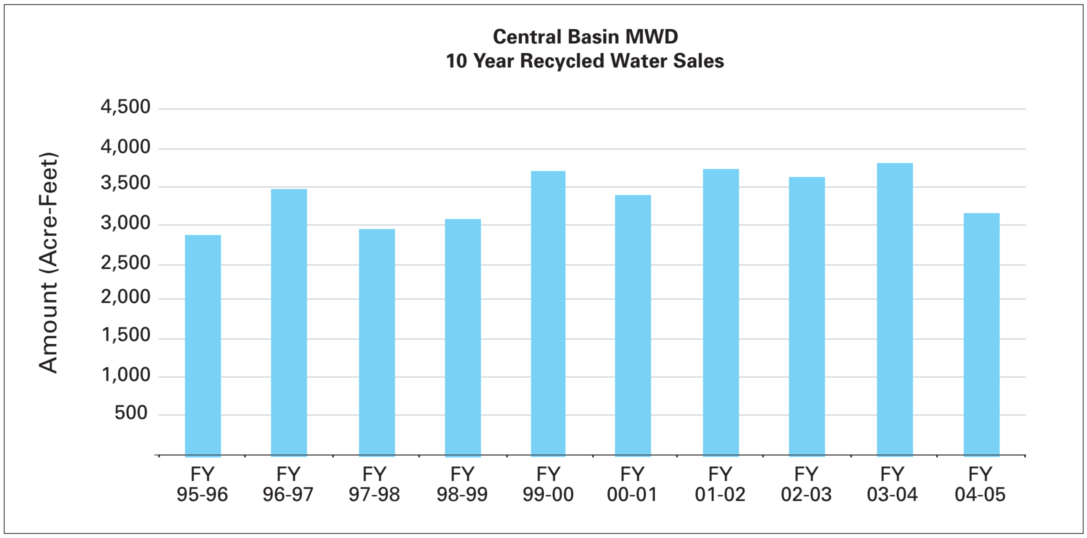


Figure 8-2
Historical Recycled Water Sales
FY 1996-2005



Source: Central Basin Watermaster Report, 2005

The amount of recycled water supplied by Central Basin during the last 10 years has totaled more than 33,800 AF, replacing enough potable water to supply the needs of approximately 67,700 families for more than a year. Central Basin anticipates recycled water sales to increase in the future as more customers switch from potable water to recycled water due to the reliability of the supply and the economic incentives associated with converting from potable water to recycled water.

Table 8-3, on page 8-6, displays a more detailed breakdown of historical sales by showing each retail customer agency's annual purchases from Central Basin for fiscal years 1996 to 2005.

Hollydale Pump Station at Hollydale Park in the city of South Gate.

In Central Basin's 2000 UWMP, the District projected deliveries of recycled water to reach 5,800 AF by 2005. As shown in Table 8-4 on page 8-6, actual sales for 2005 fell below this target. Combined with a record rainfall year and delays in connecting large based customers, Central Basin lacked the number of connections to reach the projections set in 2000. Nevertheless, Central Basin anticipates increases in sales during the next 5 - 10 years due to some large projects and partnering efforts among its customer agencies.

8.3.4 SYSTEM EXPANSIONS AND PROJECTED SALES

In 2000, Central Basin conducted a Recycled Water Program Master Plan (Master Plan) to help the District identify all of the potential customers that could benefit from recycled water. In addition, the Master Plan would provide the best system expansion routes to benefit the entire system from which the following system expansion projects were devised:

Southeast Water Reliability Project

The planned Southeast Water Reliability Project (SWRP) represents the fulfillment of the current Central Basin program as originally envisioned. The proposed project would

Table 8-3
Historical Recycled Water Sales by Retail Customer Agency of Central Basin
FY 1996 to 2005
(In Acre-Feet)

Central Basin	FY 95-96	FY 96-97	FY 97-98	FY 98-99	FY 99-00	FY 00-01	FY 01-02	FY 02-03	FY 03-04	FY 04-05	Total
Bellflower-Somerset Mutual	114	125	95	117	133	131	159	118	125	108	**1,225**
City of Cudahy	-	-	3	9	9	9	8	7	5	6	**56**
City of Downey	532	612	517	636	710	642	733	664	686	617	**6,349**
City of Huntington Park	21	61	44	56	57	49	60	48	64	49	**509**
City of Lynwood	44	74	75	59	55	69	66	70	67	46	**625**
City of Norwalk	87	118	75	89	128	100	120	109	111	53	**990**
City of Paramount	354	376	364	382	485	429	453	431	443	360	**4,077**
City of Pico Rivera	-	-	-	-	-	-	-	35	39	28	**102**
City of Santa Fe Springs	864	1,018	919	817	835	858	893	815	774	630	**8,423**
City of South Gate	144	165	151	151	189	164	191	162	177	213	**1,707**
City of Whittier	94	114	82	102	136	78	77	82	98	66	**929**
Park Water Company	363	448	315	353	479	428	469	471	489	341	**4,156**
Peerless Water Company	17	32	25	20	26	21	22	17	20	16	**216**
San Gabriel Valley Water Co	44	94	56	68	81	72	77	65	76	48	**681**
Southern California Water Co	227	244	224	234	359	358	418	506	610	523	**3,703**
Upper San Gabriel Valley MWD	-	-	-	-	-	-	-	7	35	45	**87**
Total	**2,905**	**3,481**	**2,945**	**3,093**	**3,682**	**3,408**	**3,746**	**3,607**	**3,819**	**3,150**	**33,836**

Source: Central Basin Wateruse Database, 2005

"loop" the overall system hydraulically by connecting the Rio Hondo and Century projects across the northern part of the service area (also known as the "Southeast" area because it roughly covers the southeast portion of Los Angeles County). Cities that will benefit directly from the SWRP include Pico Rivera, Montebello, East Los Angeles, Commerce, Maywood and Vernon.

Table 8-4
Recycled Water Uses
2000 Projections Compared with 2005 Actual

Type of Use	2000 Projection for 2005	2005 Actual Use[1]
Irrigation	4,600	2,654
Commercial	0	0
Industrial	1,200	496
Total	**5,800**	**3,150**

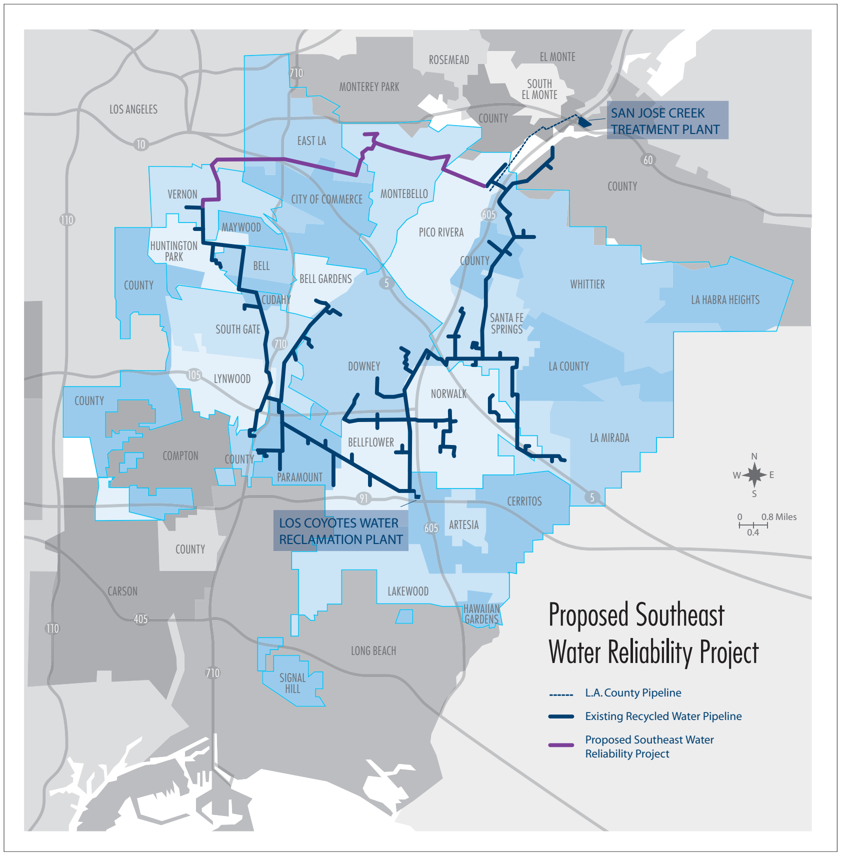
Source: Central Basin Water Use Database, 2005.
[1] Based upon 2004-05 actual sales for Central Basin.

Because the 2000 Master Plan may not accurately reflect recent changes in the industrial base of the areas to be served by the SWRP project, a Master Plan update will be completed in 2006. The Master Plan update will allow Central Basin to refine the alignment of the SWRP project and forecast more accurately future recycled water sales.

Connecting Central Basin's existing projects with the SWRP will increase flow and pressure in many areas of the distribution system that are not adequately served today, and it will provide recycled water to new customers in several cities. Figure 8-3 illustrates the connection of the SWRP to the existing system as it is currently envisioned.

Central Basin is aggressively pursuing State and Federal grant funding to reduce the cost of construction for the SWRP to be borne by Central Basin.

Figure 8-3
Southeast Water Reliability Project
Recycled Water Distribution System



Other Potential System Expansions

The Cities of South Gate, Lynwood and La Mirada have expressed interest in receiving recycled water, in some cases to augment existing demand. These potential new connections will be planned either concurrently or subsequently to the SWRP since they are dependent on the hydraulic benefits of the larger project. Other capital projects planned for the next five years include improvements that will increase the efficiency and reliability of existing facilities, including the pipeline connection in the City of Norwalk.

Projected Recycled Water Sales

According to the Master Plan, the Central Basin's recycled water system is projected to increase from its current sale of 3,150 AF to 15,500 AF by 2030.

As Table 8-5 displays, on the following page, the area of greatest potential growth in sales for the District is within landscape/irrigation. However, with system expansions planning to reach heavy industrial areas, i.e. the City of Vernon, the area of industrial recycled water usage does expect to increase.

The SWRP is anticipated to begin operation in 2009 and ultimately serve an additional 5,600 AFY of recycled water to various customers in the northern service area. However, depending upon the outcome of the updated Master Plan, the ultimate capacity of the SWRP may provide additional sales. Full project capacity will be phased in more than roughly five years to account for the construction of the many lateral distribution lines required to serve individual users.

Based on the current 5,600 AFY estimate of SWRP deliveries, Central Basin's total sales of recycled water is projected to reach approximately 10,500 AFY by FY 2010.

Table 8-5
Projected Future Use of Recycled Water in Service Area
(in Acre-Feet)

Type of Use	2010	2015	2020	2025	2030
Irrigation	7,000	7,750	8,500	9,250	10,000
Commercial	0	0	0	0	0
Industrial	3,500	4,000	4,500	5,000	5,500
Total Projected Use of Recycled Water	**10,500**	**11,750**	**13,000**	**14,250**	**15,500**

8.3.5 POTENTIAL RECYCLED WATER USE

The potential of recycled water use will increase among cities, water agencies and businesses/ industries through the years. The increased cost of imported and groundwater will enhance the beneficial usages of recycled water.

Central Basin will continue to pursue new cost-effective projects both within its service area and in partnership with willing neighboring agencies. Efforts are currently focused on maximizing the potential of the original regional system, for which Central Basin receives an incentive payment from MWD for every acre-foot delivered up to 10,500 AFY through 2019. Although current projections discussed above show Central Basin exceeding that 10,500 AFY incentive limit, the agency is preparing for the long-term financial viability of the water recycling system.

Although there is great potential to increase recycled water use in Central Basin, there are challenges and limitations in connecting customers. Among them are proximity to recycled water pipelines, capacity and pressure to serve, and retrofit cost-feasibility. These factors play a significant role in meeting the potential growth of recycled water. The ability to connect new customers dictates when and how much recycled water will be sold in the future.

In 2000, the Master Plan identified and prioritized areas within Central Basin's service area where recycled water has the potential to expand. In this study, a database was established to locate and identify future customers. The approach considered pipeline routing, hydraulic analysis and economic interests to project the growth of recycled water in Central Basin's service area. Figure 8-4 presents conceptual recycled water projects based on pipeline routing.

Although the Master Plan is in the process of being updated and could influence Central Basin's near-term and long-term projections depending primarily on the potential changes to industrial water, the principle goal of maximizing the potential usage of recycled water throughout the service area will not change.

Partnerships with neighboring agencies have already resulted in projects that expand the Central Basin system and sales beyond the service area limits. Phase I and II of an agreement with Upper San Gabriel Valley Municipal Water District to serve Rose Hills will add approximately 1,500 AFY of sales beginning in 2006, and discussions have already begun to expand this partnership further.

Within Central Basin, discussions have begun with the City of Vernon for a new agreement to potentially delivery between 6,000 to 10,000 AFY of recycled water to a new planned power generation facility.

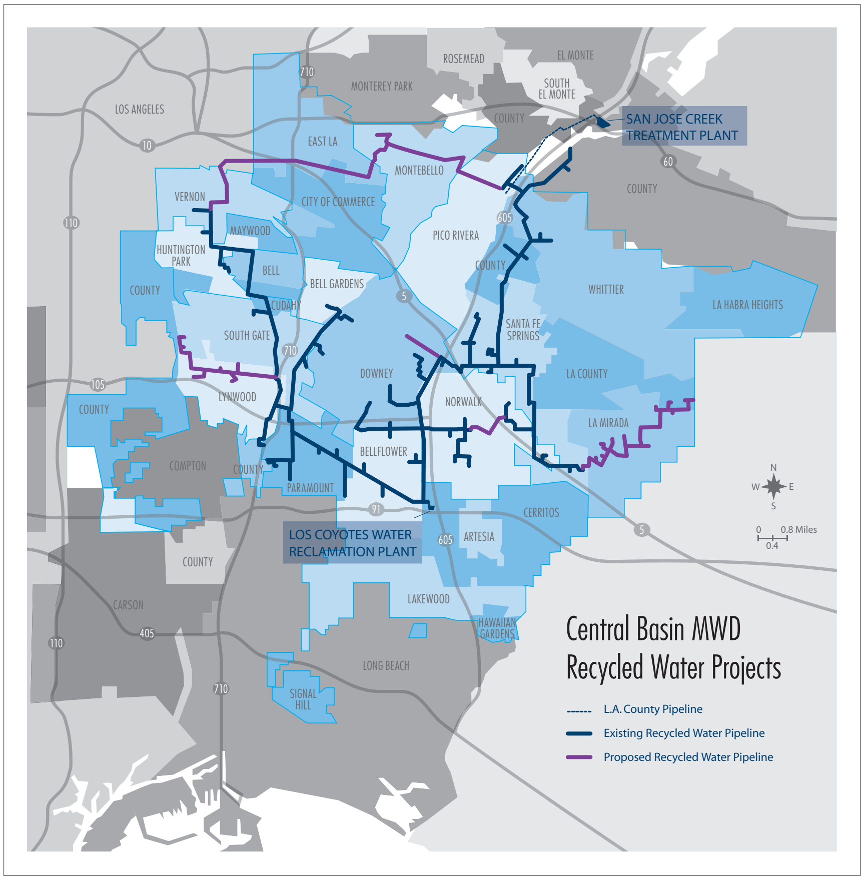
8.3.6 ENCOURAGING RECYCLED WATER USE

Central Basin's marketing efforts have been successful in changing the perception of recycled water from merely a conservation tool with minimal application to a business enhancement tool that lowers operating costs while increasing the reliability of the water supply. Central Basin markets recycled water as a resource that:

- Is less expensive than potable water;
- Is more reliable than imported water in a drought and
- Is consistent with statewide goals for water supply and ecosystem improvement on both the SWP and Colorado River systems.

The target customer is expanding from traditional irrigation users such as golf courses and parks to unconventional commercial and industrial users.

Figure 8-4
Conceptual Recycled Water Projects



Through innovative marketing, recycled water is now being used by oil refineries and dye houses. In addition, Central Basin is investigating recycled water use in paper production, co-generating plants and printing plants.

In addition to Central Basin wholesaling recycled water at a rate lower than potable water, Central Basin provides other financial incentives as well to encourage recycled water use. Some potential recycled water customers do not have the financial capability to pay for onsite plumbing retrofits necessary to accept recycled water. Therefore, Central Basin advances funds for retrofit expenses and are reimbursed through the water bills. The on-site plumbing retrofit costs are amortized through a period of time, up to 10 years at Central Basin's cost of funds. Repayment is made using the differential between potable and recycled water rates so that the customer never pays more than the potable rate. Once the loan is repaid, the rate reverts to the current recycled rate.

Optimizing Recycling Water Use

Central Basin's plan for optimizing the use of recycled water will be carried out through two efforts, both of which will be updated during the 2005-06 fiscal year, the Recycled Water Master Plan and the Recycled Water Marketing Plan (Marketing Plan). The Master Plan is Central Basin's guiding document for identifying and prioritizing potential customers. The 2000 Master Plan is currently being updated to capture changes in the industrial and commercial base within the service area, particularly in the northern portion to be served by the Southeast Water Reliability Project.

Recycled water for commercial irrigation in Santa Fe Springs.

The Marketing Plan is the companion effort to the Master Plan and will revisit the strategies and tools employed by Central Basin's staff and consultants in generating interest in recycled water with potential customers and the cities in which they do business. The thrust of the Marketing Plan will be to emphasize the benefit of recycled water as a "tool for profitability" for businesses and not just the right thing to do in terms of water conservation and the environment.

Coordination Efforts

Table 8-6 illustrates the District's coordinated effort among key stakeholders in the development of the 2000 Central Basin Water Recycling Master Plan. Central Basin plans on continuing the same coordinated effort in the updated Master Plan as well as include some participating agencies in the development process of the Marketing Plan.

8.3.7 FUNDING

Capital costs for projects planned for the future have been budgeted to average per fiscal year approximately $5,600,000.[1] These costs will be covered by the sources identified here and other sources as they become available:

- MWD Local Resources Program Incentive. To qualify, proposed recycled water projects by member agencies must cost more than projected MWD treated non-interruptible water rates and reduce potable water needs. Since founding MWD with other municipal water utilities in 1928, Central Basin has remained affiliated as a member agency and is therefore considered for the rebates for up to $250/AF offered under the program.

- Grant Funding. Central Basin continuously applies for Federal and State grant funding for recycled water projects as they become available. In 2005, Central Basin applied for a Water Recycling Construction grant for the Southeast Water Reliability Project, Phase I Water Recycling Construction Project through

Table 8-6
Recycled Water Master Plan Coordination

Participating Agencies	Role in Plan Development
1. Water Agencies (Purveyors)	Customer Development, Facilities, Impacts, Rates
2. Wastewater Agencies	Recycled Water Supply, Water Quality, Reliability
3. Groundwater Agencies	Rates, Customer Involvement
4. Planning Agencies	Economic Analysis, Rates, Data Assessment, Customer Assessment, Rates, Community Impacts, Customer Involvement, Conceptual Pipeline Routes, Cost Estimates

1. Water Purveyor Agencies: See Table 8-3.
2. Wastewater Agencies: County Sanitation Districts of Los Angeles County
3. Groundwater Agencies: Water Replenishment District of Southern California
4. Planning Agencies: Purveyors and Cities within Central Basin's service area

[1] Approximation is an average based on fiscal year capital project projections during a five year period (FY: 2005-2006 to 2009-2010).

Proposition 50. Central Basin submitted an application to the SWRCB to fund 25% of the $15.2 million cost of the pipeline. An additional source of funding is through the U.S. Army Corps of Engineers Program, which affords qualified programs 75% project funding.

8.4 RECYCLED WATER PROJECTS WITHIN CBMWD SERVICE AREA

8.4.1 CITY OF CERRITOS WATER RECYCLING PROGRAM

The City of Cerritos has its own water recycling system, which is not associated with Central Basin's recycled water program. It serves approximately 80 sites within the cities of Cerritos and Lakewood, which are located in Central Basin's service area. The City of Cerritos receives tertiary-treated recycled water from the CSDLAC's Los Coyotes WRP and serves a little more than 2,400 AFY, of which 450 AFY is sold to the City of Lakewood.

8.4.2 CITY OF LAKEWOOD WATER RECYCLING PROGRAM

The City of Lakewood purchases 450 AFY of recycled water from the City of Cerritos to help offset an equal demand of potable water.

8.4.3 WATER REPLENISHMENT DISTRICT-MONTEBELLO FOREBAY GROUNDWATER RECHARGE

The Montebello Forebay Groundwater Recharge Project allows the spreading of treated recycled water to be melded with imported and storm water within the recharge grounds with CSDLAC and Los Angeles County Department of Public Works (LACDPW). WRD has an agreement to recharge the basin with recycled water. LACDPW owns and operates the recharge facilities, while WRD purchases the recycled water from the CSDLAC. Under the conditions of a regulation permit from the Los Angeles RWQCB, approximately 50,000 AF of recycled water is the annual limit that can be recharged into the spreading grounds.

Montebello Forebay. Courtesy of WRD.

8.5 TOTAL RECYCLED WATER USE IN CENTRAL BASIN

Within Central Basin's service area there are three key water recycling programs that help offset potable water usage and provide groundwater replenishment. Among the three are the Central Basin, Cerritos and WRD water recycling programs. As illustrated in Table 8-7, together these programs delivered 52,400 AF of water recycling in 2005 and during the next 25 years they plan to increase deliveries by 10,500 AF.

Hollywood Sports Park in Bellflower.

Table 8-7
Total Projected Recycled Water Use in Central Basin's Service Area
(in Acre-Feet)

	2005[1]	2010	2015	2020	2025	2030
Central Basin						
Century/Rio Hondo Projects	3,150	10,500	11,750	13,000	14,250	15,500
Total	**3,150**	**10,500**	**11,750**	**13,000**	**14,250**	**15,500**
Other Programs within Central Basin						
City of Cerritos	1,714	1,950	1,950	1,950	1,950	1,950
City of Lakewood[2]	352	450	450	450	450	450
WRD (Replenishment Spreading)	50,000	50,000	50,000	50,000	50,000	50,000
Total	**52,067**	**52,400**	**52,400**	**52,400**	**52,400**	**52,400**
Central Basin's Service Area Total	**55,217**	**62,900**	**64,150**	**65,400**	**66,650**	**67,900**

[1] 2005 demands are based on the 2004-05 year, which is also considered one of the "wettest" years on record.
[2] City of Lakewood receive its recycled water from the Cerritos water recycling system.

Appendices

Appendix A

Urban Water Management Planning Act of 1983, as amended 2005

Established: AB 797, Klehs, 1983
Amended: AB 2661, Klehs, 1990
AB 11X, Filante, 1991
AB 1869, Speier, 1991
AB 892, Frazee, 1993
SB 1017, McCorquodale, 1994
AB 2853, Cortese, 1994
AB 1845, Cortese, 1995
SB 1011, Polanco, 1995
AB 2552, Bates, 2000
SB 553, Kelley, 2000
SB 610, Costa, 2001
AB 901, Daucher, 2001
SB 672, Machado, 2001
SB 1348, Brulte, 2002
SB 1384, Costa, 2002
SB 1518, Torlakson, 2002
AB 105, Wiggins, 2004
SB 318, Alpert, 2004

CALIFORNIA WATER CODE DIVISION 6
PART 2.6. URBAN WATER MANAGEMENT PLANNING

CHAPTER 1. GENERAL DECLARATION AND POLICY

10610. This part shall be known and may be cited as the "Urban Water Management Planning Act."

10610.2. (a) The Legislature finds and declares all of the following:

(1) The waters of the state are a limited and renewable resource subject to ever-increasing demands.

(2) The conservation and efficient use of urban water supplies are of statewide concern; however, the planning for that use and the implementation of those plans can best be accomplished at the local level.

(3) A long-term, reliable supply of water is essential to protect the productivity of California's businesses and economic climate.

(4) As part of its long-range planning activities, every urban water supplier should make every effort to ensure the appropriate level of reliability in

its water service sufficient to meet the needs of its various categories of customers during normal, dry, and multiple dry water years.

(5) Public health issues have been raised over a number of contaminants that have been identified in certain local and imported water supplies.

(6) Implementing effective water management strategies, including groundwater storage projects and recycled water projects, may require specific water quality and salinity targets for meeting groundwater basins water quality objectives and promoting beneficial use of recycled water.

(7) Water quality regulations are becoming an increasingly important factor in water agencies' selection of raw water sources, treatment alternatives, and modifications to existing treatment facilities.

(8) Changes in drinking water quality standards may also impact the usefulness of water supplies and may ultimately impact supply reliability.

(9) The quality of source supplies can have a significant impact on water management strategies and supply reliability.

(b) This part is intended to provide assistance to water agencies in carrying out their long-term resource planning responsibilities to ensure adequate water supplies to meet existing and future demands for water.

10610.4. The Legislature finds and declares that it is the policy of the state as follows:

(a) The management of urban water demands and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.

(b) The management of urban water demands and efficient use of urban water supplies shall be a guiding criterion in public decisions.

(c) Urban water suppliers shall be required to develop water management plans to actively pursue the efficient use of available supplies.

CHAPTER 2. DEFINITIONS

10611. Unless the context otherwise requires, the definitions of this chapter govern the construction of this part.

10611.5. "Demand management" means those water conservation measures, programs, and incentives that prevent the waste of water and promote the reasonable and efficient use and reuse of available supplies.

10612. "Customer" means a purchaser of water from a water supplier who uses the water for municipal purposes, including residential, commercial, governmental, and industrial uses.

10613. "Efficient use" means those management measures that result in the most effective use of water so as to prevent its waste or unreasonable use or unreasonable method of use.

10614. "Person" means any individual, firm, association, organization, partnership, business, trust, corporation, company, public agency, or any agency of such an entity.

10615. "Plan" means an urban water management plan prepared pursuant to this part. A plan shall describe and evaluate sources of supply, reasonable and practical efficient uses, reclamation and demand management activities. The components of the plan may vary according to an individual community or area's characteristics and its capabilities to efficiently use and conserve water. The plan shall address measures for residential, commercial, governmental, and industrial water demand management as set forth in Article 2 (commencing with Section 10630) of Chapter 3. In addition, a strategy and time schedule for implementation shall be included in the plan.

10616. "Public agency" means any board, commission, county, city and county, city, regional agency, district, or other public entity.

10616.5. "Recycled water" means the reclamation and reuse of wastewater for beneficial use.

10617. "Urban water supplier" means a supplier, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually. An urban water supplier includes a supplier or contractor for water, regardless of the basis of right, which distributes or sells for ultimate resale to customers. This part applies only to water supplied from public water systems subject to Chapter 4 (commencing with Section 116275) of Part 12 of Division 104 of the Health and Safety Code.

CHAPTER 3. URBAN WATER MANAGEMENT PLANS
Article 1. General Provisions

10620.

(a) Every urban water supplier shall prepare and adopt an urban water management plan in the manner set forth in Article 3 (commencing with Section 10640).

(b) Every person that becomes an urban water supplier shall adopt an urban water management plan within one year after it has become an urban water supplier.

(c) An urban water supplier indirectly providing water shall not include planning elements in its water management plan as provided in Article 2 (commencing with Section 10630) that would be applicable to urban water suppliers or public agencies directly providing water, or to their customers, without the consent of those suppliers or public agencies.

(d)

(1) An urban water supplier may satisfy the requirements of this part by participation in areawide, regional, watershed, or basinwide urban water management planning where those plans will reduce preparation costs and contribute to the achievement of conservation and efficient water use.

(2) Each urban water supplier shall coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable.

(e) The urban water supplier may prepare the plan with its own staff, by contract, or in cooperation with other governmental agencies.

(f) An urban water supplier shall describe in the plan water management tools and options used by that entity that will maximize resources and minimize the need to import water from other regions.

10621.

(a) Each urban water supplier shall update its plan at least once every five years on or before December 31, in years ending in five and zero.

(b) Every urban water supplier required to prepare a plan pursuant to this part shall notify any city or county within which the supplier provides water supplies that the urban water supplier will be reviewing the plan and considering amendments or changes to the plan. The urban water supplier may consult with, and obtain comments from, any city or county that receives notice pursuant to this subdivision.

(c) The amendments to, or changes in, the plan shall be adopted and filed in the manner set forth in Article 3 (commencing with Section 10640).

Article 2. Contents of Plans

10630. It is the intention of the Legislature, in enacting this part, to permit levels of water management planning commensurate with the numbers of customers served and the volume of water supplied.

10631. A plan shall be adopted in accordance with this chapter and shall do all of the following:

(a) Describe the service area of the supplier, including current and projected population, climate, and other demographic factors affecting the supplier's water management planning. The projected population estimates shall be based upon data from the state, regional, or local service agency population projections within the service area of the urban water supplier and shall be in five-year increments to 20 years or as far as data is available.

(b) Identify and quantify, to the extent practicable, the existing and planned sources of water available to the supplier over the same five-year increments described in subdivision (a). If groundwater is identified as an existing or planned source of water available to the supplier, all of the following information shall be included in the plan:

(1) A copy of any groundwater management plan adopted by the urban water supplier, including plans adopted pursuant to Part 2.75 (commencing with Section 10750), or any other specific authorization for groundwater management.

(2) A description of any groundwater basin or basins from which the urban water supplier pumps groundwater. For those basins for which a court or the board has adjudicated the rights to pump groundwater, a copy of the order or decree adopted by the court or the board and a description of the amount of groundwater the urban water supplier has the legal right to pump under the order or decree.

For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.

(3) A detailed description and analysis of the location, amount, and sufficiency of groundwater pumped by the urban water supplier for the past five years. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

(4) A detailed description and analysis of the amount and location of groundwater that is projected to be pumped by the urban water supplier. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

(c) Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage, to the extent practicable, and provide data for each of the following:

(1) An average water year.
(2) A single dry water year.
(3) Multiple dry water years.

For any water source that may not be available at a consistent level of use, given specific legal, environmental, water quality, or climatic factors, describe plans to supplement or replace that source with alternative sources or water demand management measures, to the extent practicable.

(d) Describe the opportunities for exchanges or transfers of water on a short-term or long-term basis.

(e)

(1) Quantify, to the extent records are available, past and current water use, over the same five-year increments described in subdivision (a), and projected water use, identifying the uses among water use sectors including, but not necessarily limited to, all of the following uses:

(A) Single-family residential.
(B) Multifamily.
(C) Commercial.
(D) Industrial.
(E) Institutional and governmental.
(F) Landscape.
(G) Sales to other agencies.
(H) Saline water intrusion barriers, groundwater recharge, or conjunctive use, or any combination thereof.
(I) Agricultural.

(2) The water use projections shall be in the same five-year increments described in subdivision (a).

(f) Provide a description of the supplier's water demand management measures. This description shall include all of the following:

(1) A description of each water demand management measure that is currently being implemented, or scheduled for implementation, including the steps necessary to implement any proposed measures, including, but not limited to, all of the following:

(A) Water survey programs for single-family residential and multifamily residential customers.

(B) Residential plumbing retrofit.

(C) System water audits, leak detection, and repair.

(D) Metering with commodity rates for all new connections and retrofit of existing connections.

(E) Large landscape conservation programs and incentives.

(F) High-efficiency washing machine rebate programs.

(G) Public information programs.

(H) School education programs.

(I) Conservation programs for commercial, industrial, and institutional accounts.

(J) Wholesale agency programs.

(K) Conservation pricing.

(L) Water conservation coordinator.

(M) Water waste prohibition.

(N) Residential ultra-low-flush toilet replacement programs.

(2) A schedule of implementation for all water demand management measures proposed or described in the plan.

(3) A description of the methods, if any, that the supplier will use to evaluate the effectiveness of water demand management measures implemented or described under the plan.

(4) An estimate, if available, of existing conservation savings on water use within the supplier's service area, and the effect of the savings on the supplier's ability to further reduce demand.

(g) An evaluation of each water demand management measure listed in paragraph (1) of subdivision (f) that is not currently being implemented or scheduled for implementation. In the course of the evaluation, first consideration shall be given to water demand management measures, or combination of measures, that offer lower incremental costs than expanded or additional water supplies. This evaluation shall do all of the following:

(1) Take into account economic and noneconomic factors, including environmental, social, health, customer impact, and technological factors.

(2) Include a cost-benefit analysis, identifying total benefits and total costs.

(3) Include a description of funding available to implement any planned water supply project that would provide water at a higher unit cost.

(4) Include a description of the water supplier's legal authority to implement the measure and efforts to work with other relevant agencies to ensure the implementation of the measure and to share the cost of implementation.

(h) Include a description of all water supply projects and water supply programs that may be undertaken by the urban water supplier to meet the total projected water use as established pursuant to subdivision (a) of Section 10635. The urban water supplier shall include a detailed description of expected future projects and programs, other than the demand management programs identified pursuant to paragraph (1) of subdivision (f), that the urban water supplier may implement to increase the amount of the water supply available to the urban water supplier in average, single-dry, and multiple-dry water years. The description shall identify specific projects and include a description of the increase in water supply that is expected to be available from each project. The description shall include an estimate with regard to the implementation timeline for each project or program.

(i) Describe the opportunities for development of desalinated water, including, but not limited to, ocean water, brackish water, and groundwater, as a long-term supply.

(j) Urban water suppliers that are members of the California Urban Water Conservation Council and submit annual reports to that council in accordance with the "Memorandum of Understanding Regarding Urban Water Conservation in California," dated September 1991, may submit the annual reports identifying water demand management measures currently being implemented, or scheduled for implementation, to satisfy the requirements of subdivisions (f) and (g).

(k) Urban water suppliers that rely upon a wholesale agency for a source of water, shall provide the wholesale agency with water use projections from that agency for that source of water in five-year increments to 20 years or as far as data is available. The wholesale agency shall provide information to the urban water supplier for inclusion in the urban water supplier's plan that identifies and quantifies, to the extent practicable, the existing and planned sources of water as required by subdivision (b), available from the wholesale agency to the urban water supplier over the same five-year increments, and during various water-year types in accordance with subdivision (c). An urban water supplier may rely upon water supply information provided by the wholesale agency in fulfilling the plan informational requirements of subdivisions (b) and (c), including, but not limited to, ocean water, brackish water, and groundwater, as a long-term supply.

10631.5. The department shall take into consideration whether the urban water supplier is implementing or scheduled for implementation, the water demand management activities that the urban water supplier identified in its urban water management plan, pursuant to Section 10631, in evaluating applications for grants and loans made available pursuant to Section 79163. The urban water supplier may submit to the department copies of its annual reports and other relevant documents to assist the department in determining whether the urban water supplier is implementing or scheduling the implementation of water demand management activities.

10632. The plan shall provide an urban water shortage contingency analysis which includes each of the following elements which are within the authority of the urban water supplier:

(a) Stages of action to be undertaken by the urban water supplier in response to water supply shortages, including up to a 50 percent reduction in water supply, and an outline of specific water supply conditions which are applicable to each stage.

(b) An estimate of the minimum water supply available during each of the next three water years based on the driest three-year historic sequence for the agency's water supply.

(c) Actions to be undertaken by the urban water supplier to prepare for, and implement during, a catastrophic interruption of water supplies including, but not limited to, a regional power outage, an earthquake, or other disaster.

(d) Additional, mandatory prohibitions against specific water use practices during water shortages, including, but not limited to, prohibiting the use of potable water for street cleaning.

(e) Consumption reduction methods in the most restrictive stages. Each urban water supplier may use any type of consumption reduction methods in its water shortage contingency analysis that would reduce water use, are appropriate for its area, and have the ability to achieve a water use reduction consistent with up to a 50 percent reduction in water supply.

(f) Penalties or charges for excessive use, where applicable.

(g) An analysis of the impacts of each of the actions and conditions described in subdivisions (a) to (f), inclusive, on the revenues and expenditures of the urban water supplier, and proposed measures to overcome those impacts, such as the development of reserves and rate adjustments.

(h) A draft water shortage contingency resolution or ordinance.

(i) A mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency analysis.

10633. The plan shall provide, to the extent available, information on recycled water and its potential for use as a water source in the service area of the urban water supplier. The preparation of the plan shall be coordinated with local water, wastewater, groundwater, and planning agencies that operate within the supplier's service area, and shall include all of the following:

(a) A description of the wastewater collection and treatment systems in the supplier's service area, including a quantification of the amount of wastewater collected and treated and the methods of wastewater disposal.

(b) A description of the quantity of treated wastewater that meets recycled water standards, is being discharged, and is otherwise available for use in a recycled water project.

(c) A description of the recycled water currently being used in the supplier's service area, including, but not limited to, the type, place, and quantity of use.

(d) A description and quantification of the potential uses of recycled water, including, but not limited to, agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, and other appropriate uses, and a determination with regard to the technical and economic feasibility of serving those uses.

(e) The projected use of recycled water within the supplier's service area at the end of 5, 10, 15, and 20 years, and a description of the actual use of recycled water in comparison to uses previously projected pursuant to this subdivision.

(f) A description of actions, including financial incentives, which may be taken to encourage the use of recycled water, and the projected results of these actions in terms of acre-feet of recycled water used per year.

(g) A plan for optimizing the use of recycled water in the supplier's service area, including actions to facilitate the installation of dual distribution systems, to promote recirculating uses, to facilitate the increased use of treated wastewater that meets recycled water standards, and to overcome any obstacles to achieving that increased use.

10634. The plan shall include information, to the extent practicable, relating to the quality of existing sources of water available to the supplier over the same five-year increments as described in subdivision (a) of Section 10631, and the manner in which water quality affects water management strategies and supply reliability.

Article 2.5 Water Service Reliability

10635.

(a) Every urban water supplier shall include, as part of its urban water management plan, an assessment of the reliability of its water service to its customers during normal, dry, and multiple dry water years. This water supply and demand assessment shall compare the total water supply sources available to the water supplier with the total projected water use over the next 20 years, in five-year increments, for a normal water year, a single dry water year, and multiple dry water years. The water service reliability assessment shall be based upon the information compiled pursuant to Section 10631, including available data from state, regional, or local agency population projections within the service area of the urban water supplier.

(b) The urban water supplier shall provide that portion of its urban water management plan prepared pursuant to this article to any city or county within which it provides water supplies no later than 60 days after the submission of its urban water management plan.

(c) Nothing in this article is intended to create a right or entitlement to water service or any specific level of water service.

(d) Nothing in this article is intended to change existing law concerning an urban water supplier's obligation to provide water service to its existing customers or to any potential future customers.

Articl 3. Adoption and Implementation of Plans

10640. Every urban water supplier required to prepare a plan pursuant to this part shall prepare its plan pursuant to Article 2 (commencing with Section 10630).

The supplier shall likewise periodically review the plan as required by Section 10621, and any amendments or changes required as a result of that review shall be adopted pursuant to this article.

10641. An urban water supplier required to prepare a plan may consult with, and obtain comments from, any public agency or state agency or any person who has special expertise with respect to water demand management methods and techniques.

10642. Each urban water supplier shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan. Prior to adopting a plan, the urban water supplier shall make the plan available for public inspection and shall hold a public hearing thereon. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned water supplier pursuant to Section 6066 of the Government Code. The urban water supplier shall provide notice of the time and place of hearing to any city or county within which the supplier provides water supplies. A privately owned water supplier shall provide an equivalent notice within its service area. After the hearing, the plan shall be adopted as prepared or as modified after the hearing.

10643. An urban water supplier shall implement its plan adopted pursuant to this chapter in accordance with the schedule set forth in its plan.

10644.

(a) An urban water supplier shall file with the department and any city or county within which the supplier provides water supplies a copy of its plan no later than 30 days after adoption. Copies of amendments or changes to the plans shall be filed with the department and any city or county within which the supplier provides water supplies within 30 days after adoption.

(b) The department shall prepare and submit to the Legislature, on or before December 31, in the years ending in six and one, a report summarizing the status of the plans adopted pursuant to this part. The report prepared by the department shall identify the outstanding elements of the individual plans. The department shall provide a copy of the report to each urban water supplier that has filed its plan with the department. The department shall also prepare reports and provide data for any legislative hearings designed to consider the effectiveness of plans submitted pursuant to this part.

10645. Not later than 30 days after filing a copy of its plan with the department, the urban water supplier and the department shall make the plan available for public review during normal business hours.

CHAPTER 4. MISCELLANEOUS PROVISIONS

10650. Any actions or proceedings to attack, review, set aside, void, or annul the acts or decisions of an urban water supplier on the grounds of noncompliance with this part shall be commenced as follows:

(a) An action or proceeding alleging failure to adopt a plan shall be commenced within 18 months after that adoption is required by this part.

(b) Any action or proceeding alleging that a plan, or action taken pursuant to the plan, does not comply with this part shall be commenced within 90 days after filing of the plan or amendment thereto pursuant to Section 10644 or the taking of that action.

10651. In any action or proceeding to attack, review, set aside, void, or annul a plan, or an action taken pursuant to the plan by an urban water supplier on the grounds of noncompliance with this part, the inquiry shall extend only to whether there was a prejudicial abuse of discretion. Abuse of discretion is established if the supplier has not proceeded in a manner required by law or if the action by the water supplier is not supported by substantial evidence.

10652. The California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) does not apply to the preparation and adoption of plans pursuant to this part or to the implementation of actions taken pursuant to Section 10632. Nothing in this part shall be interpreted as exempting from the California Environmental Quality Act any project that would significantly affect water supplies for fish and wildlife, or any project for implementation of the plan, other than projects implementing Section 10632, or any project for expanded or additional water supplies.

10653. The adoption of a plan shall satisfy any requirements of state law, regulation, or order, including those of the State Water Resources Control Board and the Public Utilities Commission, for the preparation of water management plans or conservation plans; provided, that if the State Water Resources Control Board or the Public Utilities Commission requires additional information concerning water conservation to implement its existing authority, nothing in this part shall be deemed to limit the board or the commission in obtaining that information. The requirements of this part shall be satisfied by any urban water demand management plan prepared to meet federal laws or regulations after the effective date of this part, and which substantially meets the requirements of this part, or by any existing urban water management plan which includes the contents of a plan required under this part.

10654. An urban water supplier may recover in its rates the costs incurred in preparing its plan and implementing the reasonable water conservation measures included in the plan. Any best water management practice that is included in the plan that is identified in the "Memorandum of Understanding Regarding Urban Water Conservation in California" is deemed to be reasonable for the purposes of this section.

10655. If any provision of this part or the application thereof to any person or circumstances is held invalid, that invalidity shall not affect other provisions or applications of this part which can be given effect without the invalid provision or application thereof, and to this end the provisions of this part are severable.

10656. An urban water supplier that does not prepare, adopt, and submit its urban water management plan to the department in accordance with this part, is ineligible to receive funding pursuant to Division 24 (commencing with Section 78500) or Division 26 (commencing with Section 79000), or receive drought assistance from the state until the urban water management plan is submitted pursuant to this article.

10657.

(a) The department shall take into consideration whether the urban water supplier has submitted an updated urban water management plan that is consistent with Section 10631, as amended by the act that adds this section, in determining whether the urban water supplier is eligible for funds made available pursuant to any program administered by the department.

(b) This section shall remain in effect only until January 1, 2006, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2006, deletes or extends that date.

Appendix B

2005 Urban Water Management Plan Checklist Form

Central Basin Municipal Water District
2005 Urban Water Management Plan Checklist Form

Water Code Section	Location in Guide	Items to Address	Location in Plan
10620 (d)(1)	Page 2	Participate in area wide, regional, watershed or basin wide urban water management planning	Page 1-3
10620 (d)(2)	Page 2	Describe the coordination of the plan preparation with other appropriate agencies in the area and anticipated benefits	Page 1-2-1 3
10620 (f)	Page 2	Describe how water management tools and/or options to maximize resources & minimize need to import water	Page ES-1-ES-7
10621 (a)	Page 4	Update plan every five years on or before December 31, in years ending in five and zero	Page 1-1
10621 (b)	Page 4	Notify any city or county within service area of UWMP of plan review & revision	Page 1-3
	Page 4	Consult and obtain comments from cities and counties within service area	Page 1-2
10631 (a)	Page 8	Provide current and projected population for water service area in 5-year increments to 20 or 25 years	Page 2-3
	Page 8	Identify source of population data	Page 2-3
	Page 8	Describe climate characteristics that affect water management	Page 2-1-2 2
	Page 8	Describe other demographic factors that affect water management	Page 2-2-2 3
10631 (b)	Page 10	Identify existing and planned water supply sources	Page 3-2
	Page 10	Provide current water supply quantities in 5-year increments to 20 or 25 years	Page 4-5
	Page 10	Provide planned water supply quantities in 5-year increments to 20 or 25 years	Page 4-5
10631 (b)(1)	Page 12	Attach copy of any groundwater management plans adopted, including plans adopted pursuant to Part 2.75 or any other specific authorization for groundwater management	N/A
10631 (b)(2)	Page 12	A description of any groundwater basins or basin from which the urban water supplier pumps groundwater	N/A
	Page 12	If the groundwater basin is adjudicated attach a copy of the order or decree	N/A
	Page 12	For basins that are not adjudicated, state whether basins are in overdraft	N/A
	Page 12	If basin is in overdraft or projected to be in overdraft describe plan to eliminate overdraft	N/A
	Page 12	Quantify legal pumping amounts from basin	Page 3-5
10631 (b)(3)	Page 12	Detailed description and analysis of location, amount, and sufficiency of water pumped for past five years	Page 3-6
10631 (b)(4)	Page 12	Detailed description and analysis of location, amount, and sufficiency for 20 or 25 year projection of water to be pumped	Page 3-7
10631 (c)(1)	Page 14	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage for normal water year	Page 4-5
10631 (c)(2)	Page 14	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage for single-dry water year	Page 4-5
10631 (c)(3)	Page 14	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage for multiple-dry water years	Page 4-6
10631 (c)	Page 14	Describe the reliability of the water supply due to seasonal or climatic shortages	N/A

	Page 14	Describe the vulnerability of the water supply to seasonal or climatic shortages	N/A
	Page 14	Participate in area wide, regional, watershed or basin wide urban water management planning	N/A
10631 (d)	Page 16	Describe opportunities for exchanges or water transfers on a short term or long term basis	Page 3-9
10631 (e)(1-3)	Page 18	Identify and quantify past water use by sector	Page 2-6
	Page 18	Identify and quantify current water use by sector	Page 2-6
	Page 18	Identify and quantify projected water use by sector in five-year increments to 20 or 25 years	Page 2-8
	Page 20	Identify and quantify past, current, and projected water use over five-year increments by sales to other agencies to 20 or 25 years	Page 2-6 and 2-8
	Page 20	Identify and quantify past, current, and projected water use over five-year increments by additional water uses and losses to 20 years	N/A
10631 (f)	Page 24	See (i)	Appendix F
10631 (g)	Page 40	See (j)	Appendix F
10631 (h)	Page 42	Description of water supply projects and water supply programs that may be undertaken to meet total projected water use with a timeline for each project	Page 3-5-3-12
		Quantify each proposed project's normal-year supply, single dry-year supply, and multi-dry year supply	Page 4-5-4-6
10631 (i)	Page 44	Describe opportunities for development of desalinated water (ocean, brackish water)	Page 3-9
10631 (j)	Page 22	Provide annual report from CUWCC identifying water demand management measures being implemented or scheduled for implementation to satisfy requirements (f) and (g)	Appendix F
10631 (k)	Page 46	Provide wholesale agency with water use projections for that source of water in five-year increments to 20 or 25 years	N/A
	Page 46	Wholesaler provided information identifying and quantifying existing and planned sources of water available to supplier over five-year increments to 20 or 25 years	N/A
	Page 46	Information from wholesaler describing reliability of wholesale supplies and amount to be delivered during normal, single-dry, and multiple-dry years, including factors resulting in inconsistency and information or plans to supplement or replace water sources that are not reliable	N/A
10631.5	Page 48	Include 2003-2004 or 2005 Annual Report submitted to CUWCC and CUWCC coverage report	Appendix F
10632 (a)	Page 50	Provide an urban water shortage contingency plan analysis with stages of action to be taken in response to a water supply shortage	Page 4-7-4-9
	Page 50	Provide water supply conditions for each stage	Page 4-8
	Page 50	Provide in plan a 50% supply shortage	Page 4-7
10632 (b)	Page 52	Estimate the minimum water supply available for each of the next three years based on the driest three-year historical sequence by source	Page 4-7

10631 (c)	Page 54	Provide a catastrophic supply interruption plan for non-drought related events looking at vulnerability of each source, delivery and distribution systems and actions to minimize impacts of supply interruption	Page 4-9
10632 (d)	Page 56	List mandatory prohibitions against specific water use practices during water shortages and stage when they become mandatory	Page 4-8
10632 (e)	Page 56	List the consumption reduction methods the water supplier will use to reduce water use in the most restrictive stages with up to a 50% reduction	Page 4-8
10632 (f)	Page 56	List excessive use charges or penalties for excessive use	Page 4-8
10632 (g)	Page 58	Describe how actions and conditions impact revenues	Page 4-8
	Page 58	Describe how action and conditions impact expenditures	Page 4-8
	Page 58	Describe measures to overcome the revenue and expenditure impacts	Page 4-8
10632 (h)	Page 60	Provide a draft Water Shortage Contingency resolution or ordinance	Appendix E
10632 (i)	Page 60	Describe mechanisms to determine actual reductions	Page 4-8
10633	Page 62	Identify coordination of the recycled water plan with other agencies	Page 8-10
10633 (a)	Page 64	Describe wastewater collection and treatment systems in supplier's service area including amount collected and treated and quantify volumes	Page 8-1-8 3
10633 (b)	Page 64	Describe methods of wastewater disposal and treatment levels and quantify amount meeting recycled water standards	N/A
10633 (c)	Page 64	Describe current uses of recycled water, including type, place and quantities	Page 8-4-8 6
10633 (d)	Page 66	Describe and quantify potential uses of recycled water and explain technical and economic feasibility	Page 8-8
10633 (e)	Page 66	Describe projected use of recycled water in surface area at 5-year intervals to 20 or 25 years	Page 8-8
	Page 66	Compare UWMP 2000 projections with UWMP 2005 actual use	Page 8-6
10633 (f)	Page 66	Describe actions that might be taken to encourage recycled water use and projected results	Page 8-8
10633 (g)	Page 66	Provide recycled water use optimization plan that includes actions to facilitate the use of recycled water	Page 8-9
10634	Page 68	Analyze and describe how water quality affects water management strategies and supply reliability for each source of water	Page 5-4
10635 (a)	Page 70-74	Compare projected normal water supply to projected normal water use over the next 20 or 25 years, in five-year increments	Page 4-5
	Page 70-74	Compare projected single-dry year supply to projected single-dry year water use over the next 20 or 25 years, in 5-year increments	Page 4-5
	Page 70-74	Compare projected multiple-dry year supply to projected multiple-dry year demand over the next 20 to 25 years, in 5-year increments (for following five year periods: 2006-2010, 2013-2015, 2018-2020, 2023-2025, 2028-2030)	Page 4-6-4 7

10635 (b)	Page 74	Provide Water Service Reliability section of UWMP to cities and counties within which it provides water supplies within 60 days of UWMP submission to DWR	N/A
10642	Page 78	Attach copy of adopted resolution to UWMP	Appendix C
	Page 78	Encourage involvement of social, cultural and economic community groups	Appendix C
	Page 78	Plan available for public inspection	Appendix C
	Page 78	Provide proof of public hearing	Appendix C
	Page 78	Provided meeting notice to any city or county it supplies water within	Appendix C
10643	Page 78	Review recycled water plan in 2000 UWMP and discuss whether it is being implemented as planned	Page 8-6
	Page 78	Discuss whether BMPs in CUWCC BMP Annual Reports submitted in 2000 UWMP were implemented as planned	Page 6-2
10644	Page 78	Provide 2005 UWMP to DWR and cities and counties within supplier area within 30 days of adoption	N/A
10645	Page 78	Provide documentation showing where plan will be available for public review during normal business hours 30 days after submittal to DWR	Appendix C

Appendix C

Notice of Public Hearing and Resolution for UWMP Adoption

LEGAL NOTICE

Notice of Public Hearing

Central and West Basin Municipal Water Districts

PLEASE TAKE NOTICE that the Board of Directors of Central and West Basin Municipal Water Districts will conduct a Public Hearing on **December 19, 2005** at the hours of **11:00 a.m.** and **1:00 p.m.**, respectfully; or as soon thereafter as the matter can be heard, in the board room of the District's office located at 17140 S. Avalon Blvd., Carson, California to consider adoption of its 2005 Urban Water Management Plans. This planning document assesses the Districts' water resources, demands, and strategies over the next 25 years, as a requirement set forth by the State Department of Water Resources. The Final Draft 2005 Urban Water Management Plan can be found on the Districts' website at www.westbasin.org and www.centralbasin.org or a copy can be requested from the Districts for review. Interested parties are invited to present oral or written comments.

Dated November 30, 2005

Charlene Jenson
Secretary

Publish: December 5, 12, 2005
Whittier Daily News Ad No.

Daily Breeze

DB 11-21
Notice of Public Hearing

Central and West Basin
Municipal Water Districts

PLEASE TAKE NOTICE that the Board of Directors of Central and West Basin Municipal Water Districts will conduct a Public hearing on **December 19, 2005** at the hours of **11:00 a.m. and 1:00 p.m.** respectfully; or as soon thereafter as the matter can be heard in the board room of the District's office located at 17140 S. Avalon Blvd. Carson, California to consider adoption of its 2005 Urban Water Management Plans. This planning document assesses the Districts' water resources, demands, and strategies over the next 25 years, as a requirement set forth by the State Department of Water Resources. The Final Draft 2005 Urban Water Management Plan can be found on the Districts' website at www.westbasin.org and www.centralbasin.org or a copy can be requested from the Districts for review. Interested parties are invited to present oral or written comments.

Dated November 30, 2005

Christine Jensen
Secretary

Pub.: December 5, 12, 2006.

CERTIFICATION

State of California)
County of Los Angeles) SS
Central Basin Municipal)
Water District)

I, Charlene Jensen, Board Secretary of Central Basin Municipal Water District and of the Board of Directors thereof, do hereby certify that the foregoing is a full, true and correct copy of Resolution No. 12-05-71 "A RESOLUTION OF THE BOARD OF DIRECTORS OF THE CENTRAL BASIN MUNICIPAL WATER DISTRICT APPROVING THE 2005 URBAN WATER MANAGEMENT PLAN", which was adopted at a meeting held on December 19, 2005 by the Board of Directors of the Central Basin Municipal Water District.

Dated: December 20, 2005

Charlene T. Jensen
Board Secretary, Central Basin
Municipal Water District and to
the Board of Directors thereof

I:\users\charlene\certifycb

RESOLUTION NO. 12-05-716

A RESOLUTION OF THE BOARD OF DIRECTORS OF CENTRAL BASIN MUNICIPAL WATER DISTRICT APPROVING THE 2005 URBAN WATER MANAGEMENT PLAN

BE IT RESOLVED, by the BOARD OF DIRECTORS that the Board of Directors hereby adopt and sign a Resolution approving the 2005 Urban Water Management Plan, and

BE IT RESOLVED, that the Central Basin Municipal Water District hereby agrees and further authorizes that the aforementioned document complies with all applicable requirements set forth in the California Urban Water Management Planning Act of 1983, as amended, and

BE IT FURTHER RESOLVED, that the President of the Board of Directors of the Central Basin Municipal Water District is hereby authorized to sign the 2005 Urban Water Management Plan.

PASSED, APPROVED, AND ADOPTED on the 19th day, December 2005.

Robert Apodaca
President

ATTEST.

Charlene Jensen
Secretary

(SEAL)

G:\director\resos\cb716

Appendix D

Notice of Preparation / Draft 2005 UWMP

Central Basin Municipal Water District

17140 S. Avalon Blvd • Suite 210 • Carson, CA 90746-1256

telephone 310-217-2222 • fax 310-217-2414

July 8, 2005

To Whom It May Concern:

This letter serves as notification that the Central Basin Municipal Water District is currently preparing a 2005 update of its Urban Water Management Plan, pursuant to the Urban Water Management Planning Act (Act) of the California Water Code. The Act requires urban water suppliers to update their Urban Water Management Plans and submit a complete plan to the California Department of Water Resources every five years.

A draft of Central Basin's Plan is currently available for review and comments. A Final Draft will be available for review prior to the scheduled public hearing in October 2005.

Please contact us if you would like to receive a draft Plan. If you would like more information or have any questions, please contact Harvey De La Torre at (310) 660-6233 or via email at harveyd@wcbwater.org.

Thank you,

Art Aguilar
Co-General Manager

Rich Nagel
Co-General Manager

CHRONO FILE

Central Basin
Municipal Water District
310-217-2222

West Basin
Municipal Water District
310-217-2411

June 29, 2005

Dear Central/West Basin Customer Agencies:

2005 Urban Water Management Plan

As you are aware, all California agencies providing water to more than 3,000 customers or supplying more than 3,000 acre-feet of water a year are required to update their Urban Water Management Plans (UWMP) every five years, according to California Water Code Section 10621(a). Central Basin MWD (CBMWD) and West Basin MWD (WBMWD) hosted its 2005 Urban Water Management Plan workshop with the Metropolitan Water District of Southern California and the California Urban Water Conservation Council on June 28 2005.

Enclosed you will find the District's DRAFT 2005 UWMP, which will assist you in updating your agency's UWMP. We will be meeting with each agency to discuss our Plan and answer any questions you may have throughout the months of July and August. Staff will be contacting you soon to schedule a date and time. The District anticipates completing its FINAL UWMP by September and taking it to the Board for adoption in October. All UWMPs are due to the Department of Water Resources by December 31, 2005.

If you have any questions, please feel free to contact Harvey De La Torre at (310) 660-6233 or Leighanne Reeser at (310) 660-6225.

Sincerely,

Art Aguilar
Co-General Manager

Rich Nagel
Co-General Manager

Enclosures

17140 S. Avalon Blvd • Suite 210 • Carson, CA 90746-1296
fax 310-217-2414

Appendix E

Water Shortage Contingency Plan Resolution

---DRAFT---

Resolution No. _____

A RESOLUTION OF THE BOARD OF DIRECTORS OF
THE CENTRAL BASIN MUNCIPAL WATER DISTRICT FINDING THE
EXISTENCE OF A WATER SHORTAGE,
ORDERING THE IMPLEMENTATION OF STAGE __ OF
THE WATER SHORTAGE CONTINGENCY PLAN

WHEREAS, the Central Basin Municipal Water District (District), a member agency to Metropolitan Water District of Southern California (MWD), has implemented a mandatory reduction program; and

WHEREAS, the Board of Directors has established Stages of Action contingent upon the MWD Water Surplus and Drought Management (WSDM) Plan, which provides for stages of action and an allocation methodology; and

WHEREAS, the WSDM Plan allocation methodology has yet to be determined and the District has established and will follow the following stages of action:

a) Minimum Shortage Stage: Request a voluntary effort among the District customers to reduce imported water deliveries. Pursue an aggressive Public Awareness Campaign to encourage residents and industries to reduce their usage of water.

b) Moderate Shortage Stage: In addition to the Minimum Shortage Stage actions, the District will work with its customer agencies to promote and adopt waste water prohibition and ordinances to discourage unnecessary water usage.

c) Severe Shortage Stage: In addition to the Minimum and Moderate Shortage Stage actions, the District will seek to adopt a rate structure that penalized increased water usage among its customer agencies.

d) Extreme Water Shortage Stage: In addition to the Minimum, Moderate, and Severe Shortage Stage actions, the District will call for the discontinuance of imported water based upon an allocation methodology similar to MWD for each of its customer agencies; and

WHEREAS, the Board of Directors may, upon finding that a water shortage exists, order implementation of a plan which it deems appropriate to address such water shortage and shall establish the Stage if action that it is implementing.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE CENTRAL BASIN MUNICIPAL WATER DISTRICT AS FOLLOWS:

—-DRAFT—-

1. That, for the reasons hereinabove set forth, the Board of Directors hereby finds and determines that a Water Shortage exists in the Central Basin Water District service area.
2. That the Board of Directors hereby orders implementation of the Water Shortage Contingency Plan, ____________Stage, as set forth above.
3. That reasonable action shall be taken to ensure compliance by the District's customer agencies.

THE FOREGOING RESOLUTION is approved and adopted by the Board of Directors of the Central Basin Municipal Water District this __ day of _________, 20__

PRESIDENT, CENTRAL BASIN MWD

ATTEST:

BOARD SECRETARY, CENTRAL BASIN MWD

Appendix F

Best Management Practices Report 2003-2004

Reported as of 8/2

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2003**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	no
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	
b. Determine other system verifiable uses (AF)	
c. Determine total supply into the system (AF)	
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.00
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	no
4. Did your agency complete a full-scale audit during this report year?	no
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	no
6. Does your agency operate a system leak detection program?	no
a. If yes, describe the leak detection program:	

B. Survey Data

1. Total number of miles of distribution system line.	0
2. Number of miles of distribution system line surveyed.	0

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? — No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

As a water wholesaler, we do not actually own potable water piping. We do however provide support to our water retailers as stated in BMP 10. We have provided them with requested information on how to conduct system audits and leak detection. We do have manuals provided by DWR.

Reported as of 8/2

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2003**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? yes

a. If YES, describe the program and how it's organized.

The Public Information Program consists of a variety of programs and practices that are used to educate the public about water conservation. Conservation literature is provided to the public at the various one-day ultra-low-flush (ULF) toilet programs, and at community events. A quarterly newsletter is provided to approximately 20,000 residents. Information is provided at the quarterly Public Information Committee (PIC) meeting, and at the annual "Water Harvest" festival. Information is also provided at various speaking engagements, the web site, and on the telephone. Opportunities are sought to educate the public about the importance of water conservation. Marketing is also conducted to promote the District's rebate programs.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	yes	21
b. Public Service Announcement	yes	1
c. Bill Inserts / Newsletters / Brochures	yes	2
d. Bill showing water usage in comparison to previous year's usage	no	
e. Demonstration Gardens	no	
f. Special Events, Media Events	yes	5
g. Speaker's Bureau	yes	5
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	174617	168000
2. Actual Expenditures	80000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 8/2

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2003**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? yes

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	7	190	0
Grades 4th-6th	yes	24	830	0
Grades 7th-8th	yes	3	105	0
High School	no	0	0	0

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program? 9/10/1995

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	49737	86208
2. Actual Expenditures	20000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 8/2

BMP 10: Wholesale Agency Assistance Programs

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2003**

A. Implementation

1. Financial Support by BMP

BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded	BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded
1	No			8	yes	49737	20000
2	No			9	yes	5500	5500
3	No			10	yes	0	0
4	No			11	No	0	0
5	yes	1500000	1500000	12	yes	65000	65000
6	yes	15000	15000	13	No	0	0
7	yes	174817	174817	14	yes	350500	350000

2. Technical Support

a. Has your agency conducted or funded workshops addressing CUWCC procedures for calculating program savings, costs and cost-effectiveness?	No
b. Has your agency conducted or funded workshops addressing retail agencies' BMP implementation reporting requirements?	No
c. Has your agency conducted or funded workshops addressing:	
1) ULFT replacement	No
2) Residential retrofits	No
3) Commercial, industrial, and institutional surveys	No
4) Residential and large turf irrigation	No
5) Conservation-related rates and pricing	No

3. Staff Resources by BMP

BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP	BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP
1	yes	1	8	yes	1
2	yes	1	9	yes	1
3	yes	1	10	yes	1
4	yes	1	11	yes	1
5	yes	1	12	yes	1
6	yes	1	13	yes	1
7	yes	1	14	yes	1

4. Regional Programs by BMP

BMP	Implementation/ Management Program?	BMP	Implementation/ Management Program?
1	No	8	yes
2	No	9	yes
3	No	10	yes
4	No	11	yes
5	No	12	yes
6	yes	13	yes
7	yes	14	yes

B. Wholesale Agency Assistance Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	720254	720254
2. Actual Expenditures	660254	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

In reference to BMP 5, the District spends $1.5 million on O&M for its recycled water system. This system benefits large landscape customers by utilizing recycled water instead of imported or potable water. A1 of BMP 5 includes funding for recycled water operations and maintenance. Recycled water is 100% water conservation.

D. Comments

BMP #9 - Central Basin participates in MWD's region-wide CII. MWD pays vendor to implement and market program on behalf of the Member Agencies. Central Basin budgeted $5,000 to help market the program. The District has moved its recycled water budget dollars from BMP #9 into BMP #5 - Large Landscape. It is more appropriate in this BMP than in prior reporting in BMP 9. BMP #6 - Central Basin receives a $110 rebate incentive from MWD. Central Basin budgets an additional $15,000 for marketing the program. ($15 per rebate x 1,000 rebates)

Reported as of 8/2

BMP 11: Conservation Pricing

Reporting Unit: **Central Basin MWD**	BMP Form Status: **100% Complete**	Year: **2003**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$34686195.84
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$4556848.45
2. Commercial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
3. Industrial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
4. Institutional / Government	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
5. Irrigation	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
6. Other	
a. Water Rate Structure	Decreasing Block

b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$1445258.18
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$3198559.55

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 8/2

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2003**

A. Implementation

1. Does your Agency have a conservation coordinator?	yes
2. Is this a full-time position?	no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ?	yes
4. Partner agency's name:	West Basin Municipal Water District
5. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	50%
b. Coordinator's Name	Gus Meza
c. Coordinator's Title	Conservation Coordinator
d. Coordinator's Experience and Number of Years	5 Years Conservation Related Experience
e. Date Coordinator's position was created (mm/dd/yyyy)	4/17/1991
6. Number of conservation staff, including Conservation Coordinator.	1

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	68000	68000
2. Actual Expenditures	58000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Central Basin MWD shares staff with West Basin MWD on a 50/50 basis. So conservation staff time is one-half person for each Water District.

Reported as of 8/2

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2004**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	no
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	
b. Determine other system verifiable uses (AF)	
c. Determine total supply into the system (AF)	
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.00
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	no
4. Did your agency complete a full-scale audit during this report year?	no
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	no
6. Does your agency operate a system leak detection program?	no
a. If yes, describe the leak detection program:	

B. Survey Data

1. Total number of miles of distribution system line.	0
2. Number of miles of distribution system line surveyed.	0

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

As a water wholesaler, we do not actually own potable water piping. We do however provide support to our water retailers as stated in BMP 10. We have provided them with requested information on how to conduct system audits and leak detection. We do have manuals provided by DWR

Reported as of 8/2

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2004**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? yes

a. If YES, describe the program and how it's organized.

The Public Information Program consists of a variety of programs and practices that are used to educate the public about water conservation. Conservation literature is provided to the public at the various one-day ultra-low-flush (ULF) toilet programs, and at community events. A quarterly newsletter is provided to approximately 20,000 residents. Information is provided at the quarterly Public Information Committee (PIC) meeting, and at the annual "Water Harvest" festival. Information is also provided at various speaking engagements, the web site, and on the telephone. Opportunities are sought to educate the public about the importance of water conservation. Marketing is also conducted to promote the District's rebate programs.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	yes	21
b. Public Service Announcement	yes	1
c. Bill Inserts / Newsletters / Brochures	yes	2
d. Bill showing water usage in comparison to previous year's usage	no	
e. Demonstration Gardens	no	
f. Special Events, Media Events	yes	5
g. Speaker's Bureau	yes	5
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	168000	213000
2. Actual Expenditures	180000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 8/2

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2004**

A. Implementation

1. Has your agency implemented a school information program to promote water conservation? yes

2. Please provide information on your school programs (by grade level).

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	14	330	0
Grades 4th-6th	yes	34	1190	0
Grades 7th-8th	yes	2	60	0
High School	no	0	0	0

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program? 9/10/1995

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	68208	68208
2. Actual Expenditures	26000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 8/2

BMP 10: Wholesale Agency Assistance Programs

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2004**

A. Implementation

1. Financial Support by BMP

BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded	BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded
1	No			**8**	yes	68208	26000
2	No			**9**	No	0	0
3	No			**10**	yes	0	0
4	No			**11**	No		
5	No			**12**	yes	65000	65000
6	yes	15000	15000	**13**	No	0	0
7	yes	168000	168000	**14**	yes	360500	360500

2. Technical Support

a. Has your agency conducted or funded workshops addressing CUWCC procedures for calculating program savings, costs and cost-effectiveness?	No
b. Has your agency conducted or funded workshops addressing retail agencies' BMP implementation reporting requirements?	No
c. Has your agency conducted or funded workshops addressing:	
1) ULFT replacement	No
2) Residential retrofits	No
3) Commercial, industrial, and institutional surveys	No
4) Residential and large turf irrigation	No
5) Conservation-related rates and pricing	No

3. Staff Resources by BMP

BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP	BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP
1	yes	1	8	yes	1
2	yes	1	9	yes	1
3	yes	1	10	yes	1
4	yes	1	11	yes	1
5	yes	1	12	yes	1
6	yes	1	13	yes	1
7	yes	1	14	yes	1

4. Regional Programs by BMP

BMP	Implementation/ Management Program?	BMP	Implementation/ Management Program?
1	No	8	yes
2	No	9	yes
3	No	10	yes
4	No	11	yes
5	No	12	yes
6	yes	13	yes
7	yes	14	yes

B. Wholesale Agency Assistance Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	679208	523708
2. Actual Expenditures	679208	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

In reference to BMP 5, the District spends $1.5 million on O&M for its recycled water system. This system benefits large landscape customers by utilizing recycled water instead of imported or potable water. A1 of BMP 5 includes funding for recycled water operations and maintenance. Recycled water is 100% water conservation.

D. Comments

BMP #9 - Central Basin participates in MWD's region-wide CII. MWD pays vendor to implement and market program on behalf of the Member Agencies. Central Basin budgeted $5,000 to help market the program. The District has moved its recycled water budget dollars from BMP #9 into BMP #5 - Large Landscape. It is more appropriate in this BMP than in prior reporting in BMP 9. BMP #6 - Central Basin receives a $110 rebate incentive from MWD. Central Basin budgets an additional $15,000 for marketing the program. ($15 per rebate x 1,000 rebates)

Reported as of 8/2

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2004**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$36835420.8
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$4477917.3625
2. Commercial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
3. Industrial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
4. Institutional / Government	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
5. Irrigation	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
6. Other	
a. Water Rate Structure	Decreasing Block

b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$1534809.2
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$3144069.6375

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 8/2

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
Central Basin MWD	**100% Complete**	**2004**

A. Implementation

1. Does your Agency have a conservation coordinator?	yes
2. Is this a full-time position?	no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ?	yes
4. Partner agency's name:	West Basin Municipal Water District
5. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	50%
b. Coordinator's Name	Gus Meza
c. Coordinator's Title	Conservation Coordinator
d. Coordinator's Experience and Number of Years	5 Years Conservation Related Experience
e. Date Coordinator's position was created (mm/dd/yyyy)	4/17/1991
6. Number of conservation staff, including Conservation Coordinator.	1

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	58000	58000
2. Actual Expenditures	58000	

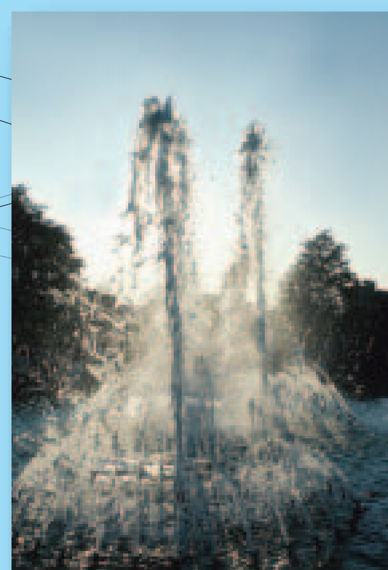
C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Central Basin MWD shares staff with West Basin MWD on a 50/50 basis. So conservation staff time is one-half person for each Water District.



Glossary

Glossary of Abbreviations and Terms

AGENCIES

AWWARF	American Water Works Association Research Foundation
CalWater	California Water Service Company
CDHS	California Department of Health Services
Central Basin	Central Basin Municipal Water District
City	City of Los Angeles
CPUC	California Public Utilities Commission
CSDLAC	County Sanitation Districts of Los Angeles County
CUWCC	California Urban Water Conservation Council
CWAC	California Water Awareness Campaign
District	Central Basin Municipal Water District
DWR	California Department of Water Resources
Edison	Southern California Edison
EPA	United States Environmental Protection Agency
LACDPW	Los Angeles County Department of Public Works
LACFCD	Los Angeles County Flood Control District
LADWP	Los Angeles Department of Water and Power
MWD	Metropolitan Water District of Southern California
RWQCB	Regional Water Quality Control Board
SCAG	Southern California Association of Governments
USBR	United States Bureau of Reclamation
West Basin	West Basin Municipal Water District
WRD	Water Replenishment District of Southern California

FACILITIES AND LOCATIONS

Barrier	Alamitos Barrier
Basin	Central Groundwater Basin
Bay-Delta	San Francisco-San Joaquin Bay Delta
CRA	Colorado River Aqueduct
CSUDH	California State University at Dominguez Hills
CVP	Central Valley Project
Hyperion	Hyperion Treatment Plant
Ibbetson Century Project	E. Thornton Ibbetson Century Water Recycling Project
Pilot Project	West Basin's Desalination Pilot Project
Spreading Grounds	Rio Hondo and San Gabriel River Spreading Grounds
SWP	State Water Project
SWRP	Southeast Water Reliability Project
Torres Project	Esteban E. Torres Rio Hondo Water Recycling Project
WCGB	West Coast Groundwater Basin
WRP	Water Recycling Plant
WRPS	Water Reclamation Plants

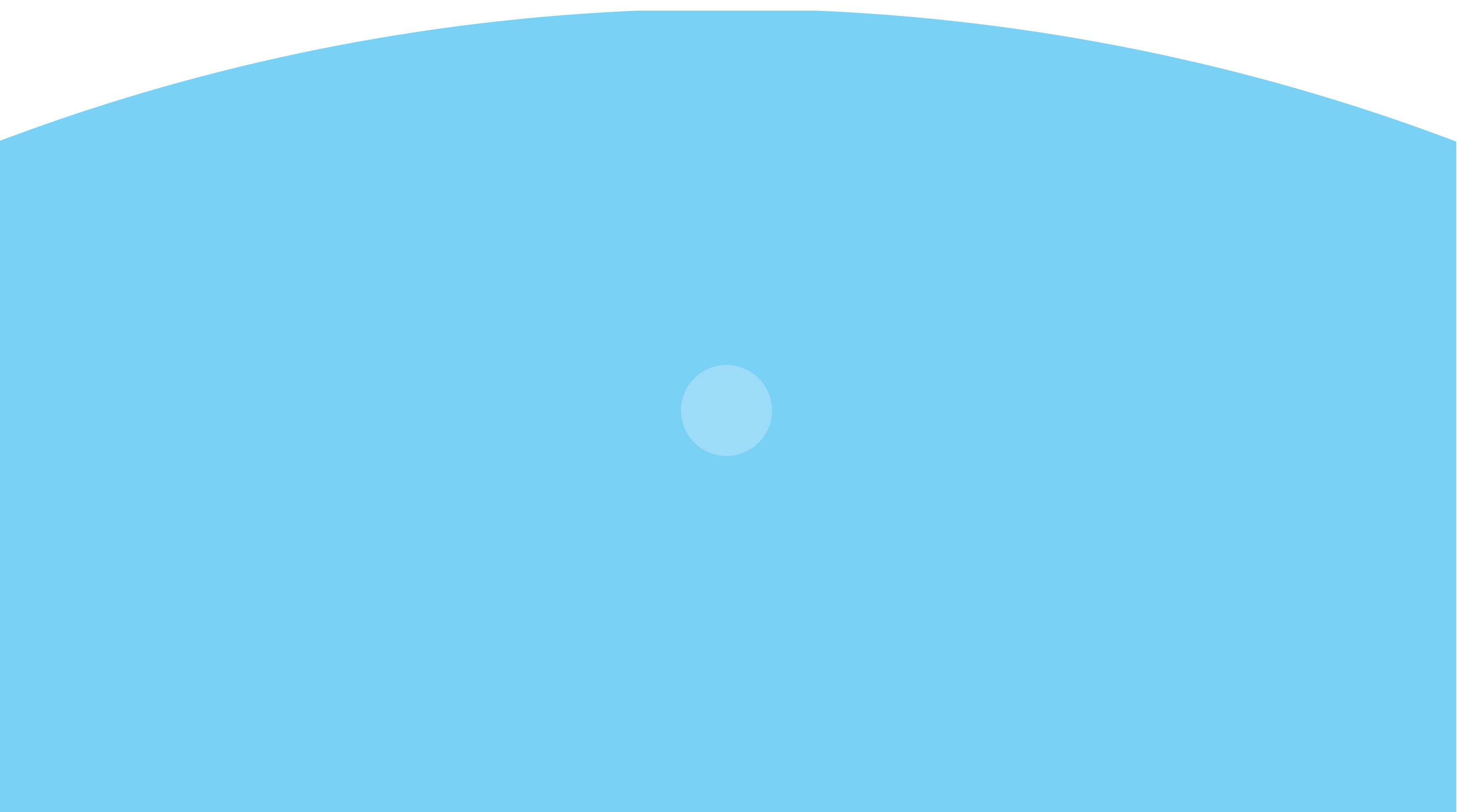
MEASUREMENTS

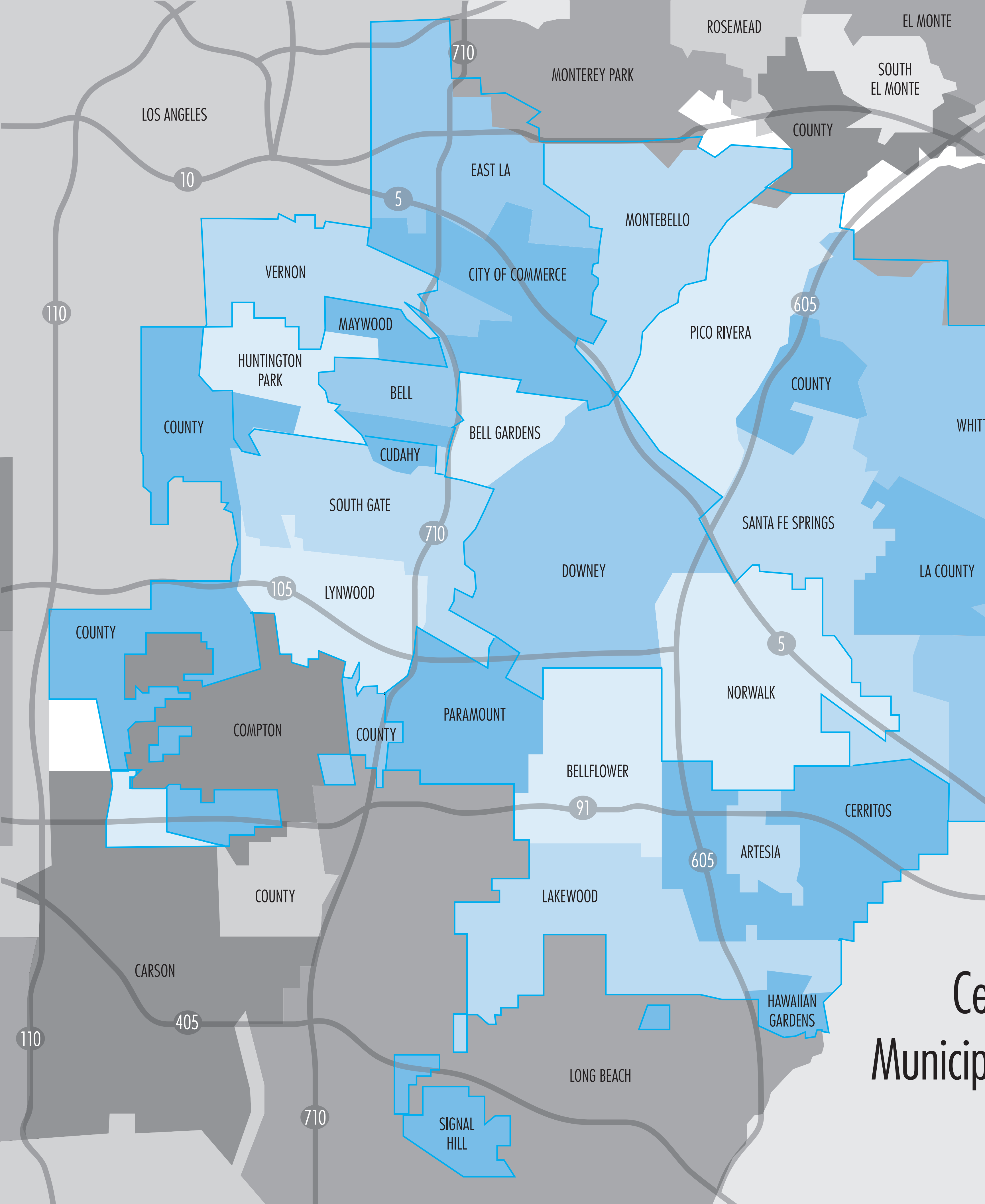
AFY	Acre-Feet Per Year
CFS	Cubic Feet Per Second
GPCD	Gallons Per Capita Per Day
GPM	Gallons Per Minute
MAF	Million Acre-Feet
MGD	Million Gallons Per Day
WF	Water Factor

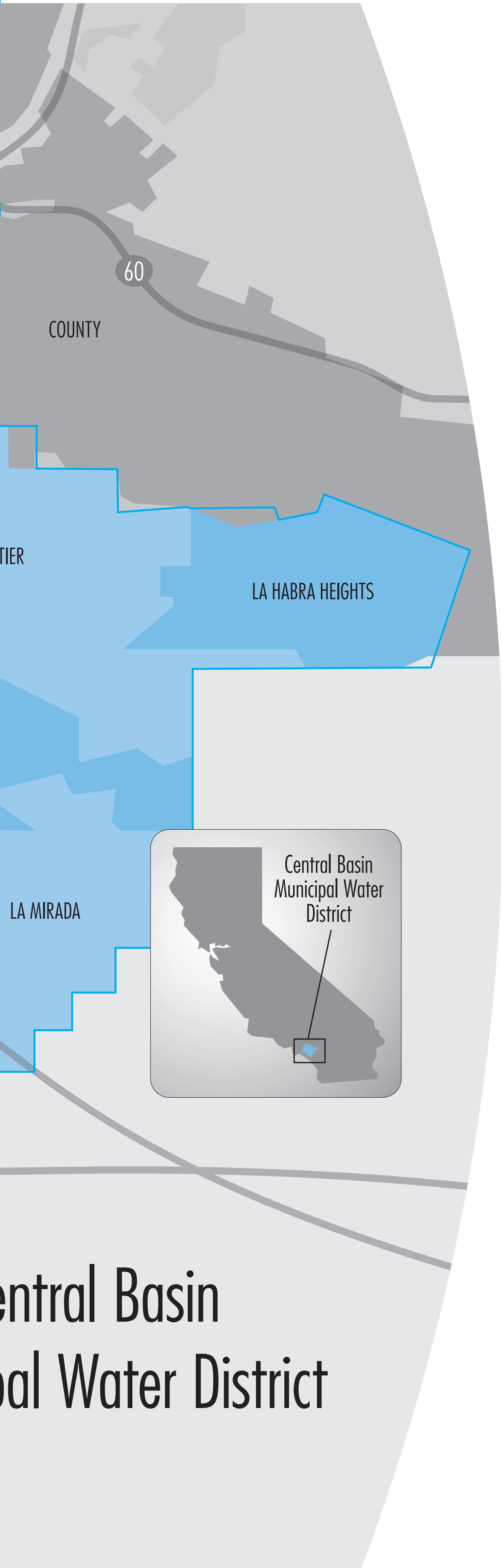
MISCELLANEOUS

ACT	California Urban Water Management Planning Act of 1983
BMPs	Best Management Practices
CBIC	Weather-Based Irrigation Program
CII	Commercial, Industrial and Institutional
EOC	Emergency Operation Center
Harbor/South Bay	Harbor/South Bay Water Recycling Project
HECW	High-Efficiency Clothes Washer Program
HET	High-Efficiency Toilets
IRP	Integrated Resources Plan
Marketing Plan	Recycled Water Marketing Plan
Master Plan	Recycled Water Master Plan
MARS	Member Agency Response System
MOU	Memorandum of Understanding Regarding Urban Water Conservation in California
MWD-MAIN	Metropolitan Water District's Municipal and Industrial Needs
NPDES	National Pollutant Discharge Elimination System
PAC	Project Advisory Committee
PIC	Public Information Committee
Plan	Conservation Master Plan
Program	Water Audit and Leak Detection Program
QSA	Quantification Settlement Agreement
RTS	Readiness-to-Serve Charge
SDWP	Safe Drinking Water Program
Title 22	California Code of Regulations Title 22 standards
ULFT	Ultra-Low-Flush Toilet
UWMP	Urban Water Management Plan
VOCs	Volatile Organic Compounds
WBIC	Weather-Based Irrigation Controller
WQPP	Water Quality Protection Project
WSDM	Water Surplus and Drought Management Plan

www.centralbasin.org




ROSEMEAD
EL MONTE
MONTEREY PARK
SOUTH EL MONTE
LOS ANGELES
COUNTY
EAST LA
MONTEBELLO
VERNON
CITY OF COMMERCE
MAYWOOD
PICO RIVERA
HUNTINGTON PARK
BELL
COUNTY
COUNTY
BELL GARDENS
CUDAHY
SOUTH GATE
SANTA FE SPRINGS
DOWNEY
LA COUNTY
LYNWOOD
COUNTY
NORWALK
COMPTON
PARAMOUNT
COUNTY
BELLFLOWER
CERRITOS
ARTESIA
COUNTY
LAKEWOOD
CARSON
HAWAIIAN GARDENS
LONG BEACH
SIGNAL HILL
710
10
5
110
605
105
91
405



60
COUNTY
TIER
LA HABRA HEIGHTS
LA MIRADA
Central Basin
Municipal Water
District
entral Basin
pal Water District

Board of Directors and Service Areas

Division I: Director Edward C. Vasquez
Bell Gardens, Downey, Montebello, Norwalk and Vernon

Division II: Director Robert Apodaca
La Habra Heights, La Mirada, Pico Rivera, Santa Fe Springs and Whittier

Division III: Director George Cole
Bell, Commerce, Huntington Park, Maywood, Walnut Park, portions of Cudahy, Monterey Park and unincorporated areas of East Los Angeles

Division IV: Director Olga E. Gonzalez
Lynwood, South Gate, portions of Cudahy, Carson, Florence-Graham and Willowbrook

Division V: Director Phillip D. Hawkins
Artesia, Bellflower, Cerritos, Hawaiian Gardens, Lakewood, Paramount and Signal Hill

West Basin
Municipal Water District

Urban Water Management Plan

Year 2005

West Basin
Municipal Water District

Message from the Board of Directors

Since the District's formation in 1947, West Basin Municipal Water District has remained steadfast in its commitment to ensure a safe and reliable water supply for the region. Through the years, the District has grown and transformed, seeking innovative and viable solutions to meet the changing needs of its communities. All of us at West Basin continue to expand our efforts to meet the growing water demand while preserving our limited and precious water resource. Through our water recycling, conservation, education, desalination, outreach and quality monitoring programs, West Basin has evolved from a potable water wholesaler to a leader safeguarding the region's water supply.

We are proud to submit this 2005 Urban Water Management Plan to the State Department of Water Resources. The Plan reports all current and projected water supplies and demands within West Basin's service area, demonstrates water reliability for the next 25 years and provides a comprehensive overview of the District's various programs.

Directors

Division I William A. Baker
Palos Verdes Estates, Rancho Palos Verdes, Rolling Hills Estates, Rolling Hills and portions of Carson

Division II Jose A. Fernandez
Inglewood, South Ladera Heights, portions of Lennox and unincorporated areas of Athens, Howard and Ross-Sexton

Division III Carol W. Kwan, President
Hermosa Beach, Lomita, Manhattan Beach, Redondo Beach and unincorporated areas of Torrance

Division IV Edward C. Little, Vice-President
Culver City, Del Aire, El Segundo, Malibu, North Ladera Heights, Topanga, View Park, West Hollywood, Windsor Hills and portions of Lennox

Division V Donald L. Dear
Gardena, Hawthorne, Lawndale and unincorporated portions of El Camino Village

Mission Statement

"To obtain and provide a safe and reliable supplemental supply of high quality water to our member agencies, including the communities, businesses and residents they serve, in an efficient, effective and economical manner. In accomplishing this mission, the District shall provide adequate information and education on water issues to the public, be instrumental in guarding the integrity, safety and security of the West Coast Basin, and maintain close cooperation with the other agencies serving our area."

West Basin Municipal Water District

2005 Urban Water Management Plan

Prepared by:

West Basin Municipal Water District
17140 S. Avalon Blvd., Suite 210
Carson, CA 90746

Table of Contents

List of Figures

List of Tables

Executive Summary

Executive Summary

1 A Brief History

The legislative requirement to prepare an Urban Water Management Plan (UWMP) every five years provides West Basin Municipal Water District (West Basin) with an opportunity to affirm and support its primary purpose – to ensure the long-term water supply reliability of its region. Although the District's overall mission has not changed in more than five decades, techniques for meeting its objective are continuously evolving.

Colorado River
Courtesy of MWD

The history of West Basin is representative of how water resource management has evolved in Southern California during the past half a century. Ensuring that residents and businesses in Southern California have a safe and reliable supply of water requires the cooperation of local water purveyors as well as regional wholesalers.

When native groundwater supplies in the growing southeastern part of Los Angeles County became critically over-drafted in the 1940s, groundwater producers formed a regional agency, West Basin Municipal Water District, in 1947. Prior to joining Metropolitan Water District of Southern California, the District explored alternative sources of water including water recycling and even ocean water desalination. Due to the then extraordinary cost in developing these sources, West Basin joined MWD. MWD had been created in 1928 by 11 cities (13 in 1933 and now 26 member agencies in 2005) for the purpose of constructing a 240-mile aqueduct from the Colorado River. The era of "imported water" and mega-projects that began at the turn of the last century with construction of the Los Angeles Aqueduct from the Owens Valley by the City of Los Angeles, and continued with the extension of the California Aqueduct into Southern California in the 1970s, was well underway. West Basin joined this era to provide a new source of water for groundwater replenishment and to meet the needs of many cities and agencies with little or no access to groundwater.

Imported water was the fuel that drove the economic engine of Southern California for decades. Through the 1960s, 70s and 80s, imported water provided by West Basin offered the reliability enjoyed by retail water agencies across most of coastal Los Angeles County. During this time, population within West Basin's service area grew by 138% from about 320,000 in 1950 to more than 760,000 people by 1990.

2 A Different Approach to Water Management

The paradigm of ensuring reliability while continuing to provide unlimited supplies of imported water began to change with the drought of 1989-1992. Even before the near-reality of mandatory water rationing in the spring of 1992, plans had begun to enhance conservation practices and to consider the development of locally-produced sources of water that, through the long-term, would significantly reduce Southern California's reliance on supply systems subject to hydrology and environmental pressures.

West Basin was at the forefront of this change in approach to water management. By 1990, funding mechanisms were in place and designs were being drawn up for a world-class recycled water production and distribution system that would directly offset potable imported water for non-potable uses such as irrigation and industrial applications and indirect potable, such as injection into a seawater barrier system. West Basin would also become renowned for its highly successful conservation and education programs that, combined with recycled water, have helped conserve more than 63 billion gallons of potable water during the past decade.

By 1996, local water supply programs were accounted for within MWD's Southern California Integrated Resources Plan (IRP), which established a rolling 20-year roadmap for diversified supply investments in recycled water, brackish groundwater treatment, surface and groundwater storage, water transfers and exchanges, conservation practices and accessibility to imported water. A recent update of the IRP also includes ocean water desalination as an additional resource for ensuring the long-term reliability of regional water supplies.

West Basin's aggressive pursuit of the resource development targets within the IRP is bringing supply diversity to a region originally dependent on groundwater.

3 Water Demand

Total water use, or demand, within West Basin's service area includes retail demand and groundwater replenishment (i.e. Barriers). Retail demand is defined as all municipal (residential, firefighting, parks, etc.) and industrial uses, and represents the population's total direct water consumption. Replenishment includes deliveries to the West Coast and Dominguez Gap Barriers to protect the West Coast Groundwater Basin. Table ES-1 summarizes the current and projected retail and replenishment demands.

Table ES-1
West Basin's Current and Projected Water Demands
(In Acre-Feet)

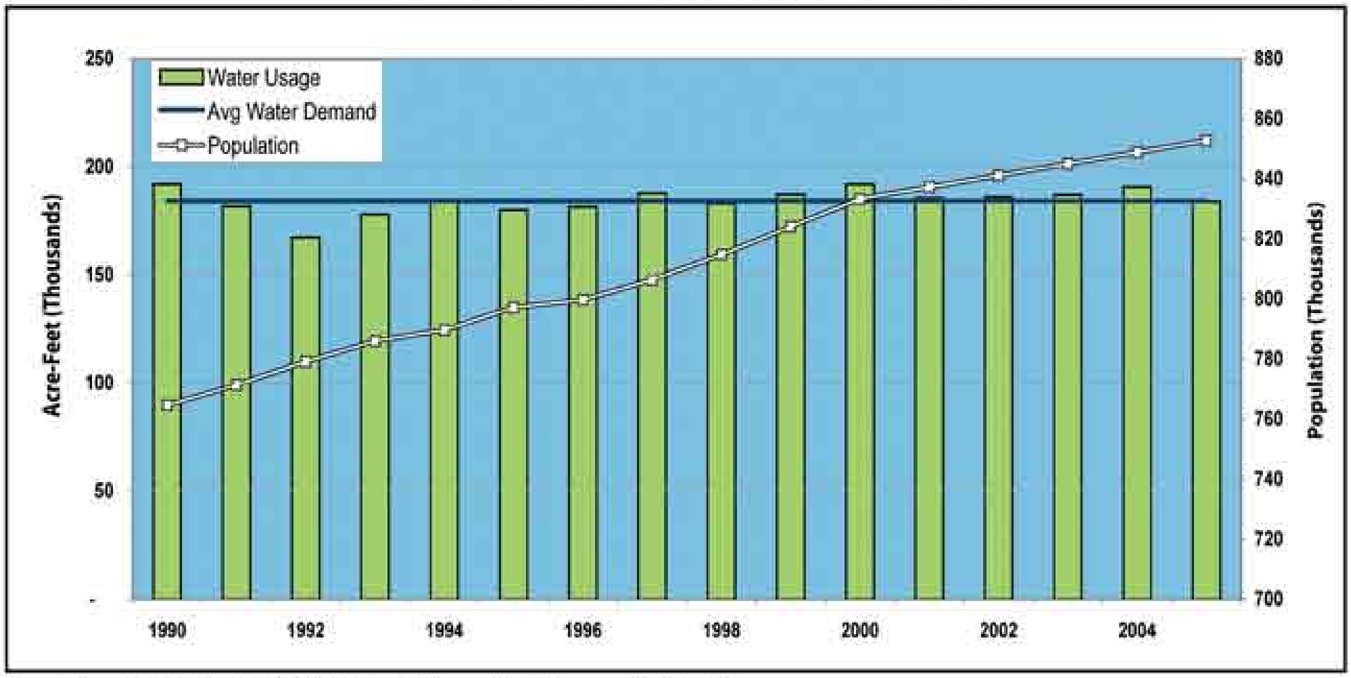
District Water Demands	2005[1]	2010	2015	2020	2025	2030
Retail Municipal & Industrial Use						
Groundwater[2]	41,535	52,000	52,000	52,000	52,000	52,000
Imported Water	129,316	123,000	97,319	98,665	100,140	101,747
Recycled Water[3]	13,065	21,848	32,500	36,250	40,000	43,750
Ocean Desalination	0	0	20,000	20,000	20,000	20,000
Total Retail Demand	**183,916**	**196,848**	**201,819**	**206,915**	**212,140**	**217,497**
Replenishment Use						
Imported Water	15,000	10,000	10,000	10,000	10,000	10,000
Recycled Water	7,500	17,500	17,500	17,500	17,500	17,500
Total Replenishment Demand	**22,500**	**27,500**	**27,500**	**27,500**	**27,500**	**27,500**
Total Demand	**206,416**	**224,348**	**229,319**	**234,415**	**239,640**	**244,997**

[1] The 2005 demands are based on the FY 2004-05, which was recorded as one of the "wettest" years on record.
[2] Groundwater demands include the amount of groundwater pumped from the West Coast and Central (avg. 2,000 AFY) groundwater basins to satisfy groundwater demands within West Basin's service area
[3] Includes M&I recycled water sales from West Basin's service area; it does not include recycled sales to Los Angeles Department of Water and Power and the City of Torrance or Replenishment sales (Barrier).

4 Impacts of Conservation and Education: Reduced Demand

Although not a traditional "wet" water supply like imported water or recycled water, water use efficiency, including conservation and education, is considered part of West Basin's water supply portfolio because it results in less retail need, or demand, for wet supplies than would otherwise be the case. Perhaps the most telling picture of the impact of conservation and education on retail demand is conveyed by Figure ES-1.

Figure ES-1
Historical Retail Demand Compared to Population

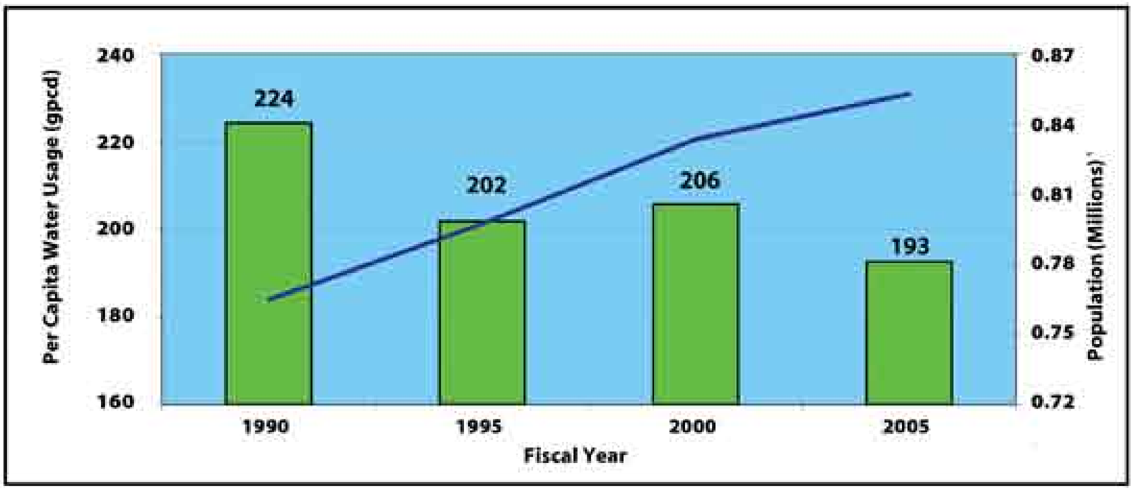


Source: Information based on WBMWD Water Use database and MWD Demographic Data, 2005.

Retail water use within West Basin's service area is largely the same today as it was 15 years ago despite the addition of more than 100,000 people. The average retail demand for the past 15 years is approximately 184,000 AFY. Clearly, residents are now using less water on an individual, or "per capita," basis, as shown in Figure ES-2, than in the past 15 years.

It is apparent that the trend of lower per capita water usage through time, with assistance from MWD and its member agencies, has been successful in continuing a water conservation ethic begun 15 years ago during the last major drought.

Figure ES-2
Per Capita Water Usage 1990-2005



Source: WBMWD Water Use database.
[1] Information based on MWD Demographic Data, 2005.

5 Water Supply

West Basin currently relies on approximately 150,000 AFY of imported water from the State Water Project (SWP) and the Colorado River delivered through MWD to meet the District's retail and replenishment demands. While groundwater supplies remain a significant source of water (20%) for customer agencies in the West Basin service area, imported water supplements this resource (65%) and assists to mitigate the over-pumping of the groundwater basin. Recycled water is added to the supply mix, serving up to 7% of the area's demands, while conservation rounds out the equation at 7%.

Table ES-2 shows current (2005) and projected (2030) supplies within West Basin's service area, with imported and local supplies being provided by West Basin.

Table ES-2
Current and Projected Water Supplies
(In Acre-Feet)

District Water Supplies	2005[1]	2030
Groundwater [2]	41,535	52,000
Imported Water [3]	129,315	101,747
Recycled Water [4]	13,065	43,750
Ocean Desalination	-	20,000
Total	**183,916**	**217,497**
Conservation [5]	14,500	42,800
Total	**198,416**	**260,297**

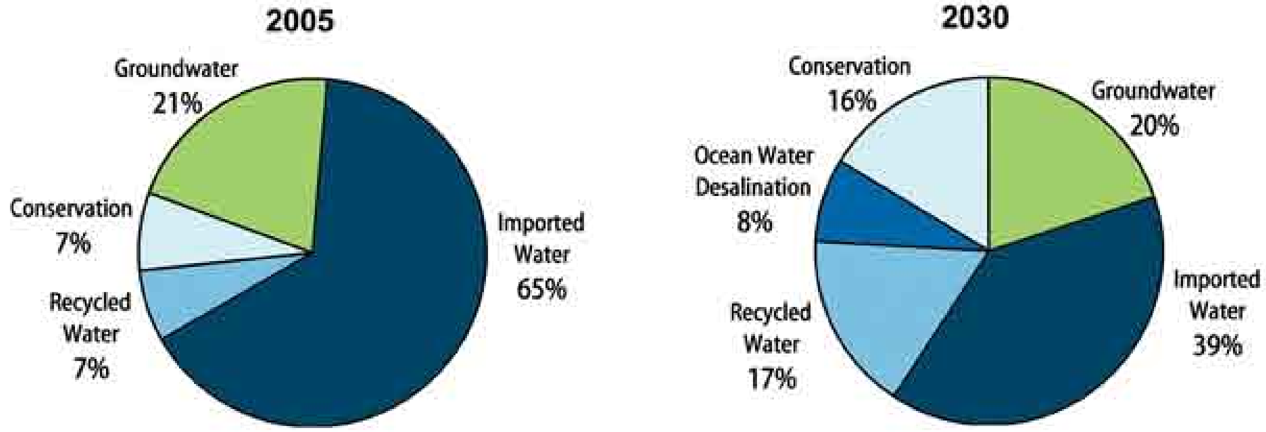
[1] 2005 demands are based on the 2004-05 year, which is also considered one of the "wettest" years on record.
[2] Groundwater production within West Basin Service area only, including imported groundwater production from California American Water Co.
[3] Imported retail uses only; does not include replenishment deliveries i.e. Barriers
[4] Recycled M&I use only; does not include projected deliveries of 17,500 AF to the Barriers
[5] Conservation consists of Active and Passive savings according to the District's projected estimates

6 Planning for Increased Diversification

Given the critical importance of water to the region's growth, economic health and quality of life, the desirable quantity and mix of supply must be planned well in advance of the actual need. Implementing water projects and changing behavior and attitudes regarding water usage are lengthy and complex endeavors. While the UWMP Act requires a 20-year planning horizon for water reliability, West Basin has used a 25-year planning horizon to ensure a minimum 20-year planning period each year until the next 5-year update of the District's UWMP.

Although implementation of supply targets is challenging, West Basin's plan is relatively simple: continue to reduce the risk of future shortage by distributing the responsibility for supply among several, well-balanced options. West Basin's projected supply portfolio for 2030, as compared to the current mix, is shown in the following figure.

Figure ES-3
Comparison of Water Supply Portfolio
2005 vs. 2030



West Basin's diversification plan includes expansion of the District's water recycling system, increased conservation efforts and groundwater storage opportunities. The District's dependence on imported water will continue to decrease with the expansion of these alternative resources. During the next 25 years, conservation is expected to have a significant dampening effect on retail water demand, lowering projected water use by roughly 42,800 AF in 2030.

West Basin's ambitious 2030 target for conservation will be directed by a Conservation Master Plan (scheduled for completion in 2006) that will identify the programs, strategies and actions that will guide policy development and commitment of resources in the future.

West Basin's increase in recycled water supply to 17% by 2030 will nearly triple recycled water use. Treatment expansions as well as distribution system extensions will provide more recycled water to meet growing demands.

Across Southern California, alternative water supplies are being explored, studied and, in some cases, implemented to enhance the area's water supply reliability. In addition to recycled water, alternative water supply projects include seawater barrier water projects, conjunctive use groundwater storage, water transfers and exchanges, and ocean and groundwater desalination. West Basin supports the ongoing efforts of all these programs.

7 Water Supply Reliability

During consecutive dry years, Southern California has historically seen demands increase by as much as 20% while supplies have decreased. Prior to recent significant improvements in water reliability, most cities and agencies were forced to mandate conservation efforts and restrict water use in some cases to maintain an adequate supply. Enormous strides made by MWD, West Basin and the entire water supply community in Southern California to increase locally-developed supplies and conservation as well as imported water storage and transfers during the past decade have increased the overall supply reliability during extended dry periods.

MWD's 2005 Regional UWMP demonstrates reliability of supply in all hydrologic conditions through the year 2030. In fact, their plan shows a surplus of supply in nearly all conditions. MWD planning initiatives to ensure water supply reliability include the IRP, the Water Surplus and Drought Management Plan (WSDM Plan) and local resource investments. These initiatives provide a framework for MWD and its member agencies to manage their water resources to meet growing demands.

Through its investments into supply diversification, support of the region's IRP and the collaborative efforts with MWD, West Basin's projections show that supplies will adequately meet service area demands in normal, single dry and multiple dry-year scenarios.

8 Water Quality

Water quality regulations are an important factor in West Basin's water management activities. Imported water quality is the responsibility of MWD to comply with State and Federal drinking water regulations. Purveyors which West Basin sells imported water are responsible for ensuring compliance in their individual distribution systems and at the customer tap. MWD maintains a rigorous water quality monitoring program and is also proactive in protecting its water quality interests in the SWP and the Colorado River. Imported water meets or exceeds all drinking water standards set by the California Department of Health Services.

Water quality of the West Coast Groundwater Basin is continually monitored by both West Basin and the Water Replenishment District. Challenges to water quality include potential contamination from seawater intrusion and the migration of shallow contamination into deeper aquifers. WRD and West Basin have several active programs to monitor, evaluate and mitigate water quality issues.

West Basin actively assists its retail agencies in meeting drinking water standards through its Cooperative Basin-Wide Title 22 Groundwater Quality Monitoring Program. West Basin offers this program to water agencies for wellhead and reservoir sample collection, water quality testing and reporting services.

Although recycled water meets Title 22 standards through tertiary treatment, West Basin's Water Recycling Facility produces five different types of water quality for various end users. The five types of recycled water include: 1) Disinfected Tertiary Water, 2) Nitrified Water, 3) Softened Reverse Osmosis Water, 4) Pure Reverse Osmosis and 5) Ultra-Pure Reverse Osmosis Water. Approximately 2,000 tests are performed monthly at the West Basin Water Recycling Facility to ensure water quality meets or exceed all State and Federal requirements.

9 Water Conservation

Since the drought of the 1990s, West Basin has been a leader in implementing aggressive water conservation programs to help limit water demand in its service area. District programs have included a strong emphasis on education and the distribution of rebate incentives and plumbing retrofit hardware. The active and passive conservation programs have resulted in significant reductions in water use. By current estimates, demand management conservation saves more than 4.5 billion gallons of imported water every year. This represents the average water use of almost 30,000 families of four in Southern California.

West Basin water conservation programs follow the recommended 14 Best Management Practices (BMPs) according to the California Urban Water Conservation Council. For fiscal year 2005-06, West Basin will complete a Conservation Master Plan that will guide the District to meet or exceed the goals of the BMPs and MWD's Conservation Strategy Plan. The plan will assess the conservation potential and incorporate local stakeholder input into a group of actions and strategies for achieving long-term targets for conservation.

10 Water Rates and Charges

In 2002, MWD adopted a new rate structure to support its strategic planning vision as a regional provider of services, incentivize the development of local supplies such as recycled water and conservation and encourage long-term planning for imported water demand. To achieve these objectives, MWD called for voluntary purchase orders from its member agencies, unbundled its water rates, established a tiered supply rate system and added a capacity charge. In all, these new rate structure components have provided a better opportunity for MWD and its member agencies to manage their water supplies.

MWD's 2002 rate structure changes were passed through to West Basin's customer agencies in a manner that preserved the water management benefits while minimizing financial impacts. With the purchase order and tiered supply rate elements, West Basin has successfully implemented a conservation-based structure that encourages agencies to stay within their annual water budget and uses revenue from agencies that exceed their water budget to fund service-area wide conservation studies and programs. West Basin also assesses a capacity charge at the retail level designed to recover the cost of MWD's capacity charge and a Readiness-to-Serve charge. In addition to the pass-through elements of MWD's rate structure, West Basin's rates include a volumetric administrative surcharge and a fixed water service charge.

Since 1995, West Basin has encouraged the maximum use of recycled water through the economic incentive of its rates and charges. West Basin commodity rates cover the operation, maintenance, labor and power costs associated with the delivery of recycled water. These rates are set up in a declining tiered structure and are wholesaled at a significant reduction to imported water so they may further encourage the use of recycled water.

11 Recycled Water

West Basin's Water Recycling Facility

Recycled water is one of the cornerstones of West Basin's efforts to augment local supplies and reduce dependence on imported water. Since the initial planning and construction of West Basin's water recycling system in the early 1990s, West Basin has become a leader in producing and marketing recycled water. This new supply of water assists in meeting the demand for non-potable applications such as landscape irrigation, commercial and industrial processes, and indirect potable such as the seawater intrusion barriers. With approximately 210 site connections, West Basin has delivered approximately 210,000 AF of recycled water during the past 10 years. During the past five years, West Basin has delivered an average 25,000 AFY to its irrigation, industrial and groundwater replenishment customers.

Although not within its service area, West Basin sells recycled water to the City of Torrance and Los Angeles Department of Water and Power. West Basin purchases secondary treated water from the City of Los Angeles' Hyperion Treatment Plant. The treated wastewater is further treated at West Basin's Water Recycling Facility, located in El Segundo, California.

West Basin anticipates recycled water use sales to increase in the future as more customers switch from potable water to recycled water due to the reliability of the supply and the economic incentives associated with the conversion. West Basin is also performing a number of expansion projects such as the Harbor/South Bay Water Recycling Project, the West Basin Water Recycling Facility Phase IV Expansion and the Madrona/Palos Verdes Lateral Extension. These three projects will increase recycled water use significantly in the coming years. Table ES-3 summarizes the current and projected demands for recycled water.

Table ES-3
Projected Recycled Water Deliveries by West Basin
(In Acre-Feet)

West Basin Water Recycling System	2005[1]	2010	2015	2020	2025	2030
Industrial & Irrigation	13,065	21,848	32,500	36,250	40,000	43,750
West Coast Barrier (Replenishment)	3,800	17,500	17,500	17,500	17,500	17,500
West Basin's Service Area Total	**16,865**	**39,348**	**50,000**	**53,750**	**57,500**	**61,250**
City Torrance	6,921	6,650	6,650	6,650	6,650	6,650
City of Los Angeles	283	1,400	1,400	1,400	1,400	1,400
Outside West Basin's Service Area Total	**7,205**	**8,050**	**8,050**	**8,050**	**8,050**	**8,050**
Total	**24,070**	**47,398**	**58,050**	**61,800**	**65,550**	**69,300**

[1] Based on West Basin MWD's actual sales for FY 2004-05

12 Ocean Water Desalination

Another important element of West Basin's supply diversification strategy is the cost-effective development of ocean desalination. Within MWD's Integrated Resources Plan, West Basin has committed to producing 20,000 AFY of potable water from the ocean beginning in 2011. West Basin is following an incremental approach to that production target, including research, pilot testing, a demonstration facility and ultimately a full-scale plant.

Since 2001, West Basin has been a leader in creating funding partnerships for research related to the application of technologies it currently uses successfully in the desalination of wastewater to produce high-purity recycled water, namely microfiltration and reverse osmosis. West Basin has successfully operated a pilot scale test facility in El Segundo using microfiltration and reverse osmosis to produce 40 gallons per minute of drinking water. These processes have demonstrated tremendous water quality and operational performance since the commissioning of the pilot project.

Recently, West Basin was awarded $1,750,000 in state grants to assist in the research and construction of the next step in its desalination program: a 500,000 gallons per day demonstration project.

Section 1

Introduction

Introduction

1.1 Purpose and UWMP Summary

An Urban Water Management Plan (UWMP or Plan) prepared by a water purveyor is to ensure the appropriate level of reliability of water service sufficient to meet the needs of its various categories of customers during normal, single dry or multiple dry years. The California Water Management Planning Act of 1983 (Act), as amended, requires urban water suppliers to develop an UWMP every five years in the years ending in zero and five.

The legislature declared that waters of the state are a limited and renewable resource subject to ever-increasing demands, that the conservation and efficient use of urban water supplies are of statewide concern, that successful implementation of plans is best accomplished at the local level, that conservation and efficient use of water shall be actively pursued to protect both the people of the state and their water resources, that conservation and efficient use of urban water supplies shall be a guiding criterion in public decisions and that urban water suppliers shall be required to develop water management plans to achieve conservation and efficient use.

West Basin Municipal Water District's (District) 2005 UWMP has been prepared in compliance with the requirements of the Act, as amended to 2005[1] (Appendix A), and includes the following:

- Water Wholesale Service Area
- Water Demands
- Water Sources and Supplies
- Water Reliability Planning
- Water Quality Information
- Water Demand Management Measures
- Water Shortage Contingency Plan
- Water Recycling
- Ocean Water Desalination

1.2 Urban Water Management Plan Update Preparation

The District's 2005 UWMP revises the 2000 UWMP prepared by the District and incorporates changes enacted by legislation, including SB 610 (2001), AB 901 (2001), SB 672 (2001), SB 1348 (2002), SB 1384 (2002), SB 1518 (2002), AB 105 (2004) and SB 318 (2004). The UWMP also incorporates water use efficiency efforts the District has implemented or is considering implementing pursuant to the *Memorandum of Understanding Regarding Urban Water Conservation in California* (MOU).[2] The District was one of the first agencies to become signatory to the MOU in September 1991.

[1] California Water Code, Division 6, Part 2.6; §10610, et. seq. Established by Assembly Bill 797 (1983).

[2] The *Memorandum of Understanding Regarding Urban Water Conservation in California* (MOU) was adopted in September 1991 by a large number of water suppliers, public advocacy organizations and other interested groups. It created the *California Urban Water Conservation Council* and established 16 Best Management Practices (BMPs) for urban water conservation, recently refined to 14 BMPs. The District became signatory to the MOU in September 1991.

The sections in this Plan correspond to the outline of the Act, specifically Article 2, Contents of Plans, Sections 10631, 10632, and 10633. The sequence used for the required information, however, differs slightly in order to present information in a manner reflecting the unique characteristics of the District. The Department of Water Resources Review for Completeness form has been completed, which identifies the location of Act requirements in this Plan and is included as Appendix B.

1.2.1 Plan Adoption

The 2005 UWMP was adopted by a resolution of the District's Board of Directors in December 2005, following a public hearing. The Plan was submitted to the California Department of Water Resources within 30 days of Board approval. Copies of the Notice of Public Hearing and the Resolution of Plan Adoption are included in Appendix C. Copies of the Plan were made available to the public within 30 days following Board approval.

1.2.2 Agency Coordination

A Notice of Preparation for the 2005 UWMP Update was prepared and sent to Metropolitan Water District of Southern California (MWD), the County of Los Angeles and all of the District's various cities and customer agencies, as shown in Table 1-1. The Notice of Preparation is included in Appendix D.

Table 1-1
Coordination with Appropriate Agencies

	Participated in UWMP Development	Commented on the Draft	Attended Public Meetings	Provided Assistance	Received Copy of Draft	Sent notice of intention to adopt
Retail Water Agencies	Metropolitan Water District of Southern California	✓	✓		✓	✓
Customer Agencies	California American Water Company			✓	✓	✓
	California Water Service Company	✓		✓	✓	✓
	City of El Segundo		✓	✓	✓	✓
	City of Inglewood			✓	✓	✓
	City of Lomita	✓	✓	✓	✓	✓
	City of Manhattan Beach		✓	✓	✓	✓
	Southern California Water Company	✓	✓	✓	✓	✓
	LA County Waterworks District 29	✓	✓	✓	✓	✓
	Water Replenishment District	✓	✓		✓	✓

Development of this Plan was performed by District staff in coordination with its water purveyors and MWD. District staff has met with many of its customer agencies to discuss the UWMP, answer questions related to the UWMP and/or projects occurring throughout the service area, and provide assistance when requested. Staff provided many of its agencies with conservation data that they were able to use in their conservation section of the UWMP.

The District is a water wholesaler and is fully dependent on MWD for its imported water supplies to its service area. This UWMP details the specifics as they relate to the District and it service area and will refer to MWD throughout the document. The District held two UWMP workshops, one in January 2005 for the public, in coordination with MWD and the California Urban Water Conservation Council, and the other in June 2005 for the District's water purveyors. Further, MWD held multiple UWMP information meetings for stakeholders and the public throughout its service area during the months of June and July 2005. On August 24, 2005, MWD held an additional Public Information Meeting at the Southern California Water Dialogue monthly forum. The Southern California Water Dialogue participants meet voluntarily to explore water-related issues of vital interest to the Southern California region.

The UWMP is intended to serve as a general, flexible and open-ended document that periodically can be updated to reflect changes in the region's water supply trends, as well as conservation and water use efficiency policies. This Plan, along with the District's other planning documents, will be used by District staff to guide the service area's water use and management efforts through the year 2010, when the UWMP is required to be updated.

1.3 The District's Service Area

1.3.1 Background

The District was established by a vote of the people in 1947 to help mitigate the overpumping in the West Coast Groundwater Basin (Basin). West Basin's founders realized they would have to curtail the use of pumping by providing the region with imported water. As a water supplier, MWD provides the Southern California region with a reliable supply of imported water. West Basin remains one of the largest member agencies in MWD's family of wholesalers.

Today, West Basin wholesales potable water to 17 cities, mutual water companies, investor-owned utilities, water districts and private companies in the region. In addition, the District supplies recycled water to the region for municipal, commercial and industrial use. West Basin supplies imported and recycled water to its customer agencies to help reduce their reliance on groundwater supplies.

West Basin is governed by a five member elected Board of Directors from within the service area of the District. Each Director serves a four-year term once elected. The Board of Directors guides the mission and policy of the District.

Also, West Basin's Board of Directors appoints two representatives to serve on the 37-member MWD Board of Directors. West Basin's representation on the MWD Board is critical to shaping a regional voice on water issues.

1.3.2 District's Service Area

West Basin's service area covers approximately 185-square miles and includes 17 cities and several unincorporated areas in Los Angeles County. Approximately 852,800 people are served within West Basin's service area. The cities and their associated divisions include:

Division 1:
: Palos Verdes Estates, Rancho Palos Verdes, Rolling Hills, Rolling Hills Estates and Portions of Carson

Division 2:
: Inglewood, South Ladera Heights, a portion of Lennox and unincorporated areas of Athens, Howard, & Ross-Sexton

Division 3:
: Hermosa Beach, Lomita, Manhattan Beach, Redondo Beach and unincorporated areas of Torrance

Division 4:
: Culver City, El Segundo, Malibu, West Hollywood, North Ladera Heights, Del Aire, Topanga, View Park, Windsor Hills and a portion of Lennox

Division 5:
: Gardena, Hawthorne, Lawndale and unincorporated portions of El Camino Village

1.3.3 Relationship to Metropolitan Water District

West Basin became a member agency of MWD in 1947. West Basin joined MWD to purchase, on a wholesale level, potable water imported from the Colorado River and the State Water Project and then sell it to the local municipalities, investor-owned and districts. The imported water is provided to supplement existing groundwater supplies in all areas of West Basin (there are some utilities within the District service that do not receive MWD water directly but receive their drinking water through groundwater wells).

The District plays an important role in managing the imported supplies for the region. Through various programs and projects, the District ensures that its residents have a safe and reliable supply of water.

Figure 1-1 shows the supply chain, which illustrates the relationship the District plays to its customer agencies. The District is the voice and representative of its customers to MWD. As such, the District takes great pride in knowing that its retailers are receiving a safe and reliable supply of drinking water.

Figure 1-1 Imported Water Supply Chain

Section 2

Water Demands

Water Demand

2.1 Overview

Today, the total retail water demand for the 852,800 people living within West Basin's service area is approximately 183,900 acre-feet (AF) with replenishment demands adding an additional 15,200 AF. One acre-foot equals 326,000 gallons and serves the annual water needs of two families. In 1980, West Basin's population was 707,500 people and the service area's retail water demand was 162,653 AF with replenishment demands adding an additional 43,131 AF. In those 25 years, West Basin's retail water demand has grown 13.1%, while population has grown 21%. Some of the contributing factors to this growth in demand have been population, new development, land use, economic growth and persons-per-household ratios.

In the last five years West Basin's water demand has increased by only 0.4% while population has increased by more than 2%. This gradual increase in water usage is attributed to West Basin's efforts in education and promotion of water conservation as well as incentives for people to retrofit their homes and businesses with more efficient water use devices.

Despite the flattening demand trend due to conservation, water use will continue to increase. Projections show that West Basin's water usage is expected to increase roughly 0.4% per year during the next 25 years, as illustrated later in Table 2-5.

This section will explore in greater detail West Basin's population trends and historical and current water demands as well as offer some insight into expected future water demands for the next 25 years.

2.2 Climate Characteristics

West Basin's service area lies in the heart of Southern California's coastal plain. The climate is Mediterranean, characterized by typically warm, dry summers and wet, cool winters with an average precipitation level of approximately 14.9 inches per year.[1] The combination of mild climate and low rainfall makes the area a popular residential destination, which creates challenges for water agencies to provide for increased water demands with a tight water supply.

Areas with low precipitation, such as Southern California, are typically vulnerable to droughts. Historically, West Basin has been plagued with some severe dry years (Droughts of 1977-78 and 1989-92), and recently the Los Angeles region had the driest five years on record (1999-2004). In fact, anything less than the average yearly rainfall causes concern for water agencies.

1 According to the National Weather Service

Table 2-1 illustrates the climate characteristics for the Los Angeles region, taken at both the Long Beach Station and the Los Angeles WSO Airport Station, for the period between 1944 and 2004 (60 years) including standard monthly average ETo[2] (Long Beach Station), average rainfall (Los Angeles WSO Airport Station) and average temperature (Los Angeles WSO Airport Station). In comparison to other cities with an abundant supply of precipitation each year, the low rainfall in this region invariably challenges West Basin to provide sufficient, reliable, quality water to meet the area's increasing water needs. The average precipitation for the last 60 years is approximately 12.13 inches, indicating the need for water conservation in an area with a water demand that will continue to grow as urban infiltration continues to rise.

Table 2-1
West Basin
Climate Characteristics- Los Angeles Region
Period 8/1/1944 to 12/31/2004

	Jan	Feb	Mar	Apr	May	June
Standard Monthly Average Eto	1.65	2.15	3.59	4.77	5.12	5.71
Average Rainfall (inches)	2.67	2.69	1.94	0.78	0.17	0.06
Average Temperature (Fahrenheit)	65	65.4	65.3	67.5	69.2	72

Climate (continued)

	July	Aug	Sept	Oct	Nov	Dec	Annual
Standard Monthly Average Eto	5.93	5.91	4.39	3.22	2.18	1.68	**46.3**
Average Rainfall (inches)	0.02	0.08	0.16	0.35	1.48	1.75	**12.13**
Average Temperature (Fahrenheit)	75.2	76.4	76.2	73.6	70.2	66.1	**70.2**

[1]Data taken from the California Irrigation Management Information System (CIMIS) at the Long Beach Station for the Los Angeles Region for Calendar Year 2004: http://www.cimis.water.ca.gov/cimis/welcome.jsp.
[2] Data taken from the Western Regional Climate Center's web site at the Los Angeles WSO Airport Station: http:wrcc.dri.edu/cgi-bin/cliMAIN.pl?calosa.

2.3 Demographics

West Basin's service area encompasses 185 squares miles in southwest Los Angeles County, including 17 cities, water agencies and several unincorporated areas. With the population in West Basin's service area expected to increase by 83,300 people by the year 2020, the demand on the limited existing water supplies will also increase.

Based on the Metropolitan Water District of Southern California's (MWD) demographic projections, population is expected to increase an average of roughly 3.1% every five years for the next 25 years, or 0.6% annually. Table 2-2 displays the demographic projections for the next 25 years.

[2] Evapotranspiration is the water lost to the atmosphere by two processes-evaporation and transpiration. Evaporation is the loss from open bodies of water, such as lakes and reservoirs, wetlands, bare soil and snow cover; transpiration is the loss from living-plant surfaces.

Table 2-2
Demographic Projections for West Basin's Service Area

Year	2005	2010	2015	2020	2025	2030
Population	**852,800**	**876,400**	**906,500**	**936,100**	**964,600**	**991,900**
Single-family	168,300	173,900	175,800	181,600	186,900	189,700
Multi-family	123,200	128,900	138,300	143,900	149,900	158,500
Total Household	**291,500**	**302,800**	**314,100**	**325,400**	**336,800**	**348,100**
Persons per Household	2.89	2.86	2.86	2.85	2.84	2.82
Employment	455,800	514,500	530,000	544,000	556,500	586,200

Source: Information based on MWD Demographic Data, 2005.
Note: All units are rounded to the nearest hundred; totals may not sum exactly due to rounding

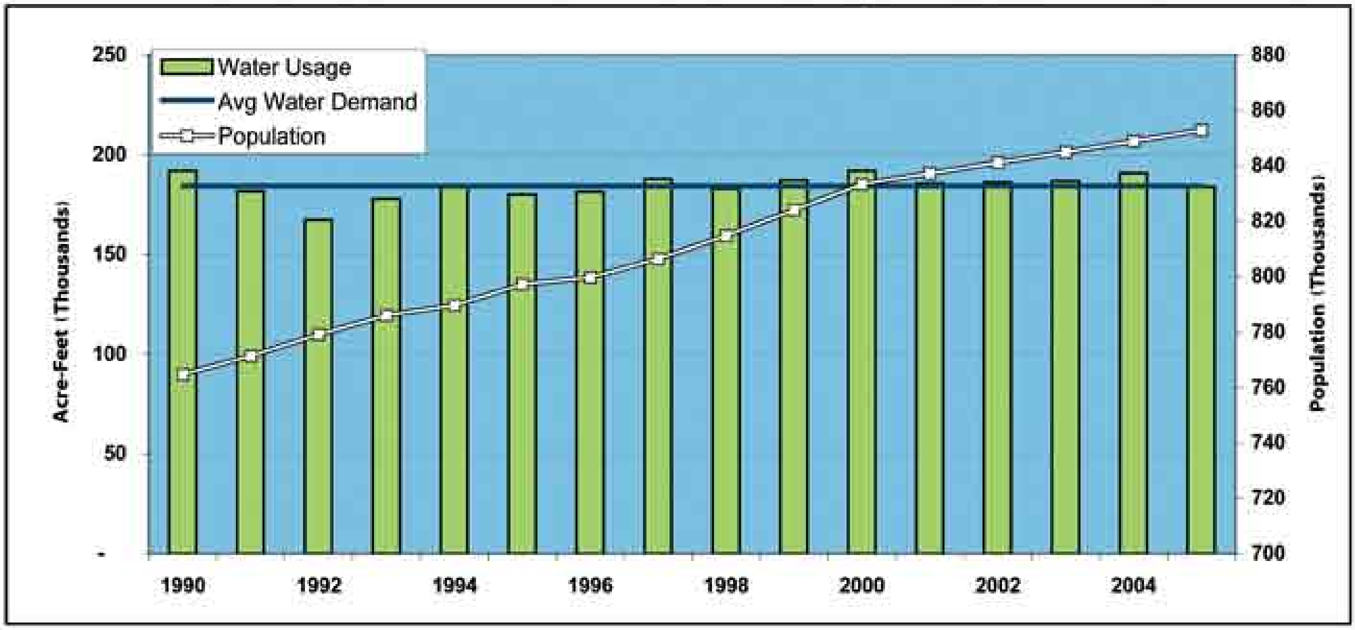
Table 2-2 displays West Basin's total households, which are expected to increase 20% by 2030, especially in the Multi-family category where households will increase by 35,300 people. As it relates to water demand, the availability of more households increases the demand on water supplies. As for employment, West Basin is expected to see a 29% increase by 2030. As urban employment grows, so does the demand on water supplies.

2.4 Historical and Current Water Demands

The key factors that affect water demands are growth in population, increases in land use development, industrial growth and hydrology. However, since the end of the 1989-1992 drought, retail water demands in West Basin's service area have remained fairly consistent. As illustrated in Figure 2-1 (on the following page), the West Basin region has not seen significant increases in water demands during the past 15 years despite population growth at an average rate of 3,875 persons per year and continued in-fill development in the service area. West Basin's FY 2004-05 retail water demand was 183,916 AF.

Total water use, or demand, within West Basin's service area includes retail demand and groundwater replenishment. Retail demand is defined as all municipal (residential, firefighting, parks, etc.) and industrial uses, and represents the population's total direct water consumption. Replenishment uses, including deliveries to the saline barriers (West Coast and Dominguez Gap Barriers), are not directly delivered to the public but enable continued groundwater production and helps to satisfy retail demand.

Figure 2-1
West Basin
Historical Total Retail Water Demand vs. Population



Source: Information based on MWD Demographic Data, 2005.
Note: The totals do not include Replenishment Sales i.e.Barrier Sales RW & Imported

Figure 2-1 displays West Basin's total retail water demand from FY 1990 to 2005. As previously discussed, retail demands have remained very consistent since 1994 following several years of increasing demands after the drought. The average retail water demand for the past 15 years is 184,295 AF.

The District averaged 187,554 AF for the past five years, which is only 1.8% above the 15 year average.

West Basin's service area is using an average amount of water as it has since 1990. This indicates that water conservation and education has significantly affected the manner in which West Basin's residents are using water today. This can be verified by reviewing West Basin's water usage per person in the "Historical Per Capita Water Usage" Section, which follows.

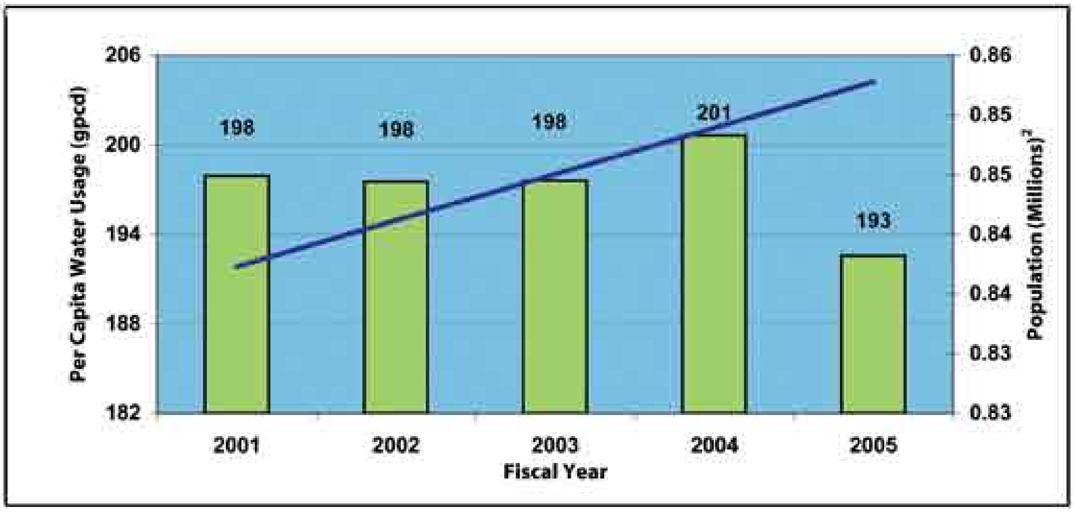
2.4.1 Historical Per Capita Water Usage

According to the Pacific Institute, the State's total water usage is equivalent to 183 gallons per capita per day (gpcd) for the nearly 34 million people living in California.[3] Through conservation measures such as Ultra-Low-Flush Toilets (ULFT), High-Efficiency Clothes Washers, low-flow showerheads and new technologies in water irrigation and education programs, West Basin has gradually reduced per capita water usage.

[3] Pacific Institute, *Waste Not, Want Not: The Potential for Urban Water Conservation in California*, 2003. pg. 4

For the last five years the usage has decreased to an average of 199 gpd. Figure 2-2 illustrates the retail water usage per capita for the last five fiscal years comparative to population in West Basin's service area.

Figure 2-2
Historical Per Capita Retail Water Usage [1]



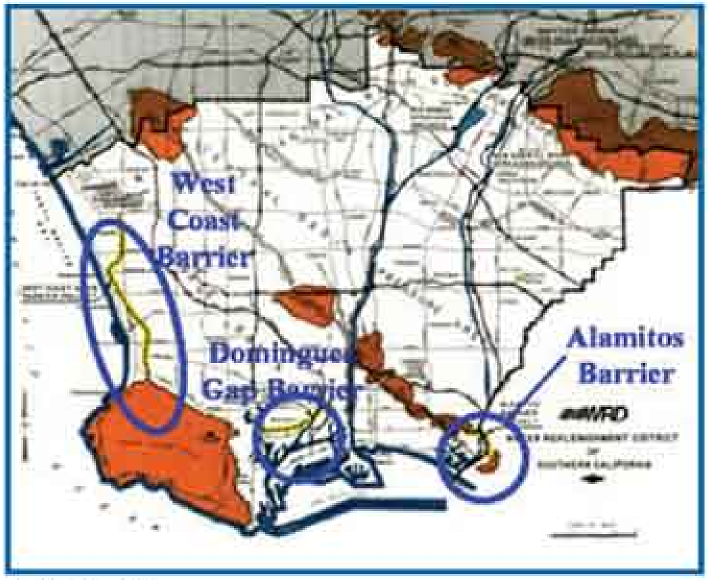
[1] Information based on MWD Demographic Data, 2005.
[2] M&I Water Usage from West Basin MWD Water Use Data

As displayed above, population has been steadily increasing from Fiscal Year 2001 - 2005 while per capita water usage remained stable at around 199 gpcd, verifying the positive impact of the District's current water resource conservation efforts.

2.4.2 Replenishment Demands

Replenishment water is defined as water that is used to refill or protect the groundwater basin. The Water Replenishment District of Southern California (WRD) is the entity responsible for maintaining and replenishing the West Coast and Central Groundwater Basins. WRD is a special district created by the State and governed by a five-member elected body to protect and replenishment these groundwater basins with imported water, storm water and recycled water. Within the West Coast (Central Basin only) Groundwater Basin (WCGB), WRD's responsibility is to protect the basin by injecting treated water at the West Coast and Dominguez Gap Barriers along the western South Bay Region.

WRD
Water Replenishment District of Southern California



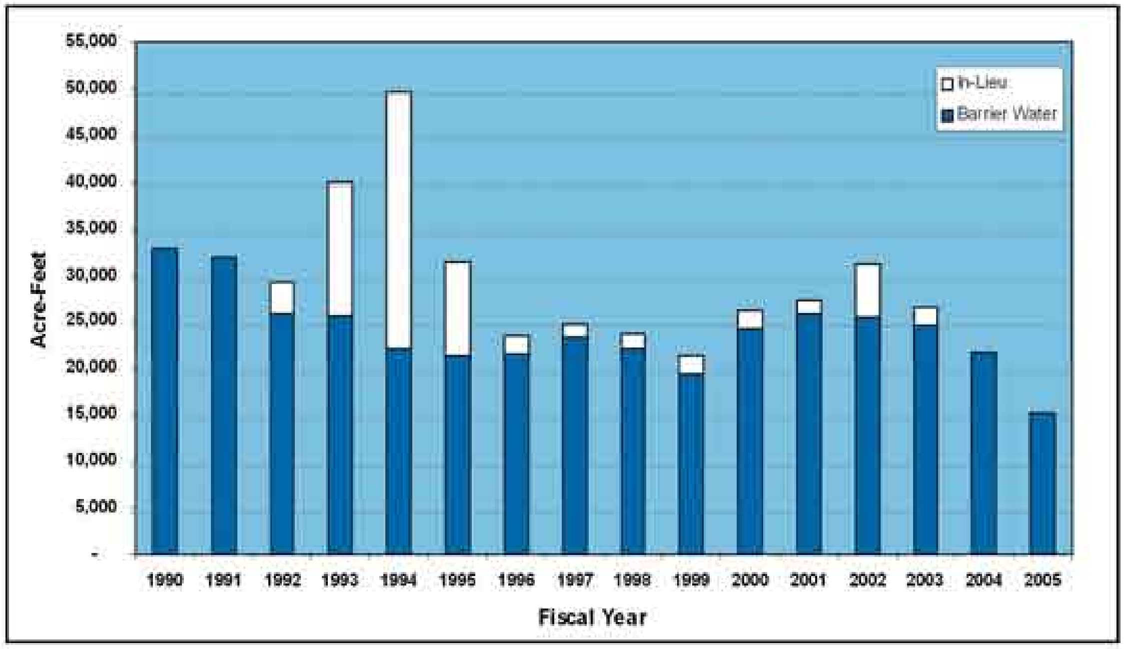
Courtesy of WRD

Barrier Demands

As groundwater is extracted annually beyond the natural level of replenishment, seawater begins to intrude into the basin along the coast. The current method in preventing seawater from contaminating the groundwater basin is to create a hydrologic barrier. The Los Angeles County Department of Public Works (LACDPW) maintains two barriers where imported and recycled water is injected on a consistent basis to protect the groundwater basins.

As the wholesaler, West Basin sells treated imported and recycled water to WRD to inject into the saltwater barriers. WRD's purchases average a total of 17,000 AFY of imported water and 5,000 AFY of recycled water from West Basin. Water demands at the barriers usually do not shift dramatically due to the limited groundwater production each customer is allowed annually. Figure 2-3 displays the total barrier demands within West Basin's service area.

Figure 2-3
Replenishment Demands[1]
in West Basin MWD's Service Area
(In Acre-Feet)



Source: WBMWD Wateruse Database, 2005

[1] Replenishment demands include both in-lieu and barrier deliveries. Barrier deliveries include both imported and recycled water. In-lieu is the practice of curtailing groundwater production and meeting those demands with imported surface water.

2.4.3 Retail Water Demand by Customer Agency

Overall, retail water demands within West Basin's service area have not seen significant increases for the past 15 years. However, individual retail customer agencies have experienced some changes in their retail demand since 1990. Table 2-3 illustrates the changes, either increases or decreases, in each retail customer agencies' average water usage during two different five year periods since 1990.

Table 2-3
Total Water Demand per West Basin Customer Agency
Average (1990-1995) vs. Average (2000-2005)
(In Acre-Feet)

Customer Agency	1990-1995 Average Total Water Use	2000-2005 Average Total Water Use	%Increase/ (Decrease)
California American Water Co.	3,261	3,834	17.6%
Cal Water Service Co.- Dominguez	33,288	35,134	5.5%
Cal Water Service Co.- Hermosa/Redondo	13,704	15,816	15.4%
Cal Water Service Co.- Palos Verde	18,479	21,684	17.3%
Cal Water Service Co.- Hawthorne	4,948	5,020	1.5%
City of El Segundo	17,802	17,296	(2.8%)
City of Inglewood	12,424	12,533	0.9%
City of Lomita	2,491	2,764	11.0%
City of Manhattan Beach	6,279	7,088	12.9%
L.A. County Waterworks District 29	8,036	9,822	22.2%
Southern California Water Co.	36,605	40,002	9.3%
Water Replenishment District	25,310	25,021	(1.1%)
Total	**182,627**	**196,014**	

Source: West basin WMD Water Use Database, 2005.

Although some agencies have seen some dramatic shifts in water demand usage during the past 15 years, the average increase for a West Basin customer agency was 9.1%. Some of the significant changes among customer agencies may be attributed to population growth, increases in industrial customers and/or further land use development.

2.5 Projected Water Demands

One of the objectives of this Plan is to provide some insight into West Basin's expected water demands for the next 25 years. The predictability of water usage is an important element in planning future water supplies. The methodology used to determine demand forecasting is a combination of historical water use analysis, population growth and commercial and residential development. West Basin, with the assistance of MWD's forecasting model known as MWD-MAIN (Municipal and Industrial Needs) Water Use Forecasting System, is able to develop some well formulated water demand projections.

The MWD-MAIN forecasting model determines expected urban water usage for the next 25 years. This model incorporates Census data, industrial growth, employment and regional development from regional planning agencies, such as SCAG (Southern California Association of Governments), to project water demands. It also features demands in sectors such as single family, multi-family, industrial, commercial and institutional usage for the region. MWD also takes into account current and future water management efforts, such as water conservation Best Management Practices (BMPs) and education programs.

Table 2-4 illustrates the current and projected retail water demands to the year 2030 for West Basin under normal demand conditions.

Table 2-4
West Basin's Service Area
Current and Projected M&I Water Demands

District Water Demands	2005[1]	2010	2015	2020	2025	2030
Retail Municipal & Industrial Use						
Groundwater[2]	41,535	52,000	52,000	52,000	52,000	52,000
Imported Water	129,316	123,000	97,319	98,665	100,140	101,747
Recycled Water[3]	13,065	21,848	32,500	36,250	40,000	43,750
Ocean Desalination	0	0	20,000	20,000	20,000	20,000
Total	**183,916**	**196,848**	**201,819**	**206,915**	**212,140**	**217,497**

[1] The 2005 demands are based on the FY 2004-05, which was recorded as one of the "wettest" years on record
[2] Groundwater demands include the amount of groundwater pumped from the West Coast and Central (avg. 2,000 AFY) groundwater basins to satisfy groundwater demands within West Basin's service area.
[3] Includes M&I recycled water sales from West Basin's service area; it does not included recycled sales to Los Angeles Department of Water and Power and the City of Torrance or Replenishment sales (Barrier)

As displayed above, the retail demand in West Basin is expected to grow approximately 0.5% each year. Groundwater will remain consistent, due to the limited amount of extractable pumping rights within the basin, but imported water is expected to decrease with the expansion of water recycling and the development of ocean water desalination meeting the growing demand during the next 25 years.

WATER FACT

"A 10-minute shower uses about 55 gallons of water."

2.5.1 Projected Per Capita Water Usage

As discussed previously, water demand is determined by the water usage per person. The future per capita usage shows how water demand is growing at a modest pace.

Table 2-5
Projected Per Capita Retail Water Usage in West Basin's Service Area

Year	Estimated Population[1]	Retail Water Usage[2] (AF)	Per Capita[3] (GPCD)
2010	876,400	196,848	201
2015	906,500	201,819	199
2020	936,100	206,915	197
2025	964,600	212,140	196
2030	991,900	217,497	196
		Avg.	198

[1] Information based on MWD Demographic Data, 2004.
[2] Retail Water usage includes recycled water but does not include replenishment sales i.e. barrier water.

Table 2-5 shows a gradual decrease in per capita usage at a time when water has become a scarce commodity in a region where population is projected to increase. Although the total retail water usage continues to increase, the amount of water used per person will decline during the next 25 years. Essentially, more people are using less water.

2.5.2 Projected Replenishment Demand

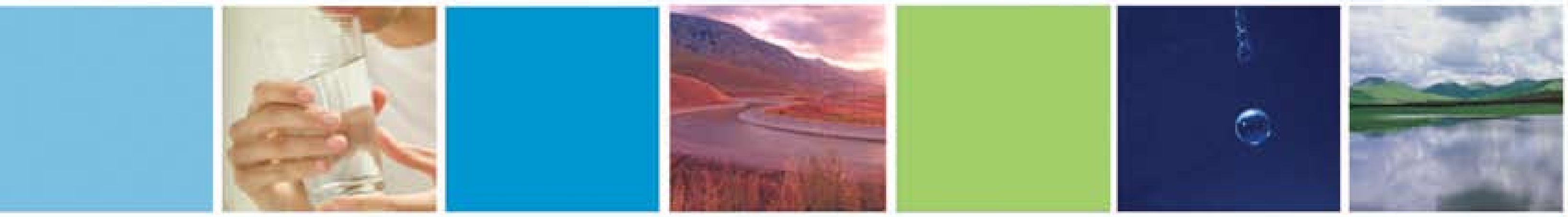
Future replenishment demands are difficult to project because of the variation in operational changes and replenishment needs. WRD expects reduced deliveries of imported water at both of the Barriers, Dominguez Gap and West Coast with increased deliveries of recycled water.

The estimated replenishment demands during the next 25 years under normal conditions are presented in Table 2-6. Although replenishment demands may fluctuate year to year, the overall demand should stay relatively the same because groundwater production is limited according to the allowable pumping rights each groundwater producer is allocated. Furthermore, groundwater production is at or around its maximum amount; therefore, replenishment demands should not significantly increase.

Table 2-6
Projected Replenishment Demands
(In Acre-Feet)

District Water Demands	2010	2015	2020	2025	2030
Replenishment					
Imported Water[1]	10,000	10,000	10,000	10,000	10,000
Recycled Water[2]	17,500	17,500	17,500	17,500	17,500
Total	**27,500**	**27,500**	**27,500**	**27,500**	**27,500**

[1] Imported water demands are based on the Water Replenishment District's projected estimate needs, although they may adjust annually depending upon groundwater production. Imported water demands are for both the West Coast and Dominguez Gap Barriers.
[2] Recycled water deliveries are only at the West Coast Barrier; with a 5,000 AF expansion in 2006. Additional Recycled water deliveries in 2010 are contingent upon a regulatory permit to expand recycled water to 100% at the West Coast Barrier.



Section 3

Water Supply

Water Supply

3.1 Overview

It is West Basin's mission to ensure a safe, adequate and reliable supply of water for the region it serves. However, with a limited supply and growing demand for water, the task of meeting this mission is becoming increasingly challenging.

Seventy years ago the average customer agency in West Basin relied completely on groundwater. Today, however, it relies on a more diverse mix of water resources: 21% groundwater, 65% imported, 7% recycled water (only Municipal & Industrial [M&I]) and 7% conservation efforts. It is projected that by 2030, the resource mix on average will be 20% groundwater, 39% imported, 17% recycled water, 8% ocean water desalination and conservation 16%. Diversification of water supplies has become one of the District's answers to ensuring a reliable supply of water for its service area.

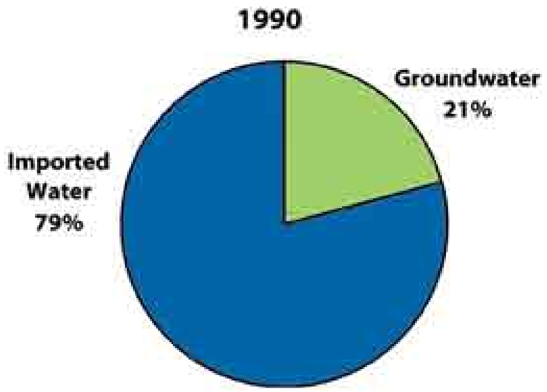
This section provides an overview of the current and future water supplies needed to meet the expected demands of West Basin, including a review of the District's current and projected water supply mix, a description of each water source on which West Basin's customer agencies currently rely and expected future supplies that West Basin is planning and/or developing to meet the demands by year 2030.

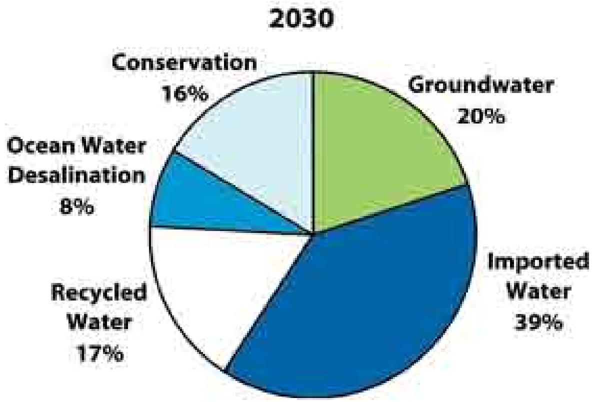
3.2 West Basin's Water Supply Portfolio

Since its formation in 1947, West Basin has fulfilled its responsibility of providing its customer agencies with supplemental supplies to ensure reliability. Today, diversification is the key to an ample future supply of water throughout its service area. As illustrated in Figure 3-1 (on the following page), West Basin's supply portfolio has changed through the years.

Similar to creating a balanced investment portfolio to reduce risk, the District plans to further diversify the water resource mix during the next 25 years with the expansion of the District's water recycling system, increased conservation efforts and groundwater storage opportunities. The District's dependence on traditional sources of water (groundwater and imported) will continue to decrease with the expansion of these alternative resources. Figure 3-1 and Table 3-1 show the historical, current and projected water supply portfolio that the District is anticipating meeting by the year 2030.

Figure 3-1
West Basin's Service Area
Projected Water Supplies





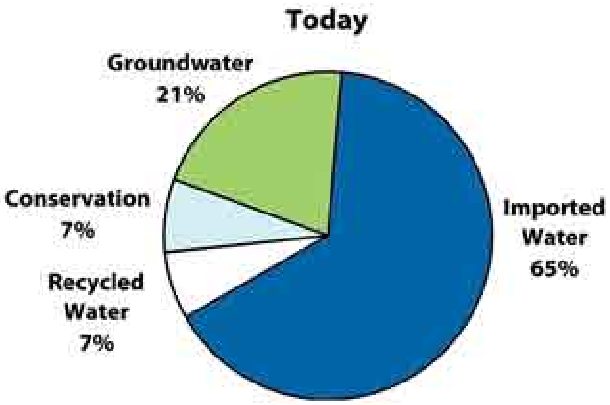


Table 3-1
West Basin
Historical & Projected Retail Water Supplies
(In Acre-Feet)

Type of Water	FY 1990	Today[1]	2030
Groundwater[2]	40,148	41,535	52,000
Imported Water[3]	151,829	129,315	101,747
Recycled Water[4]	-	13,065	43,750
Ocean Desalination[5]	-	-	20,000
Total	**191,977**	**183,916**	**217,497**
Conservation	-	14,500	42,800
Total	**191,977**	**198,416**	**260,297**

[1] Based upon actual FY 2004-05 sales.
[2] Groundwater production within West Basin Service area only, including imported groundwater production from California American Water Company (FY 1990 1,658 AF, FY 04-05 2,228 AFY, and average of 2,000 AFY for 2030).
[3] Imported retail use only; does not include replenishment deliveries i.e. Barrier.
[4] Recycled M&I use only; does not include replenishment deliveries i.e. Barrier.
[5] Conservation consists of Active and Passive savings according to the District's projected estimates.

3.3 West Basin's Water Source

3.3.1 Imported Water Supply

West Basin relies on approximately 150,000 acre-feet per year (AFY) of imported water from the Colorado River and State Water Project to meet the District's retail and replenishment demands. MWD receives this supply from these two major water systems that supplies a majority of the southern California region.[1]

Colorado River

Colorado River

MWD was established to develop a supply from the Colorado River. Its first mission was to construct and operate the Colorado River Aqueduct (CRA), which can deliver roughly 1.2 million acre-feet (MAF) per year. Under its contract with the Federal government, MWD has a basic entitlement of 550,000 AFY of Colorado River water. MWD also holds a priority for an additional 0.662 MAF per year. MWD can obtain water under this priority when the U.S. Secretary of the Interior determines that either one or both of the following exists:

- surplus water; and/or
- water is apportioned to but unused by Arizona and/or Nevada.

MWD and the State of California have acknowledged that they could obtain less water from the Colorado River in the future than they have in the past, but the lack of clearly quantified water rights hindered efforts to promote water management projects. The U.S. Secretary of Interior asserted that California's users of Colorado River water had to limit their use to a total of 4.4 MAF per year, plus any available surplus water. The resulting plan, known as "California's Colorado River Water Use Plan" or the "California Plan," characterizes how California would develop a combination of programs to allow the State to limit its annual use of Colorado River water to 4.4 MAF per year plus any available surplus water. The Quantification Settlement Agreement (QSA) among the California agencies is the critical component of the California Plan. It establishes the baseline water use for each of the agencies and facilitates the transfer of water from agricultural agencies to urban uses.

[1]The Los Angeles Aqueduct, a third aqueduct to Southern California, supplies imported water from the eastern Sierra Nevada region to the City of Los Angeles.

In the context of the QSA, MWD has identified a number of storage and transfer programs that could be used to achieve long-term development targets for a full CRA and it has entered into or is exploring agreements with a number of agencies.

State Water Project

Transport of imported supply

Courtesy of MWD

California's State Water Project (SWP), MWD's second main source of imported water, is the nation's largest state-built water and power development and conveyance system. It includes facilities—pumping and power plants, reservoirs, lakes and storage tanks, and canals, tunnels and pipelines—that capture, store, and convey water from the Lake Oroville watershed in Northern California to 29 water agencies in Central and Southern California. Planned, designed, constructed and now operated and maintained by the California Department of Water Resources, this unique facility provides water supplies for 23 million Californians and for 755,000 acres of irrigated farmland.

The original State Water Contract called for an ultimate delivery capacity of 4.2 MAF, with MWD holding a contract for 2.011 MAF. More than two-thirds of California's drinking water, including all of the water supplied by SWP, passes through the San Francisco-San Joaquin Bay-Delta (Bay-Delta). For decades, the Bay-Delta system has experienced water quality and supply reliability challenges and conflicts due to variable hydrology and environmental standards that limit pumping operations.

In 1999, MWD's Board of Directors set new goals for the SWP with the adoption of its CALFED Policy Principles. These goals committed MWD to water quality objectives, the development of 0.65 MAF minimum dry-year supply from the SWP by 2020 and average annual deliveries of 1.5 MAF (excluding transfers and storage programs along the SWP). To achieve these goals while minimizing impacts to the Bay-Delta ecosystem, MWD would maximize deliveries to storage programs during wetter years, implement a number of source water qualities and supply reliability improvements in the Delta, remove operational conflicts with the Central Valley Project (CVP) and better coordinate planning and operations between the SWP and CVP.

Types of Imported Supplies

MWD offers different types of imported water to its member agencies depending on the ultimate use. Among them, West Basin has delivered Non-Interruptible Water (treated full-service) and Seasonal Treated Replenishment Water (In-Lieu Replenishment).

Non-Interruptible Water is the treated firm supply that is available all year. West Basin delivers an average of 150,000 AF of non-interruptible water annually. It is used as the main supplemental supply of cities and water agencies, including the main supply for the Saline Barriers.

Seasonal Treated Replenishment Water, also known as the "In-Lieu" water is delivered to customer agencies that are eligible to offset groundwater production with imported water. This program incentivizes customer agencies to take imported surplus water "when available," which indirectly replenishes the groundwater basin. This surplus water is purchased at a discount rate in exchange for leaving groundwater in the basin for no less than a year so that it can be used subsequently during dry years.

3.3.2 Groundwater Supply

Groundwater has for many years represented a fifth of the District's supplies within West Basin's service area. Today, the average customer agency in West Basin relies on groundwater production for 20% of its retail demand. This is a result of the geographical location where most of West Basin's customer agencies are located. There are a few agencies within the District's service area that rely exclusively on imported water to meet all their current water needs.

Courtesy of WRD

The West Coast Groundwater Basin (WCGB) is an adjudicated basin. The extensive overpumping of the WCGB through the years led to critically low groundwater levels, resulting in seawater intrusion along the coast. This over pumping of the WCGB resulted in a legal judgment, or adjudication that limits the allowable extraction, that could occur in any given year and assigned water rights to basin pumpers. The adjudicated water rights were greater than the basin yield; therefore, the WCGB was operating with an annual overdraft. To address this overdraft, imported and recycled water sources and a means to purchase these sources were required.

In 1959, the State Legislature enacted the Water Replenishment Act, enabling the water association for the basin to secure voter approval for the formation of the "Central and West Basin Water Replenishment District" (now referred to as the Water Replenishment District of Southern California or "WRD") to be the permanent agency responsible for replenishing the basin. The State Legislature has vested in WRD the statutory responsibility to manage, regulate, replenish and protect the quality of the groundwater supplies within its boundaries for the beneficial use of the approximately 3.5 million residents and water users who rely upon those groundwater resources to satisfy all or a portion of their water needs.

Although the water rights have been bought, sold, exchanged or transferred through the years, the total amount of allowable extraction rights within the entire groundwater basin has remained virtually the same. The adjudicated pumping rights available within West Basin's service area total 54,730 AF. However, not all of these water rights holders are water retail agencies. Many of these holders are school districts, businesses, cemeteries and private entities that make up approximately 42% (23,215 AF) of the total water rights. Shown below in Table 3-2 are all of the water retailers' adjudicated groundwater rights in West Basin's service area for Fiscal Year 2003-04.

Table 3-2
Groundwater Pumping Rights 2003-2004

West Basin Retail Agencies	Adjudicated Pumping Rights in West Basin
Cal Water Service Co. (Hermosa/Redondo)	4,070
Cal Water Service Co. (Dominguez)	10,417
City of El Segundo	953
City of Hawthorne	1,882
City of Inglewood	4,450
City of Lomita	1,352
City of Manhattan Beach	1,131
Southern California Water Co.	7,260
Non-Retail Water Agencies[1]	23,215
Total	**54,730**

Source: West Basin Watermaster Report, 2004
[1] Water right holders that are not water retail agencies: ie. Nurseries, Cemeteries, industries, refineries, etc.

Although the groundwater supply is extracted from the WCGB, there is a small amount of groundwater that is imported from the Central Groundwater Basin. The Central Groundwater Basin underlies the southeastern part of the Los Angeles Coastal Plain. It is bounded on the north by the hills separating it from the San Gabriel Valley, on the east by Orange County and on the southwest by the West Coast Groundwater Basin.

The total amount of water extracted and imported within West Basin's service area is approximately 2,000 AFY. Table 3-3 below displays the water retailer and the amount produced from this adjoining basin for the past five fiscal years:

Table 3-3
Amount of Groundwater Pumped from Central Basin
(In Acre-Feet)

Water Retailer	2000	2001	2002	2003	2004
California American Water Co.	1,669	1,707	1,935	1,979	2,509
Total	**1,669**	**1,707**	**1,935**	**1,979**	**2,509**

Source: Central Basin Watermaster Report, 2004

As illustrated in Table 3-4, the total amount of groundwater produced during the past five years in the WCGB and Central Groundwater Basin has remained fairly consistent. The amount of groundwater produced ranges from 73% to 86% of the total groundwater supply available from both Basins (56,797 AF).

Table 3-4
Total Amount of Groundwater Pumped

Basin Name	2000	2001	2002	2003	2004
West Coast Basin[1]	50,295	46,867	45,367	46,555	42,421
Central Basin[2]	1,669	1,707	1,935	1,979	2,509
Total	**51,964**	**48,574**	**47,302**	**48,534**	**44,930**
% of Total Water Supply[3]	**91%**	**86%**	**83%**	**85%**	**79%**

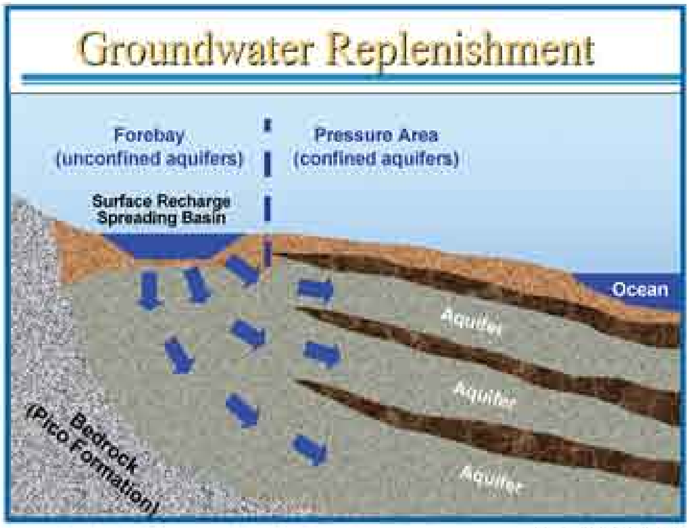
Source: West Basin Wateruse Database, 2005

[1] Includes West Basin service area including Desalter sales

[2] Includes California American Water Co. groundwater imported from Central Basin

[3] Percentage of the available groundwater supply of both basins totaling 56,797 AFY

The total amount of groundwater projected to be extracted during the next 25 years will be fairly consistent due to the adjudication of both basins. The economic costs to pumped groundwater versus the purchase of imported water will pressure water retailers to maximize their groundwater rights. Therefore, the total amount of groundwater produced is projected to range in the 92nd percentile of available supply, as illustrated in Table 3-5.



Courtesy of WRD

Table 3-5
Total Amount of Groundwater Projected to be Pumped

Basin Name	2010	2015	2020	2025	2030
West Coast Basin[1]	50,000	50,000	50,000	50,000	50,000
Central Basin[2]	2,000	2,000	2,000	2,000	2,000
Total	**52,000**	**52,000**	**52,000**	**52,000**	**52,000**
% of Total Water Supply[3]	**92%**	**92%**	**92%**	**92%**	**92%**

[1] Includes West Basin service area including Desalter sales

[2] Includes California American Water Co. groundwater imported from Central Basin

[3] Percentage of the available groundwater supply of both basins totaling 56,797 AFY

Groundwater Recharge

To replenish the WCGB and prevent further seawater intrusion, the Los Angeles County Flood Control District (LACFCD) created the injection barriers along the West Coast and at the Dominguez Gap, located north of the Los Angeles Harbor.

For the past 42 years, WRD has accomplished its statutory replenishment objectives primarily by allowing recycled and imported water to be injected into "seawater intrusion barriers" owned and operated by the County of Los Angeles Department of Public Works (LACDPW) in the WCGB.

WRD assesses a groundwater production fee, known as their "Replenishment Assessment", to pumpers of the WCGB. This assessment provides funds that

WRD uses to purchase and produce water for both spreading and injection to replace groundwater pumped and creating hydrological barriers to seawater intrusion. Stormwater is not used in West Basin for replenishing the groundwater basin.

WRD also encourages In-Lieu replenishment of the basins. Under the "In-Lieu program" pumpers of the WCGB are encouraged through a financial incentive to purchase surplus imported water from the West Coast Groundwater Basin "in-lieu" of pumping groundwater.

Table 3-6 summarizes the historical amounts of imported water purchased to replenish the basin.

Table 3-6
Historical Imported Water Replenishment Deliveries

Fiscal Year	In-Lieu	Barrier Water[1]	Total
1990	-	32,850	**32,850**
1991	-	31,876	**31,876**
1992	3,434	25,736	**29,170**
1993	14,265	25,705	**39,970**
1994	27,656	21,958	**49,614**
1995	10,094	21,274	**31,368**
1996	1,962	21,585	**23,547**
1997	1,453	23,208	**24,661**
1998	1,593	22,088	**23,680**
1999	1,942	19,353	**21,294**
2000	2,045	24,176	**26,221**
2001	1,455	25,811	**27,265**
2002	5,726	25,414	**31,140**
2003	1,864	24,631	**26,495**
2004	-	21,672	**21,672**
2005	-	15,199	**15,199**

[1] Barrier Water includes recycled and imported water deliveries to both the west coast and Dominguez Gap Barriers

3.3.3 Recycled Water Supply

Water recycling is one of the cornerstones of West Basin's efforts to augment local supplies and reduce dependence on imported water. Since the planning and construction of West Basin's water recycling system in the early 1990s, West Basin has become a leader in producing and marketing recycled water. This new supply of water assists in meeting the demand for non-potable applications such as landscape irrigation, commercial and industrial processes, and seawater barriers.

Recycled water is a resource that is reliable and environmentally beneficial to the region. It is only limited by the infrastructure needed to deliver this source of water. With approximately 210 site connections, West Basin has delivered an average of 14,000 AF of recycled water within the District's service area.

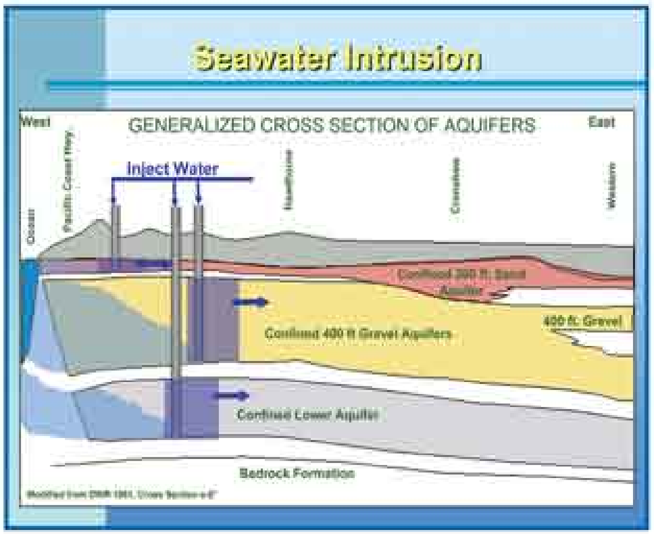
West Basin projects on delivering 21,850 AF of recycled water by year 2010. Refer to a more detailed description of West Basin's water recycling program in Section 8 of this Plan.

3.4 Alternative Water Supply Projects

3.4.1 Seawater Barrier Water Conservation Project

To prevent seawater intrusion into the WCGB, two injection barriers were created along the West Coast and at the Dominguez Gap. These barriers are a series of wells that act like a freshwater dam between the ocean and the groundwater aquifer. To ensure groundwater protection, the barriers require a reliable source of high quality water for continuous injection.

For more than a decade, West Basin has supplied a combination of 50% imported water and approximately 50% highly purified recycled water into the West Coast Barrier. To further enhance water reliability and water quality, West Basin is currently expanding the use of recycled water in the barrier to 75% for the following reasons:



Courtesy of WRD
Schematic of West Coast Seawater Injection Barrier

- West Basin is committed to conserving imported water. A 25% increase in the amount of recycled water used for injection at the barrier represents an additional 5,000 AFY of imported water that can be used for potable purposes. Furthermore, recycled water is more reliable than imported water, which is subject to drought and changes in weather patterns.

- Since it has been treated to have impurities removed, recycled water is a higher quality water source than Colorado River water. This purified water has one-half the salt concentration of existing groundwater and one-fifth the salt of Colorado River water. This will help improve water quality in the aquifer, which is consistent with West Basin's commitment to ongoing water quality enhancement.

- Using highly purified recycled water is less expensive than imported water and helps to control water rates in West Basin's service area.

3.4.2 Ocean Water Desalination

Desalting ocean water as a source of potable water in the West Basin region is a foreseeable goal. May 2003 marked the first anniversary of West Basin's Desalination Pilot Project and research program in which 40,000 gallons per day undergo microfiltration and reverse osmosis treatment and a battery of water quality tests. It is anticipated that West Basin will be able to provide up to 20,000 AF of ocean desalinated water in 2012. A more detailed description of West Basin's desalination efforts are described in Section 9 of this Plan.

3.4.3 Conjunctive Use Groundwater Storage

Conjunctive Use can be defined as the coordinated management of surface and groundwater supplies to increase the yield of both supplies and enhance water supply reliability in an economic and environmentally responsible manner. West Basin sees the development of Conjunctive Use Storage Programs as part of the District's core responsibility to ensure a reliable supply of water for its service area. If done in a publicly responsible manner, groundwater storage can be viewed as an additional source in diversifying our water resource supply portfolio.

The potential benefits of a Conjunctive Use program include:

- Operational flexibility for groundwater production;
- Increased yield of the basin;
- More efficient use of surplus surface water during wet years;
- Financial benefits to groundwater users;
- Better distribution of water resources and
- Increased measures of reliability.

At this time there are programs available for water retailers to create groundwater storage both within and outside of the WCGB groundwater judgment. District-sponsored storage programs with MWD are available for retail agencies with imported water connections. The size of such a program would depend on retailers' total demand and the amount of groundwater they could realistically shift to imported water.

3.4.4 Water Transfers & Exchanges

Water transfers and exchanges are management tools to address increased water needs in areas of limited supply. Although transfer and exchange of water does not generate a new supply of water, these management tools distribute water from where it is abundant to where it is limited.

MWD, in recent years, has played an active role statewide in securing water transfers and exchanges as part of their IRP goals. Although West Basin is a member of MWD, there has not been a compelling reason or opportunity to pursue transfers directly.

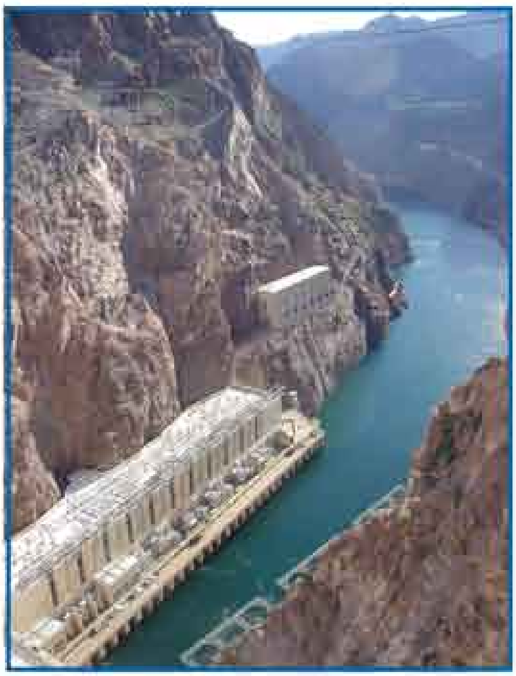
Section 4

Water Reliability

Water Reliability

4.1 Overview

Among the future challenges of continued urbanization in Southern California are the questions of water reliability. In other words, can Southern California meet the necessary water demands of the region during times of drought? During consecutive dry years, Southern California has historically seen demands increase by as much as 20% while supplies have decreased. Prior to recent significant improvements in water reliability, most cities and agencies were forced to mandate conservation efforts and restrict water use in some cases in order to maintain an adequate supply[1].



Colorado River water at Hoover Dam in Nevada

This section will discuss how the regional supplier, MWD, in partnership with its member agencies such as West Basin, plans on ensuring future reliability through water management measures, long-term planning and investment in local resources, West Basin's projections for meeting its service area's future demands during single and multiple dry-year conditions and a review of the District's Water Shortage Contingency Plan in the event that MWD limits deliveries.

4.2 MWD Water Supply Reliability

With the experience of the droughts of 1977-78 and 1989-92, MWD has undertaken a number of planning initiatives to ensure water supply reliability. Included among them are the Integrated Resources Plan (IRP), the Water Surplus and Drought Management Plan (WSDM Plan) and local resource investments. Together these initiatives have provided the policy framework for MWD and its member agencies to manage their water resources to meet a growing population even under recurrences of the worst historical hydrologic conditions locally and in the key watersheds that supply Southern California. Below is a brief description of each water management initiative MWD has undertaken to ensure 100% reliability during the next 20 years.

4.2.1 MWD Integrated Resource Plan

To meet the challenges of the supply shortages on the State Water Project (SWP) and the Colorado River Aqueduct in spite of increases in population and growing State and Federal regulatory requirements, MWD's Board of Directors called for the development of an IRP in 1996. The IRP's objective was to determine the appropriate combination of water resources to provide 100% reliability for full service demands during the next 20 years. With the support of its member agencies, MWD developed a preferred supply mix that includes conservation,

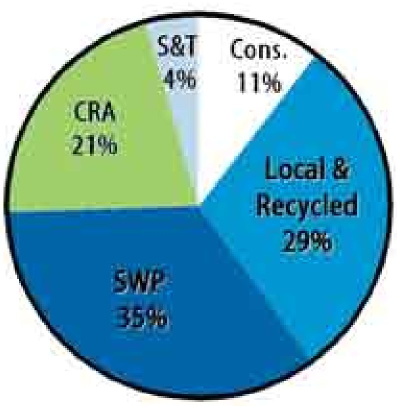
[1]By contrast, the loss of a large portion of our Colorado River supply in 2004 during an extended dry period in Southern California did not cause hardship or require any drastic return on the part of the general population. This was a tribute to planning and investments made into water reliability during the past decade.

local supplies (recycled, brackish, desalination), SWP supplies, CRA supplies, groundwater banking and water transfers that could meet projected water demands under severe shortage conditions. The IRP identifies supply targets for each supply option and has become the blueprint for guiding investment and policy decisions for decades to come.

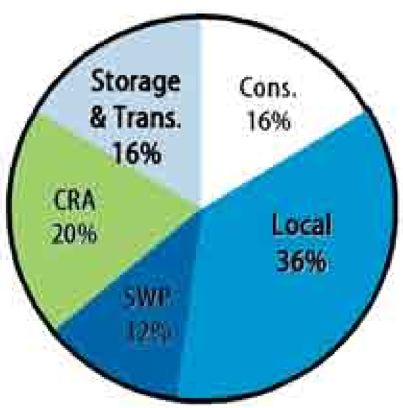
By design, the IRP is subject to revision when conditions and opportunities change through time. In 2003, MWD completed its first update to the IRP, which included revised projected demands and an updated resource supply mix. MWD had three clear objectives for the IRP update: (1) to review the goals and achievements of the 1996 IRP, (2) to identify changed conditions for water resource development and (3) to update the resource targets through 2025.

Among the most significant findings from the updated IRP was the increased participation of local agencies in developing local supplies such as recycled water and brackish groundwater desalination as well as promoting savings from conservation. The result of which revealed a greater source of local supply reliability than anticipated among MWD member agencies. However, it also identifies the limitations expected on the Colorado River and the need for local infrastructure improvements to provide the flexibility to manage and overcome supply risks.

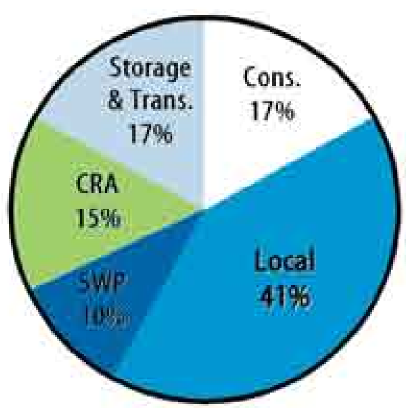
Overall, the 2003 IRP Update revealed a decrease in the region's reliance on Colorado River and SWP supplies compared to the 1996 IRP while continuing to provide 100% reliability through the year 2025.



Prior to the IRP
2020



1996 IRP
2020



2003 IRP Update
2025

4.2.2 MWD Water Surplus and Drought Management Plan

In order for MWD to be 100% reliable in meeting all non-discounted non-interruptible demands in the region, MWD adopted the WSDM Plan in 1999. The WSDM Plan provides the policy guidance to manage the region's water supplies to achieve the reliability goals of the IRP. This is achieved by integrating the operating activities of surplus and shortage supplies through a series of stages and principles.

Those principles include water management actions needed to secure more imported water during times of drought by promoting efficient water usage, increasing public awareness and seeking additional water transfers and banking programs. Should supplies become limited to the point where imported supplies are truncated, the WSDM Plan would allocate water through a calculation on the basis of need, as opposed to any historical purchases through MWD. MWD and its member agencies have not yet decided on a formula for the allocation calculation.

4.2.3 MWD Local Resource Investments

A key element within MWD's IRP objectives to ensure regional reliability is to further enhance local resources. In addition to the traditional supplies of imported water and groundwater, MWD has looked to invest in numerous local resource projects including: water recycling, conservation, groundwater and surface water storage, and even ocean water desalination to meet future demands.

Since 1982, MWD has provided financial assistance to more than 75 projects in the areas of recycled water and groundwater recovery totaling approximately $124 million and $41 million, respectively.

MWD has already invested more than $290 million in water conservation, which has produced significant water savings during the last 15 years.

One of MWD's most significant investments is Diamond Valley Lake. Built in the saddle of two mountains, Diamond Valley Lake, Southern California's newest and largest reservoir, is a vital link in the regional system that has brought water to Southern California for the past 75 years. The lake nearly doubled the region's surface water storage capacity and provides additional water supplies for drought, peak summer and emergency needs. This newly created reservoir, located in southwestern Riverside County , holds

Diamond Valley Lake
Courtesy of MWD

enough water to meet the region's emergency and drought needs for six months and is an important component in MWD's plan to provide a reliable supply of water to the 18 million people in Southern California. Water began pouring into the reservoir in November 1999 and the lake was filled by early 2002. Diamond Valley Lake holds 800,000 AF, or 260 billion gallons, of water. By comparison, Lake Havasu on the Colorado River holds just 648,000 AF or 201 billion gallons.

4.3 West Basin's Water Supply Reliability

Along with MWD's reliability initiatives, West Basin has also taken important steps during the past decade to reduce the District's vulnerability to extended drought or other potential threats. The District's investments in recycled water to replace imported water for non-potable uses and the implementation of conservation devices and education have resulted in more self-reliance.

Based on the District's current water supply portfolio, as illustrated in Table 4-1, West Basin provides an adequate supply for the single dry-water year and multiple dry-water year scenarios. The Normal Water Year used in this plan is based on the average rainfall year of 2000-01. According to the National Weather Service, the recorded rainfall in FY 2000-01 was 17.94 inches - one of the closest years to the historical average of more than 100 years (16.42 inches). The Single Dry Year is based on the lowest rainfall year of 2001-02. The recorded rainfall in FY 2001-02 was at 4.42 inches - the lowest recorded year in more than 100 years. The three Multiple Dry-Water Years used below were based upon the most recent dry period - FY 2001-02, 2002-03 and 2003-04.

Table 4-1
Supply Reliability

Supplies	Normal Water Year	Single Dry-Water Year	Multiple Dry-Water Years		
	FY 2000-01	FY 2001-02	FY 2001-02	FY 2002-03	FY 2003-04
Groundwater[1]	56,797	56,797	56,797	56,797	56,797
Imported Water	126,000	129,936	129,936	130,940	135,334
Recycled Water[2]	14,000	14,000	14,000	14,000	14,000
Total Supply	**196,797**	**200,733**	**200,733**	**201,737**	**206,131**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Barrier.
[1] Based upon the total water rights for each customer agency within West Basin's service area, according to the 2004 DWR West Coast Basin Watermaster Report. Also includes groundwater rights (2,000 AFY) from the Central Groundwater Basin, which are imported in West Basin.
[2] Includes M&I Recycled Water sales from West Basin's service area; does not include recycled water sales to LADWP and Torrance or replenishment sales (Barrier).

Groundwater is shown constant in all scenarios due to the Basin's adjudication, which limits the total amount that each customer within West Basin's service area is able to extract. Recycled water, which includes only M&I sales, is also constant in all scenarios because the availability of recycled water is not subject to hydrologic variation. This leaves imported water as the only supply currently that can fluctuate under different hydrological scenarios. The supply reliability scenarios described in this section focus exclusively on municipal and industrial usage within the District's service area; it does not include replenishment water.

Looking forward, West Basin will continue to evaluate opportunities to increase its water supply portfolio within its service area. These opportunities include the expanded use of water recycling, brackish water recovery, ocean water desalination and additional conservation programs as well as the exploration of investments in groundwater storage through Conjunctive Use programs.

4.3.1 Normal-Year Reliability Comparison

As discussed in the Water Demand Section, West Basin's normal demands are projected to increase modestly during the next 25 years. Increases in recycled water use and ocean water desalination during the 25 year planning period equate to a corresponding reduction in the need for imported water.

Table 4-2
Projected Normal Water Year Supply and Demand

Supplies	2005	2010	2015	2020	2025	2030
Groundwater[1]	56,797	56,797	56,797	56,797	56,797	56,797
Imported Water	126,000	123,000	97,319	98,665	100,140	101,747
Recycled Water[2]	14,000	21,848	32,500	36,250	40,000	43,750
Ocean Desalination	0	0	20,000	20,000	20,000	20,000
Total Supply	**196,797**	**201,645**	**206,616**	**211,712**	**216,937**	**222,294**
Total Demand[3]	**183,916**	**196,848**	**201,819**	**206,915**	**212,140**	**217,497**
Surplus/(Shortage)	**12,881**	**4,797**	**4,797**	**4,797**	**4,797**	**4,797**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Barrier.

[1] Based upon the total water rights for each customer agency within West Basin's service area, according to the 2004 DWR West Coast Basin Watermaster Report. Also includes groundwater rights (2,000 AFY) from the Central Groundwater Basin, which are imported in West Basin.

[2] Includes M&I Recycled Water sales from West Basin's service area; does not include recycled water sales to LADWP and Torrance or replenishment sales (Barrier).

[3] Total Demand includes Projected Groundwater within West Basin's service area as well as Imported and Recycled M&I Demands.

4.3.2 Single Dry-Year Reliability Comparison

West Basin's projected single dry-year water supply is expected to call for additional imported supplies from MWD. According to historical demands, the total water demands in a single dry-year are projected to be 3.5% greater than normal year projections. Table 4-3 compares the dry-year supply and demand projections for the West Basin service area.

Table 4-3
Projected Single-Dry Year Water Supply and Demand*

Supplies	2005	2010	2015	2020	2025	2030
Groundwater[1]	56,797	56,797	56,797	56,797	56,797	56,797
Imported Water	129,936	125,460	99,586	101,110	102,768	104,562
Recycled Water[2]	14,000	21,848	32,500	36,250	40,000	43,750
Ocean Desalination	0	0	20,000	20,000	20,000	20,000
Total Supply	**200,733**	**204,105**	**208,883**	**214,157**	**219,565**	**225,109**
Total Demand[3]	**190,353**	**203,738**	**208,883**	**214,157**	**219,565**	**225,109**
Surplus/(Shortage)	**10,380**	**367**	**0**	**0**	**0**	**0**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Spreading.

[*] 3.5% increase in water demand from a "normal water year"
[1] Based upon the total water rights for each customer agency within West Basin's service area, according to the 2004 DWR West Coast Basin Watermaster Report. Also includes groundwater rights (2,000 AFY) from the Central Groundwater Basin, which are imported in West Basin.
[2] Includes M&I Recycled Water sales from West Basin's service area; does not include recycled water sales to LADWP and Torrance or replenishment sales (Barrier).
[3] Total Demand includes Projected Groundwater within West Basin's service area as well as Imported and Recycled M&I Demands.

4.3.3 Multiple Dry-Year Reliability Comparison

Under the multiple dry-year water scenarios, West Basin is projected to meet demands by continuing to implement conservation, water recycling and introducing ocean water desalination as a new source of potable water to replace imported water. Tables 4-4 through 4-8 illustrate the projected water supplies and demands within multiple dry-year reliability comparisons for the next 25 years.

Table 4-4
Projected Water Supply and Demand during Multiple Dry-Year

Supplies	2008	2009	2010
Groundwater[1]	56,797	56,797	56,797
Imported Water	129,936	130,940	135,334
Recycled Water[2]	21,000	21,420	21,848
Ocean Desalination	0	0	0
Total Supply	**207,733**	**209,157**	**213,979**
Total Demand[3]	**198,792**	**200,785**	**206,188**
Surplus/(Shortage)	**8,941**	**8,372**	**7,791**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Barrier.
[1] Based upon the total water rights for each customer agency within West Basin's service area, according to the 2004 DWR West Coast Basin Watermaster Report. Also includes groundwater rights (2,000 AFY) from the Central Groundwater Basin, which are imported in West Basin.
[2] Includes M&I Recycled Water sales from West Basin's service area; does not include recycled water sales to LADWP and Torrance or replenishment sales (Barrier).
[3] Total Demand includes Projected Groundwater within West Basin's service area as well as Imported and Recycled M&I Demands.

quite expensive, but market demand has helped to drive the price down. The new HECWs cost twice as much as regular inefficient models, but by providing a $100 rebate (along with other utility/store incentives), consumers are purchasing the new HECWs. In addition to saving 50% water, the HECWs also have other benefits: They save 60% electricity and use less detergent. Consumer acceptance has been very positive.

In 2004, the MWD Board of Directors, along with the support of West Basin, approved additional funding to continue the program through 2005. At the same time, MWD applied for Proposition 50 funding in an effort to maintain the program at the higher incentive level through 2006. MWD was successful in its Prop. 50 application and was awarded roughly $1.6 million from the California Department of Water Resources for the High-Efficiency Clothes Washer Rebate Program. This funding will allow MWD and West Basin to continue offering its $100 rebate to residents in an effort to encourage the purchase of high-efficient clothes washers with a Water Factor (WF) of 6.0 or less.

The Water Factor of a clothes washer can range from 13.5 to 3.6, with the lower number being more efficient. A complete list of qualifying washers can be obtained at MWD's web site www.bewaterwise.com, or by calling the District's program vendor at **1-800-442-0467**.

In 2003, the Governor of California signed Assembly Bill 1561 that would require clothes washer manufacturers to only manufacture and provide residential washers with a WF of 8.5 in 2007 and 6.0 by 2010. The legislation was adopted by the California Energy Commission and was submitted to the Federal Government for approval. The Federal Government must approve this legislation before the new standards can be applied. This process is anticipated to take 1–2 years.

As long as funding is available, MWD and West Basin will continue offering its $100 rebate to residential customers for clothes washers with a WF of 6.0 or less. Table 6-3 illustrates the number of rebates West Basin has distributed during the past two years.

Table 6-3
High-Efficiency Washing Machine

	2003	2004	Total
$ per Rebate	$100	$100	**N/A**
# of Rebates	104	602	**706**
Water Savings (AF)	1.6	9.4	**11**

In an effort to continue the successful washer rebate program, MWD along with its member agencies, applied for and received Proposition 50 funding from DWR in the amount of $1,660,000. This funding will allow West Basin to continue its program through 2006.

Table 4-5
Projected Water Supply and Demand during Multiple Dry-Year 2013-2015
(In Acre-Feet)

Supplies	2013	2014	2015
Groundwater[1]	56,797	56,797	56,797
Imported Water	129,936	130,940	135,334
Recycled Water[2]	27,500	31,000	32,500
Ocean Desalination	20,000	20,000	20,000
Total Supply	**234,233**	**238,737**	**244,631**
Total Demand[3]	**203,812**	**205,855**	**211,395**
Surplus/(Shortage)	**30,421**	**32,882**	**33,236**

Table 4-6
Projected Water Supply and Demand during Multiple Dry-Year 2018-2020
(In Acre-Feet)

Supplies	2018	2019	2020
Groundwater[1]	56,797	56,797	56,797
Imported Water	129,936	130,940	135,334
Recycled Water[2]	34,750	35,500	36,250
Ocean Desalination	20,000	20,000	20,000
Total Supply	**241,483**	**243,237**	**248,381**
Total Demand[3]	**208,959**	**211,053**	**216,733**
Surplus/(Shortage)	**32,524**	**32,184**	**31,648**

Table 4-7
Projected Water Supply and Demand during Multiple Dry-Year 2023-2025
(In Acre-Feet)

Supplies	2023	2024	2025
Groundwater[1]	56,797	56,797	56,797
Imported Water	129,936	130,940	135,334
Recycled Water[2]	38,500	39,250	40,000
Ocean Desalination	20,000	20,000	20,000
Total Supply	**245,233**	**246,987**	**252,131**
Total Demand[3]	**214,235**	**216,383**	**222,205**
Surplus/(Shortage)	**30,998**	**30,604**	**29,926**

Table 4-8
Projected Water Supply and Demand during Multiple Dry-Year 2028-2030
(In Acre-Feet)

Supplies	2028	2029	2030
Groundwater[1]	56,797	56,797	56,797
Imported Water	129,936	130,940	135,334
Recycled Water[2]	42,250	43,000	43,750
Ocean Desalination	20,000	20,000	20,000
Total Supply	**248,983**	**250,737**	**255,881**
Total Demand[3]	**219,645**	**221,847**	**227,816**
Surplus/(Shortage)	**29,338**	**28,890**	**28,065**

4.4 Water Shortage Contingency Plan

The State requires that each urban water supplier provide a water shortage contingency analysis within its UWMP. Below is a brief description of the District's plan for water shortage according to the state's water code requirements.

4.4.1 Minimum Supply

Currently, the District's water supplies are groundwater, imported water and recycled water. As it relates to the estimated minimum supply available during a severe drought, the District's groundwater supply, as stated in Section 3, is not affected by hydrology because the Basin is adjudicated. The available supply for each groundwater producer (Allowable Production Allocation), set by the Judgment, remains the same regardless of the service area's rainfall. The same relates to recycled water, where the supply is not affected by hydrology but rather through the number of service connections and production capacity. The benefit of recycled water is that it is drought-proof and the supply of recycled water remains available regardless of the rainfall. Imported water, on the other hand, is the only supply affected by hydrology. As the wholesaler of imported water to the region, the District's minimum imported water supply is based upon the recent historical demand of imported water during a dry-year sequence of fiscal years 2001-02 to 2003-04; rainfall for these three years range among the lowest on record. The estimated minimum supplies during the next three years for the District is shown in Table 4-9.

Table 4-9
Three-Year Estimated Minimum Water Supply
(In Acre-Feet)

Supplies	2006	2007	2008
Groundwater[1]	56,797	56,797	56,797
Imported Water	129,936	130,940	135,334
Recycled Water[2]	14,500	18,000	21,000
Ocean Desalination	0	0	0
Total Supply	**201,233**	**205,737**	**213,131**
Total Demand[3]	**196,819**	**198,792**	**204,142**
Surplus/(Shortage)	**4,414**	**6,945**	**8,989**

Note: Supply Reliability covers only retail water demand; does not include replenishment deliveries such as Barrier.
[1] Based upon the total water rights for each customer agency within West Basin's service area, according to the 2004 DWR West Coast Basin Watermaster Report. Also includes groundwater rights (2,000 AFY) from the Central Groundwater Basin, which are imported in West Basin.
[2] Includes M&I Recycled Water sales from West Basin's service area; does not include recycled water sales to LADWP and Torrance or replenishment sales (Barrier).
[3] Total Demand includes Projected Groundwater within West Basin's service area as well as Imported and Recycled M&I Demands.

4.4.2 Stages of Action to Reduce Imported Deliveries

As the area's wholesaler of MWD imported water, the District's stages for reduction are subject to MWD's WSDM Plan, which guide the management of water supplies for the region during shortage conditions.

According to MWD's WSDM Plan, an array of water resource management measures would take place prior to any supply reductions. Through a series of seven shortage stages, MWD will seek the steps to encourage more efficient water usage with its member agencies. Not until the last stage, under an extreme shortage condition, will MWD discontinue imported water deliveries according to an allocation formula. Currently, however, MWD has not determined the shortage allocation methodology to complete the WSDM Plan. Conversely, MWD's 2005 Regional UWMP demonstrates 100% reliability in multiple dry-years through 2030. Nevertheless given the resources described in MWD's IRP, MWD fully expects to be reliable, under the most extreme supply shortage scenarios, during the next 10 years.

However, if imported water supplies were discontinued according to MWD's WSDM Plan, the District would consider reducing supplies through a series of action stages, which would include an allocation methodology similar to MWD. Once MWD determined such an allocation, the District would work with each of its customer agencies to set a specific allocation level to cumulatively meet the District's allocation from MWD. Below is a four step stage rationing plan the District would implement to reduce imported deliveries up to 50%.

West Basin Municipal Water District
Stages of Action

Minimum Shortage – The District would request for a voluntary effort among its customers to reduce imported water deliveries. In addition, the District would pursue an aggressive Public Awareness Campaign to encourage residents and industries to reduce their usage of water.

Moderate Shortage – In addition to the stage above, the District would work with its customer agencies to promote and adopt water waste prohibitions and ordinances to discourage unnecessary water usage.

Severe Shortage – In addition to the two stages above, the District would seek to adopt a rate structure that penalizes increased water usage among its customer agencies.

Extreme Shortage – In addition to all the stages above, the District would call for the discontinuance of imported water based upon an allocation methodology similar to MWD for each of its customer agencies.

Since these action stages are contingent upon MWD's WSDM Plan's allocation methodology and such a formula has yet to be determined, the District's shortage stages will remain in draft form. Until MWD completes the WSDM formula, the District's implementation of any rationing stage will be subject to a variety of conditions, among them the severity of the drought, the District allocation level and the current water supply mix available to each customer agency before the Board would apply any action stage listed above.

Once the Board determines what action is necessary, the Board will adopt, by resolution, the appropriate stage of action, which will take effect immediately and the District's customer agencies will be notified. A draft resolution is included in Appendix E.

4.4.3 Prohibitions, Penalties and Consumption Reduction Methods

Through the years the District has developed strong relationships with its customer agencies to promote community awareness of water conservation. Should water reductions become necessary, the District will work with each city, water agency or investor-owned water company within its service area to encourage the adoption of water waste prohibition measures that establish mandatory water use restrictions. Moreover, the District will provide the necessary assistance and information to apply the best suited water reducing practice(s) for each customer agency.

Additionally, the District will encourage behavioral change through the adoption of an appropriate water rate structure. As part of MWD's WSDM Plan, the District will pass through additional charges where MWD will enforce water reductions by setting a minimum amount per AF for any deliveries exceeding a member agency's allotment up to 102%

once an allocation plan is determined. Any deliveries exceeding 102% will be assessed a surcharge equal to three times MWD's full-service rate. The District will impose MWD's penalties for excess use to its customer agencies that exceed their allocation.

4.4.4 Impacts to Revenue

The District will seek to recover the shortfall of revenue caused by water reductions from its Rate Stabilization Fund as well as from any surplus revenues collected from excess penalties. Moreover, the District will closely monitor its revenue and expenditure impacts on a monthly basis and respond with any rate adjustments needed at each action stage.

Through the District's imported water invoices per connection, the District will measure each customer agencies' actual performance on a monthly basis.

4.4.5 Catastrophic Supply Interruption

In the event imported water supplies are interrupted from a catastrophic event, the District, through coordination with MWD, can respond at both a regional and a local level.

In the event that an emergency such as an earthquake, system failure or regional power outage, etc. affected the entire Southern California region, MWD would take the lead and activate its Emergency Operation Center (EOC). The EOC coordinates MWD's and the District's responses to the emergency and concentrate efforts to ensure the system can begin distributing potable water in a timely manner.

If circumstances render the Southern California's aqueducts to be out of service, MWD's Diamond Valley Lake can provide emergency storage supplies for its entire service area's firm demand for up to six months. With few exceptions, MWD can deliver this emergency supply throughout its service area via gravity, thereby eliminating dependence on power sources that could also be disrupted. Furthermore, should additional supplies be needed, MWD also has surface reservoirs and groundwater conjunctive use storage accounts that can be drawn upon to meet additional demands. The WSDM plan guides MWD's management of available supplies and resources during an emergency to minimize the impacts of a catastrophic event.

Locally, the District has the Member Agency Response System (MARS) to immediately contact its customer agencies and MWD during an emergency about potential interruption of services and the coordination of critical resources to respond to the emergency, also known as mutual aid. The MARS is a radio communication system developed by MWD and its member agencies to provide an alternative means of communication in extreme circumstances. The District is currently in the process of enhancing its communication system in order to provide a more rapid response.

Section 5

Water Quality

Water Quality

5.1 Overview

Compliance with water quality regulations within West Basin's service area is a critical water management activity. MWD is responsible for complying with State and Federal drinking water regulations on its imported water sold to West Basin. West Basin's retail customer agencies are responsible for ensuring compliance in their individual distribution systems and at the customer tap.

For groundwater quality, West Basin assists retail agencies in its service area in meeting drinking water standards through its *Cooperative Basin-Wide Title 22 Groundwater Quality Monitoring Program.* Title 22 refers to the California Code of Regulations section pertaining to both domestic drinking water and recycled water standards. West Basin offers this program to water agencies for wellhead and reservoir sample collection, water quality testing and reporting services. Sampling is conducted for compliance with the Federal Safe Drinking Water Act and Title 22 regulations. Three agencies in West Basin's service area participate in the monitoring program. Results are compiled in a published annual report called the Consumer Water Quality Report.

Gravity thickener tanks at the West Basin Water Recycling Facility

The West Basin Water Recycling Facility (WBWRF), located in El Segundo, processes and distributes water through three distinct treatment trains: Title 22, Barrier and Boilerfeed. Tertiary recycled water meeting Title 22 standards is used for a wide variety of industrial and irrigation purposes where high-quality, non-potable water is needed. The WRP also produces recycled water to meet the strict standards required for injection into the West Coast Basin Barrier Project to protect the underground aquifer from seawater intrusion and to replenish the aquifer. The Boilerfeed treatment process produces high-quality water treated through microfiltration and reverse osmosis for use in oil refinery boiler systems.

5.2 Quality of Existing Water Supplies

Providing a safe drinking water supply to consumers is a task of paramount importance to MWD and West Basin. All prudent actions are taken to ensure that water delivered throughout the service area meets or surpasses drinking water standards set by the State's primary water quality regulatory agency, the California Department of Health Services (CDHS). MWD is also proactive in its water quality efforts, protecting its water quality interests in the SWP and Colorado River through active participation in the regulatory arena and in treatment processes that provide the highest water quality from both sources.

A number of issues are considered when evaluating alternative water supply options. Of primary consideration is a project's ability to provide a safe, reliable and cost-effective drinking water supply.

5.2.1 Imported Water

West Basin's imported water comes from the SWP and Colorado River via MWD pipelines and aqueducts. MWD tests its water for microbial, organic, inorganic and radioactive contaminants as well as pesticides and herbicides. Protection of MWD's water system is a top priority. In coordination with its 26 member agencies, MWD added new security measures in 2001 and continues to upgrade and refine procedures. Changes have included an increase in the number of water quality tests conducted each year (more than 300,000) as well as contingency plans that coordinate with the Homeland Security Office's multicolored tiered risk alert system.[1] MWD also has one of the most advanced laboratories in the country where water quality staff performs tests, collects data, reviews results, prepares reports and researches other treatment technologies. Although not required, MWD monitors and samples elements that are not regulated but have captured scientific and/or public interest.

West Bain's water quality laboratory performs between 2,000-2,500 analysis per month for process control, compliance, and research development.

MWD has a strong record of identifying those water quality issues that are most of concern and have identified necessary water management strategies to minimize the impact on water supplies. Part of its strategy is to support and be involved in programs that address water quality concerns related to both the SWP and Colorado River supplies. Some of the programs and activities include:

CALFED Program – This program coordinates several SWP water feasibility studies and projects. These include:

1. A feasibility study on water quality improvement in the California Aqueduct.
2. The conclusion of feasibility studies and demonstration projects under the Southern California-San Joaquin Regional Water Quality Exchange Project.[2] This exchange project was discussed earlier as a means to convey higher quality water to MWD.
3. DWR's Municipal Water Quality Investigations Program and the Sacramento River Watershed Program. Both programs address water quality problems in the Bay-Delta and Sacramento River watershed.

Delta Improvement Package – MWD, in conjunction with DWR and the U.S. Geologic Survey, have completed modeling efforts of the Delta to determine if levee modifications at Franks Tract would reduce ocean salinity concentrations in water exported from the Delta. Currently, tidal flows trap high saline water in the track. By constructing levee breach openings and flow control structures, it is believed saline intrusion can be reduced. This would significantly reduce total dissolved solids and bromide concentrations in water from the Delta.

[1] MWD's web site, www.mwdh2o.com/mwdh2o/pages/yourwater/2005_report/protect_02.html
[2] The Metropolitan Water District of Southern California, Regional Urban Water Management Plan, 2005

Source Water Protection – In 2001, MWD completed a Watershed Sanitary Survey as required by CDHS to examine possible sources of drinking water contamination and identify mitigation measures that can be taken to protect the water at the source. CDHS requires the survey to be completed every five years. MWD also completed a Source Water Assessment (December 2002) to evaluate the vulnerability of water sources to contamination. Water from the Colorado River is considered to be most vulnerable to contamination by recreation, urban/storm water runoff, increasing urbanization in the water shed, wastewater and past industrial practices. Water supplies from SWP are most vulnerable to urban/storm-water runoff, wildlife, agriculture, recreation and wastewater.[3]

5.2.2 Groundwater

As part of West Basin's customer service, the Water Quality Department works closely with regulatory agencies to assist retail agencies in meeting State and Federal drinking water regulations through the *Cooperative Basin-Wide Title 22 Groundwater Quality Monitoring Program*. This voluntary program offers water quality testing to purveyors in the service area, funded through an annual assessment. The District's Water Quality staff coordinates a wellhead and reservoir water quality testing at approximately seven groundwater wells in the service area to ensure high quality of the local supply of drinking water. Under the program, a contract laboratory provides sampling, analytical and reporting services. Laboratory results are reported to the District, retail agencies and the CDHS. The program helps retail agencies save time and expense while providing a valuable service for public health.

West Basin's Water Recycling Facility Laboratory

Other services provided under the program are an annual report summarizing water quality throughout the basin and production of the annual Customer Water Quality report at the purveyor's request. The Customer Water Quality Report is required by State and Federal law. District water quality staff has prepared Annual Consumer Confidence Water Quality Reports for several West Basin purveyors for more than 10 years.

Water Replenishment District Programs

As the regional groundwater management agency for the Central and West Coast Groundwater Basins, WRD has several active programs to monitor, evaluate and mitigate water quality issues.

Under its Groundwater Quality Program, WRD continually evaluates current and proposed water quality compliance in agency production wells, monitoring wells and recharge/injection waters of the groundwater basins. If non-compliance is identified, WRD staff develops a recommended course of action and associated cost estimates to address the problem and to achieve compliance. WRD also monitors and evaluates the impacts of pending drinking water regulations and proposed legislation.

[3] The Metropolitan Water District of Southern California, Regional Urban Water Management Plan, 2005

WRD's Regional Groundwater Monitoring Program consists of a network of about 200 WRD and USGS-installed monitoring wells at 45 locations throughout the District. Monitoring well data is supplemented with information from production wells to capture the most accurate information available. WRD staff, comprised of certified hydrogeologists and registered engineers, provides the in-house capability to collect, analyze and report groundwater data. This information is stored in the District's GIS database and provides the basis to better understand the characteristics of the Central and West Coast Groundwater Basins.

WRD's Safe Drinking Water Program (SDWP) is intended to promote the cleanup of groundwater resources at specific well locations. Through the installation of wellhead treatment facilities at existing production wells, the District hopes to remove contaminants from the underground supply and deliver the extracted water for potable purposes. Projects implemented through the program are accomplished through direct input and coordination with well owners. The current program focuses on the removal of volatile organic compounds (VOCs) and offers financial assistance for the design and equipment of the selected treatment facility.

More information regarding these and other groundwater management programs can be found in the WRD's current Engineering and Survey Report and Regional Groundwater Monitoring Report.

WRD provides extensive information on groundwater quality in both its current Engineering and Survey Report (March 2005) and the Regional Groundwater Monitoring Report (April 2005). Both reports have a section devoted solely to groundwater quality management. The groundwater quality issues facing West Basin customers are summarized in the following sections.

5.2.3 Groundwater Recovery - Saltwater Plume

Although construction of seawater barriers was effective in halting the intrusion of seawater into the WCGB, exiting plumes of brackish water are still trapped behind the barriers. In the early 1990s, West Basin completed the C. Marvin Brewer Desalting facility in the City of Torrance area as a demonstration project for removing and treating brackish water from two existing drinking water wells. Enhancements in the Desalter's water supply and water quality in 2005 included the replacement of two wells with a new, more productive well. This well will have a design capacity of approx. 1,000 to 1,500 gallons per minute (gpm). This corresponds to approximately 1,600 to 2,400 AFY of saltwater treatment capability.

Since 2002, WRD has been operating the Robert W. Goldsworthy Desalter, located adjacent to West Basin's Brewer Desalter. Product water from the Goldsworthy Desalter is delivered for potable use to the City of Torrance's water distribution system.

5.2.4 Recycled Water

The WBWRF, in continuous operation since 1995, has conserved more than 48 billion gallons of imported water by serving reliable supplies of recycled water for a wide variety of non-potable uses. The WBWRF produces five different types of water quality from irrigation water to ultra-pure water for groundwater injection and industrial boilerfeed. Tertiary treated recycled water meeting California Title 22 regulations is produced for non-potable irrigation use through a conventional treatment process of flocculation, coagulation, filtration and disinfection. Some Title 22 recycled water is further treated in a process called nitrification for use in refinery cooling towers.

Barrier water is high-quality recycled water that undergoes lime or microfiltration pretreatment, reverse osmosis and disinfection. The resulting product is higher quality water than the Colorado River or SWP water from Northern California, with one-half the salt concentration of existing groundwater and one-fifth the salt concentration of Colorado River water. This purified water is blended with imported potable water from MWD before being injected into a series of wells that act as a barrier to protect inland fresh water supplies from sea water intrusion. Upgraded treatment facilities are being constructed that will improve the barrier water product quality, including state-of-the-art microfiltration and disinfection with ultraviolet (UV) and hydrogen peroxide.

Reverse Osmosis Units

The last two water quality types are treated with microfiltration and reverse osmosis to an ultra-pure quality for use in refinery boiler feed. More information on West Basin's water recycling efforts is included in Section 8 of this Plan.

5.2.5 West Coast Barrier Monitoring Well

The Barrier Monitoring Well was completed in June 2005. This well will monitor the quality of the groundwater down-gradient of the barrier. West Basin is committed to monitoring and maintaining the high quality of the seawater barrier and surrounding groundwater from migrating contamination sources. The monitoring well will be essential in providing critical water quality data for the surrounding groundwater. The well is located within a 3-6 month groundwater travel time from the barrier injection wells. This will serve as a first line of monitoring the blended water quality.

5.2.6 Ocean Water Desalination

West Basin's Desalination Pilot Project (Pilot Project) marked the first use of microfiltration as a pretreatment to reverse osmosis for ocean water desalination. The goal was two-fold: 1) identify optimal performance conditions and 2) evaluate the water quality. The research findings would then be shared with the rest of the industry on the suitability of microfiltration/ reverse osmosis technology for producing potable water from ocean water.

Since it first began operation, West Basin has identified the optimal operating parameters for desalination and will continue with the research, focusing primarily on water quality. Along with 500 analytical tests performed monthly, additional water quality studies will be completed under the auspices of the American Water Works Association Research Foundation (AWWARF). The Pilot Project's analytical test results indicate that the quality of the desalinated ocean water meets current State and Federal drinking water standards set by the CDHS and the EPA. West Basin's plan for the future is a full-scale desalination plant capable of providing 20,000 AFY of potable water, enough to supply 40,000 families (of four) for a year. More information on West Basin's ocean water desalination efforts is included in Section 9 of this Plan.

5.3 Effects on Water Management Strategies

Retail water agencies in densely populated Southern California are acutely aware of the economic impact of water quality on a public water system. Management strategies must be developed to maintain a safe, reliable supply at reasonable cost without jeopardizing water quality and public health. Water quality, pressure and supply are maintained through operational practices that can include wellhead treatment for contaminated groundwater sources or blending down contaminated groundwater with purchased imported surface water from MWD or high quality groundwater from adjacent purveyors.

WATER FACT

"One Acre-Foot of water equals 325,900 gallons-enough to supply two families of 4 for one year."

5.4 Effects on Supply Reliability

Poor water quality makes a water source unreliable, affects overall supply and increases the cost of serving water to the public. More importantly, it results in a loss of customer's confidence, which can be very difficult to overcome, even after water quality is restored. A water source that fails drinking water regulations must be taken out of service. The source can be restored through treatment or other management strategies.

Groundwater can become impaired through leaching of contaminants into an aquifer or by excessive concentrations of naturally-occurring constituents that impact quality, such as arsenic. Surface water sources become contaminated from human activities in the watershed or through deliberate contamination.

Section 6

Water Conservation

Water Conservation

6.1 Overview

Since the drought of the 1990s, West Basin has been a leader implementing aggressive water conservation programs to help limit water demand in its service area. District programs have included a strong emphasis on education and the distribution of rebate incentives and plumbing retrofit hardware. The results of these programs, in conjunction with passive conservation measures such as modifications to the plumbing and building codes, have resulted in significant reductions in retail water use within West Basin's service area. By current estimates, demand management conservation saves more than 4.5 billion gallons of imported water every year. This represents the average water use of almost 30,000 families (of four) in Southern California.

West Basin's conservation programs are made up of a wide array of cost-effective programs that contribute to conserving water, improving water quality, reducing imported water needs and increasing the region's water supply reliability.

Water Conservation is made of two main elements: Active and Passive. Below is a brief description of these two.

Active Conservation: Water savings produced from incentive based programs: Rebates, Giveaways, Retrofits, etc.

Passive Conservation: Water savings produced from building and plumbing codes, consumer behavioral changes and price responses.

West Basin prides itself in the partnerships it has created with Federal, State and local entities to offer these programs. By developing integrated programs with its partners, West Basin has been able to leverage funding and resources to provide effective programs throughout its region.

This section will present the past and current water conservation efforts West Basin has undertaken since 1990. In addition, this section provides a detailed analysis of West Basin's water conservation programs, implemented in accordance with the California Urban Water Conservation Council's (CUWCC) recommended Best Management Practices (BMPs), followed by a brief description of West Basin's upcoming conservation efforts and its Conservation Master Plan to promote additional water savings for the service area by the year 2030.

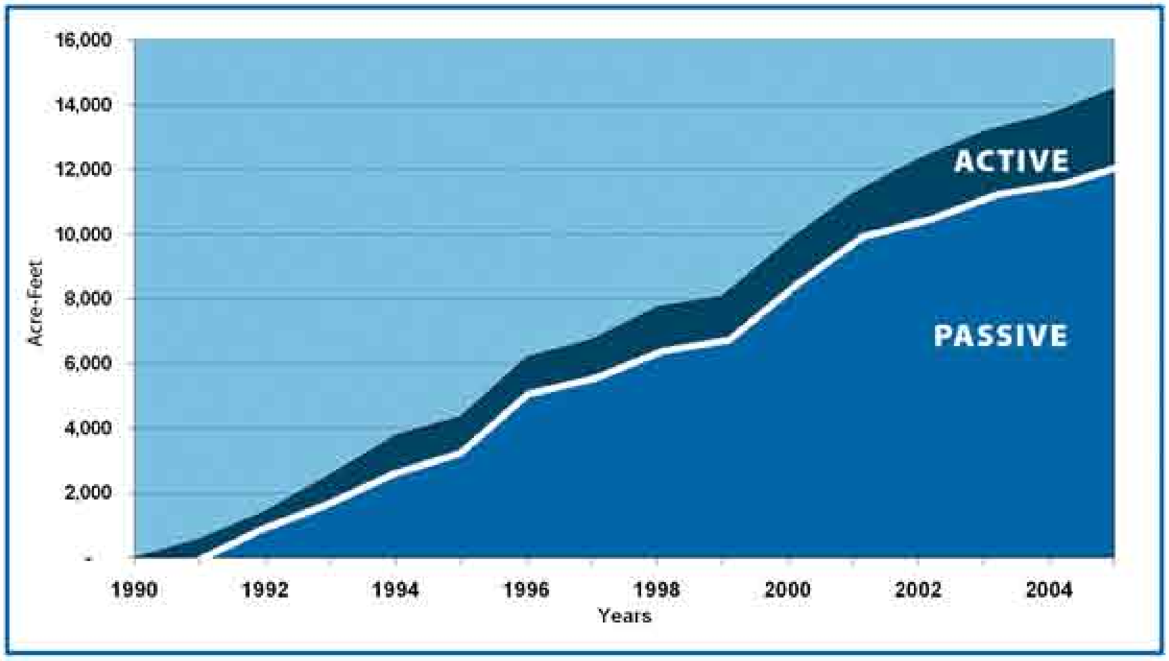
6.2 West Basin's Past and Current Water Conservation Efforts

Today, West Basin's conservation programs are made up of a wide array of cost-effective programs, which include:

- Zero Water Consumption Urinal Program
- Ultra-Low-Flush-Toilets
- High Efficiency Clothes Washer Rebate Program
- Commercial, Industrial and Institutional Rebates
- Commercial Clothes Washers
- Water Brooms
- School Education Programs
- Cooling Towers Conductivity Controllers
- Pre-Rinse Spray Nozzles
- X-Ray Machine Recirculating Devices
- Landscape Conservation Programs
- Weather-Based Irrigation Controller
- Landscape Classes
- Public Outreach

It is estimated that West Basin has distributed and installed more than 274,000 devices from 1990 to 2003. As a result, it is estimated that West Basin currently saves, from active and passive conservation combined, more than 14,500 AF (4.7 billion gallons), or 7% annually, of West Basin's total water demand. The total cumulative savings since 1990 is more than 116,000 AF.

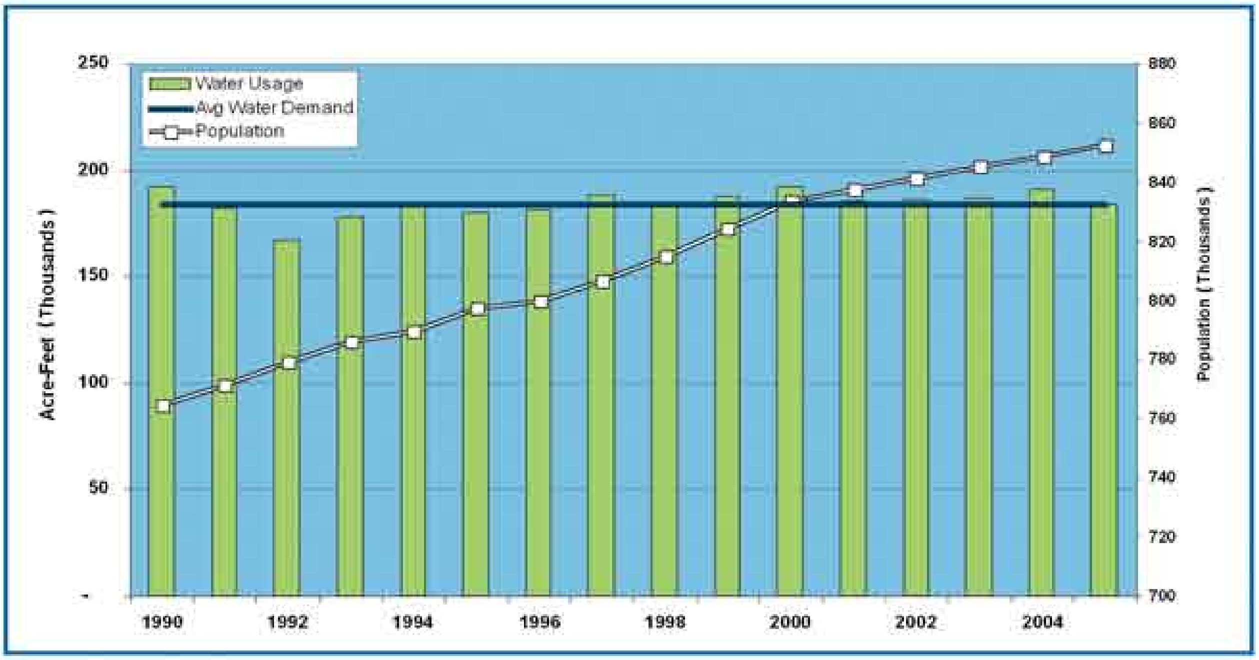
Figure 6-1
West Basin Conservation Water Savings From 1990 to 2005



Source: Estimated total water savings from conservation from MWD-MAIN Model 2004.

Conservation savings can further be verified by comparing West Basin's water usage versus population. As shown in Figure 6-2, water usage has remained relatively consistent while population has escalated an average of 1% annually.

Figure 6-2
Total Retail Water Demand vs. Population Growth
From 1990 to 2005



Source: Information based on MWD Demographic Data, 2005.
Note: The total retail demand does not include replenishment sale i.e. Barrier Sales - RW & Imported.

6.2.1 Metropolitan Water District's Conservation Goal

MWD, in adopting its 2004 IRP Update, is committed to an aggressive water conservation goal. MWD's IRP Update set water supply targets for Southern California through 2025, which includes a conservation target of 1.1 MAF during the next 20 years. MWD's strategy and approach for meeting the conservation targets is outlined in a "Conservation Strategy Plan." The Strategy Plan emphasizes three main areas of incentive based conservation: Residential, Landscape and Commercial, Industrial & Institutional (CII), and provides Board policy guidelines and action plans for the implementation of conservation under MWD's Conservation Credit Program.

6.3 California Urban Water Conservation Council

In 1991, the CUWCC was created to increase water use efficiency by integrating urban water conservation BMPs into the planning and management of California water agencies. It is a partnership of agencies and organizations concerned with water supply and conservation of natural resources in California.

To encourage water use efficiency, the CUWCC asked water agencies and organizations to sign a Memorandum of Understanding (MOU) regarding urban water conservation in California, which committed participating urban water suppliers to use their "good faith efforts" to implement the CUWCC's 14 BMPs. West Basin was one of the first urban water suppliers to become signatory to the CUWCC's MOU. In addition, West Basin has submitted a Best Management Practices Wholesaler Water Agency Report to the CUWCC every other year that details West Basin's progress in implementing the 14 BMPs as currently specified in the MOU. In Appendix F, the District has attached its 2003-04 CUWCC Report.

The BMPs are becoming increasingly important as benchmarks of agency conservation efforts throughout the State. This UWMP, for example, requires agencies that are not members of the CUWCC to describe current and future implementation efforts for all 14 BMPs (referred to as Demand Management Measures, or DMMs). Eligibility for grant funding from State agencies, such as DWR, is now contingent upon satisfactory completion of the urban water management plans and the conservation reporting within them.

6.3.1 Best Management Practices (BMPs)

The BMPs are a list of recommended conservation measures that have been proven to provide reliable savings to a given urban area. There are currently 14 BMPs that a signatory member is committed to implement. Table 6-1 lists the 14 existing BMPs.

Table 6-1
List of Best Management Practices for California Urban Water Conservation Council

1. Residential Water Surveys	Indoor and outdoor audits of residential water use and distribution of water-saving devices
2. Residential Plumbing Retrofits	Distribution or installation of water-saving devices in pre-1992 residences
3. System Water Audits	Unaccounted for water calculated annually and distribution system audits as required
4. Metering with Commodity Rates	Metering of consumption and billing by volume
5. Large-Landscape Conservation	ET-based water budget for large landscape irrigators
6. High-Efficiency Clothes Washers	Rebates for efficient washing machines
7. Public Information	Public information to promote water conservation
8. School Education	Provision of education materials and services to schools

Table 6-1 (Continued)
List of Best Management Practices for California Urban Water Conservation Council

9. **Commercial, Industrial and Institutional Conservation (CII)**	Programs to increase water use efficiency in CII sectors
10. **Wholesale Agency Assistance**	Support by wholesalers for conservation programs of retail water suppliers
11. **Conservation Pricing**	Uniform or increasing block rate structure, volume related water charges and service cost recovery
12. **Conservation Coordinator**	Designation of staff coordination of agency conservation programs
13. **Water Waste Prohibition**	Enforced prohibition of wasteful use of water
14. **Residential Ultra-Low-Flush Toilet Replacement**	Programs promoting replacement of high-water-using toilets with Ultra-Low-Flush Toilets

As a signatory to the MOU, West Basin currently implements the wholesaler BMPs, which are BMPs #3, 7, 8, 10, 11 and 12. Although only certain BMPs apply to a wholesaler, West Basin also provides additional support to its cities and water retailers (customers) through BMP #10. As a water wholesaler representing 17 cities throughout the South Bay, West Basin also supports its customers with BMPs #5, 6, 9 and 14. In order to enhance the programs, West Basin offers partnership opportunities to its customers who can add additional funding and resources in order to increase the size of the programs or rebates, which increases participation and water savings.

6.4 West Basin's Conservation Programs

West Basin's mission is to ensure a safe, reliable supply of water to its service area. Since the drought of the early 1990s, West Basin has strived to expand its role in water use efficiency. Not only is water conservation and education a method for public outreach but an essential part of West Basin's water resources portfolio to drought-proof the region.

Although West Basin is required to meet only the wholesaler BMPs, West Basin is committed to assisting its customer agencies with their conservation efforts. Described below are West Basin's efforts in each of the 14 BMPs.

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

Residential surveys look to all the water using devices inside the home such as toilets, faucets and showerheads. A trained surveyor checks for leaks and tests the flow indoors and outdoors. Once the survey is completed, recommendations are provided for retrofitting certain water use devices, and educational materials are also supplied to the resident.

Because West Basin is a water wholesaler and does not have direct access to single or multi-family customer account data, West Basin can only provide support to the water retailers. MWD currently provides funding for residential survey devices, and if requested, West Basin will act as the liaison to MWD and provide retailers with funding available through MWD. It is anticipated that West Basin will review the market strategy for promoting residential water use surveys within the Conservation Master Plan.

Residential surveys provide cities and water retailers with a great opportunity to provide their customers with a program that offers customer outreach opportunities.

6.4.2 BMP #2-Residential Plumbing Retrofit

This BMP recommends the distribution and retrofit of low-flow showerheads Ultra-Low-Flush Toilets and faucet aerators as well as the adoption of enforceable ordinances.

Since 1990, it is estimated that West Basin has distributed the following number of faucet aerators and low-flow showerheads.

Table 6-2
Residential Plumbing Retrofit Devices

Devices	1990 - 2000		2000 - 2005		Total	
	# units	AF	# units	AF	# units	AF
Faucet Aerators	954	3	0	0	**954**	**3**
Low-Flow Showerheads	215,563	1,014	7,500	35	**223,063**	**1,049**

6.4.3 BMP #3 - System Water Audits, Leak Detection, and Repair

In 1996, West Basin and its sister agency, Central Basin Municipal Water District, partnered with the United States Bureau of Reclamation (USBR) and hired a consultant to develop and provide a Water Audit and Leak Detection Program (Program). The Program was offered to 40 water purveyors. Of the 40, 10 participated in the audit, and of the 10, only three agencies found their unaccounted for water to be above 10%.

According to BMP #3, water retailers shall complete an annual pre-screening system audit of its potable water system to determine the need for a full-scale system audit. This BMP is geared more toward a water retailer, but West Basin has provided support in the past. As part of its Conservation Master Plan, West Basin will seek input from its water retailers regarding support for this program.

6.4.4 BMP #4 - Metering with Commodity Rates for all New Connections and Retrofit of Existing Connections

Since West Basin is a water wholesaler, this BMP does not directly apply. However, every water agency within West Basin's service area bills their retail customers according to meter consumption. This BMP requires that agencies identify intra- and inter-agency disincentives and barriers to retrofitting mixed use commercial accounts with dedicated landscape meters and conduct a feasibility study to assess the merits of a program that provides incentives to switch mixed use accounts to dedicated landscape meters.

By encouraging the installation of dedicated landscape meters, agencies will be able to recommend the appropriate irrigation schedules through future landscape programs.

6.4.5 BMP #5 - Large Landscape Conservation Programs and Incentives

Despite the urbanization of Southern California, the region is dotted with large turf areas that require year-round irrigation to keep them green. Large turf areas include city and county parks, golf courses, schools, cemeteries and street medians. West Basin is reducing demand for imported water for irrigation purposes by providing recycled water in its service area. Virtually anywhere potable water is used to irrigate, recycled water can, and should, replace it. However, in areas where recycled water is not available, West Basin provides other programs to conserve water. Below is a list of the programs West Basin is currently implementing.

Landscape irrigation controllers installed at the City of Gardena's City Hall

Irrigation Controller Programs

In 2004, MWD was awarded a Proposition 13 grant for a new Weather-Based Irrigation Controller (WBIC) Program. MWD and its member agencies developed a Project Advisory Committee (PAC) to work on developing the program, which includes marketing, reporting, databasing and implementing. MWD allocated a limited amount of funding to each member agency for this program. West Basin has been working with the PAC to develop the program. West Basin recognizes the water savings potential and is beginning to test Weather-Based Irrigation Controllers in sites that use potable imported water. The plan is to use the new controllers in areas where recycled water is unavailable. The funding incentives provided vary based on the number of stations and acreage at each site. The funding is used to help pay for the hardware and to help motivate cities, parks and schools to participate in the program.

Protector Del Agua Irrigation Program

West Basin also partners with MWD on the "Protector Del Agua" or "Protector of Water" landscape classes. In partnership with cities, classes are offered to residents as a way to teach them about various topics that help conserve water and reduce urban runoff. Residents learn about gardening with native plants and using Weather-Based Irrigation Controllers to conserve water and reduce runoff. More than 50% of the potable water in Southern California is used for maintaining landscaping; therefore, offering these classes is an ideal way to reduce outdoor water use and waste. By educating the public on properly maintaining the irrigation system, trouble-shooting problems such as overwatering that are simple yet difficult to address can be solved without spending additional funding.

Ocean Friendly Gardens

Also in 2005, West Basin formed a partnership with the Surfrider Foundation to develop "Ocean Friendly Garden" workshops and demonstration gardens. West Basin took the lead in applying for a State grant to help finance the classes. The classes focus on planting "ocean friendly plants" and installing Weather-Based Irrigation Controllers as a way to reduce urban runoff that finds its way to the local waterways and the ocean. The installation of water efficient plants and efficient sprinkler controllers can conserve between 20%-50% of water and reduce runoff by up to 70%.

6.4.6 BMP #6 - High-Efficiency Washing Machine Rebate Programs

Beginning in 1999, West Basin participated with MWD in a pilot program with Southern California Edison (Edison) to offer rebates to residents who replaced their existing clothes washer with a high efficiency model. The rebate from Edison varied according to the model purchased (which was tied into the total energy savings), but the amount offered by West Basin and MWD at the time was capped at $35 per washer. That pilot program ended in September 1999.

HECWS save 50% water and 60% electricity

In 2003, West Basin again partnered with MWD on a new program. MWD received funding from CALFED and provided a higher rebate incentive. West Basin developed the program and offered residents a $100 rebate.

The CALFED portion of the funding expired, but the program was so successful that, at the request of the MWD member agencies, MWD continued to provide funding at the current level. The High-Efficiency Clothes Washer (HECW) Program has exceeded all expectations and continues to be one of West Basin's more successful programs. When the HECWs first hit the market, they were quite expensive, but market demand has helped to drive the price down. The new HECWs cost twice as much as regular inefficient models, but by providing a $100 rebate (along with other utility/store incentives), consumers are purchasing the new HECWs. In addition to saving 50% water, the HECWs also have other benefits: They save 60% electricity and use less detergent. Consumer acceptance has been very positive.

In 2004, the MWD Board of Directors, along with the support of West Basin, approved additional funding to continue the program through 2005. At the same time, MWD applied for Proposition 50 funding in an effort to maintain the program at the higher incentive level through 2006. MWD was successful in its Prop. 50 application and was awarded roughly $1.6 million from the California Department of Water Resources for the High-Efficiency Clothes Washer Rebate Program. This funding will allow MWD and West Basin to continue offering its $100 rebate to residents in an effort to encourage the purchase of high-efficient clothes washers with a Water Factor (WF) of 6.0 or less.

The Water Factor of a clothes washer can range from 13.5 to 3.6, with the lower number being more efficient. A complete list of qualifying washers can be obtained at MWD's web site www.bewaterwise.com, or by calling the District's program vendor at **1-800-442-0467**.

In 2003, the Governor of California signed Assembly Bill 1561 that would require clothes washer manufacturers to only manufacture and provide residential washers with a WF of 8.5 in 2007 and 6.0 by 2010. The legislation was adopted by the California Energy Commission and was submitted to the Federal Government for approval. The Federal Government must approve this legislation before the new standards can be applied. This process is anticipated to take 1–2 years.

As long as funding is available, MWD and West Basin will continue offering its $100 rebate to residential customers for clothes washers with a WF of 6.0 or less. Table 6-3 illustrates the number of rebates West Basin has distributed during the past two years.

Table 6-3
High-Efficiency Washing Machine

	2003	2004	Total
$ per Rebate	$100	$100	**N/A**
# of Rebates	104	602	**706**
Water Savings (AF)	1.6	9.4	**11**

In an effort to continue the successful washer rebate program, MWD along with its member agencies, applied for and received Proposition 50 funding from DWR in the amount of $1,660,000. This funding will allow West Basin to continue its program through 2006.

6.4.7 BMP #7 - Public Information Programs

"Public information" is a very broad term with various meanings. Since West Basin operates a strong outreach program, public information about West Basin and its mission, programs and events are constantly disseminated to many interested parties. The method by which the public receives this information is important.

- The first significant method is the Public Information Committee (PIC), formed several years ago. The Committee is made up of Public Information and Public Affairs Officers from cities and water agencies within West Basin's service area. The purpose is to share information on a variety of topics that would be of interest to customers.

- West Basin, in cooperation with MWD, also provides inspection tours of the Colorado River Aqueduct and the State Water Project to legislators, local elected officials, retail agency staff and the general public on various dates throughout the year. The purpose of the three-day trips is to give local decision-makers a better understanding and appreciation of the water supply throughout the State.

- West Basin, through its Speaker's Bureau, provides speakers to local community groups, service clubs and schools when requested. In addition, West Basin operates a very successful and aggressive school education program that promotes the importance of conservation and water recycling.

- In October 1999, West Basin began its first annual "Water Harvest Festival" located at the West Basin Water Recycling Facility in El Segundo. West Basin invites children and their parents to participate in a variety of games and to obtain information on water recycling and conservation.

West Basin's Annual Water Harvest Festival

- West Basin is also active in the California Water Awareness Campaign (CWAC), which is an association formed several years ago to coordinate efforts throughout the State during "May is Water Awareness Month." With this effort, water agencies throughout the State, large and small, can tap into a large pool of knowledge and materials to promote a water awareness message not only in May but throughout the year.

- West Basin maintains a strong link with the local news media through press releases on important subjects and periodic meetings with newspaper editorial boards.

6.4.8 BMP #8 - School Education Programs

Water and environmental education continue to be critical components of West Basin's outreach strategy. Therefore, West Basin offers a variety of elementary through high school programs free of charge to all schools within its service area. The following is a list of West Basin's current and future education programs.

Descriptions of each program can be found in Section 6.5.

- Planet Protector Water Explorations
- Think Earth It's Magic
- Conservation Connection
- Think Earth Curriculum Kits
- Water Awareness Month Poster Contest
- Water Wanderings: A Journey Through Water
- SEWER SCIENCE

School education tour at West Basin's Water Recycling Facility in El Segundo

6.4.9 BMP #9 - Conservation Programs for Commercial, Industrial and Institutional (CII) Accounts

West Basin, in partnership with MWD, participates in MWD's region-wide CII rebate program. West Basin helps promote these rebates to the businesses, schools and facilities throughout its service area. Rebates are offered for commercial clothes washers, waterbrooms, cooling tower conductivity controllers, pre-rinse spray nozzles, x-ray machine recirculating devices and commercial toilets and urinals.

In 2002, the CUWCC pursued and received a $2.3 million grant from the California Public Utilities Commission (CPUC) to purchase and install restaurant pre-rinse spray nozzle valves. The new nozzles use 1.6 gpm compared to 2 to 6 gpm valves. These valves conserve water and heating costs and reduce waste water discharge. West Basin supported CUWCC's efforts in marketing the program. The nozzles and installations were provided free of charge to the food services sector.

In 2005, West Basin entered into a 10-year agreement with MWD to help support the on-going regional marketing efforts of the CII rebate program. As a way to increase the success of this program, West Basin offers its cities and water purveyors with partnering opportunities to increase the rebate amounts. Through the years, agencies have partnered to provide higher rebate incentives in an effort to increase program participation of their customers.

6.4.10 BMP #10 - Wholesale Agency Programs

The programs provided by West Basin are done in partnership with and benefit the following retail water agencies that are located within the 17 cities serviced by West Basin: 1) California American Water Company, 2) California Water Service Company, 3) City of El Segundo, 4) City of Inglewood, 5) City of Lomita, 6) Los Angeles County Water Works #29, 7) City of Manhattan Beach and 8) Southern California Water Company.

Among the 14 BMPs West Basin provides assistance for are:

- BMP #3 - System Audits
- BMP #5 - Landscape Programs
- BMP #6 - Washing Machines
- BMP #7 - Public Information
- BMP #8 - School Education
- BMP #9 - CII Rebates
- BMP #10 - Wholesaler Incentives
- BMP #12 - Water Conservation Coordinator
- BMP #14 - ULFT Replacement

Since 2000, West Basin has acquired more than $1 million from State and local grant funding sources for program development and implementation. Furthermore, West Basin markets, designs and implements a majority of the BMPs within its service area. West Basin has also invested more than $1 million to provide conservation programs that help increase water supply reliability for the region.

West Basin plans on expanding its conservation programs and the support it provides to cities and water retailers in their conservation program efforts.

WATER FACT

> Just 3% of the world's water exists as fresh water—2% is locked in the polar ice caps; less than 1% resides in freshwater lakes and streams.

6.4.11 BMP #11 - Conservation Pricing

In 2003, West Basin passed through MWD's two-tiered rate structure to its customer agencies to promote water conservation and regional water supply reliability. This rate structure called for customer agencies, in coordination with West Basin, to develop a reasonable budget for their Tier 1 annual maximum limit for imported water. Through voluntary purchase agreements, these customers will pay a higher price (Tier 2) for purchases that exceed their Tier 1 allotment.

To help assist agencies from exceeding their Tier 1 allocation limits, West Basin works with agencies to enhance conservation, education and expand recycled water use.

6.4.12 BMP #12 - Water Conservation Coordinator

As the regional wholesaler, West Basin has a full time water conservation coordinator who not only promotes West Basin's conservation programs and devices but also works with cities and water agencies to enhance their conservation efforts. This close collaboration between West Basin's conservation coordinator and the customer agencies' staff provides for a successful execution of the BMPs. In addition, West Basin's conservation coordinator represents the service area at regional and statewide workshops and organizations.

West Basin's conservation coordinator also seeks Federal, State and local funding to develop new programs on which cities and water purveyors can partner and provide additional benefits to the end-users.

6.4.13 BMP #13 - Water Waste Prohibition

West Basin encourages its customer agencies to adopt water waste prohibition ordinances. West Basin can also assist local cities and agencies in the development of ordinances that will reduce water wasting in the area.

6.4.14 BMP #14 - Residential Ultra-Low-Flush Toilet (ULFT) Replacement Programs

Local residents inspect high efficiency toilet

One of West Basin's more successful programs has been its free ULFT distribution program. Since 1991, West Basin has provided more than 80,000 ULFTs to the public "free of charge" in an effort to conserve water. These devices have proven water savings and have contributed to the overall water reduction through the years.

In 2004, West Basin partnered with MWD on a joint-project to identify the existing opportunity within West Basin's service area for this device. Data shows that there are still many inefficient toilets that need to be replaced. Within West Basin, there is a 30%-40% saturation level in many of its cities. The saturation levels and program performance will continue to be evaluated. For the time being, West Basin plans on continuing to provide ULFTs and rebates as long as funding is available, programs continue to be cost-effective and a significant saturation level has not been met. Due to the large areas of high density and numerous multi-family facilities, there are still many older toilets that need replacing. West Basin will continue to partner with cities and water purveyors in order to implement these programs. In addition, West Basin will continue to offer its $50 rebate for the purchase and installation of ULFTs.

West Basin also provides a $70 rebate for the purchase and installation of Dual-Flush-Toilets. These new toilets have the capability of flushing at either 0.8 gallons for liquids and 1.6 gallons for solids; they average 1 gallon per flush. Also, new 1 gallon per flush High-Efficiency Toilets (HET) are beginning to enter the market place. Advances in technology continue to create new conservation devices that are more water efficient than today's products.

Tables 6-4 and 6-5 illustrate the ULFT Rebate Program and the ULFT Replacement Program for the last five years.

Table 6-4
ULFT Rebate Program

	2000	2001	2002	2003	2004	Total
$ per Rebate	$50	$50	$50	$50	$50	**N/A**
# of Rebates	564	564	377	736	581	**2,822**
Water Savings (AF)	16	16	10	21	16	**79**

Table 6-5
ULFT Replacement Program (Free ULFT Distributions to the Public)

	2000	2001	2002	2003	2004	Total
# of Devices	4,234	2,946	2,214	2,234	1,544	**13,172**
Water Savings (AF)	123	85	64	65	44	**381**

6.4.15 Additional Conservation Programs

West Basin is very active in working with MWD to develop new conservation programs that are included in the CUWCC BMPs. In 2005, MWD implemented several new programs that West Basin supports, including:

Synthetic Turf Program

MWD, in partnership with the USBR, developed and provided funding to test the effectiveness of using synthetic turf. West Basin helped promote the program by issuing press releases and forwarding information to cities, water purveyors, non-profit organizations and others.

City Makeover Program

West Basin continues to support MWD's City Makeover Program. Through a competitive application process, MWD provides funding for development of new water efficient landscapes that promote California native plants and water efficient techniques. More information about this program can be found on MWD's web site, **www.mwdh2o.com**.

Community Partnering Program

MWD, in cooperation with the Member Agencies, accepts applications from non-profit organizations and public agencies that promote discussions and educational activities for regional water quality, conservation and reliability issues. This program provides support for the following types of programs:

- after-school water education
- community water festivals
- watershed education outreach
- environmental museum exhibits
- library water resources education book drives
- public policy water conferences
- other projects that directly support water conservation or water quality education

6.5 Current and Future Education Programs

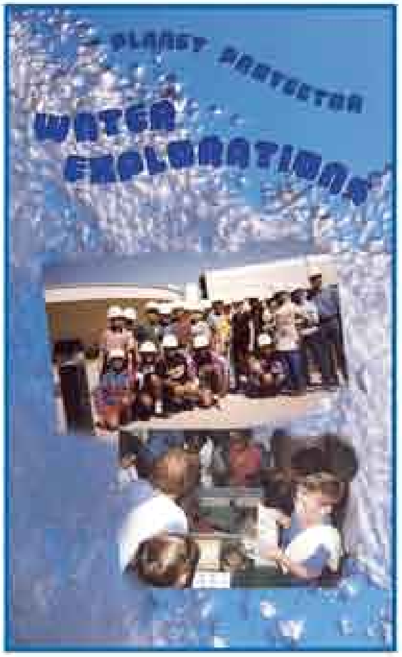
6.5.1 Current Programs

Planet Protector Water Explorations

Now in its 10th year of operation, Planet Protector Water Explorations is a collaborative water education field trip program between West Basin and the Roundhouse Marine Research Lab and Aquarium in Manhattan Beach. The

Roundhouse is operated by Oceanographic Teaching Stations, a non-profit organization, and is affiliated with the Los Angeles County Office of Education.

The objectives of Planet Protector Water Explorations are:



1. To increase the awareness of water as a valuable and limited resource.
2. To encourage water conservation efforts.
3. To introduce the concept of water recycling.
4. To introduce the concept of ocean water desalination.
5. To increase the awareness of urban runoff pollution.
6. To teach about local marine life.
7. To promote the concept of stewardship of the environment and its resources.

By the end of the 2004-2005 school year, more than 25,000 students will have experienced Planet Protector Water Explorations since the program began in September 1995. Table 6-6 displays the number of students that have been educated through the Planet Protector Water Exploration program from fiscal year 2000-01 to fiscal year 2004-05. Beginning in fiscal year 2004-05, additional programs have become available to students, therefore increasing the number of students that become educated.

Table 6-6
School Education Program

Grade Level	FY 2000-01	FY 2001-02	FY 2002-03	FY 2003-04	FY 2004-05[1]	Total
Grades K-3rd	240	250	480	690	1,014[2]	2,674
Grades 4th-6th	350	575	450	690	1,632	3,697
Grades 7th-8th	70	36	150	120	876	1,252
High School	0	70	30	30	174	304
Total	**660**	**931**	**1,110**	**1,530**	**3,696**	**7,927**

[1] Program includes *Planet Protector Water Exploration* in addition to *Think Earth It's Magic*, *Conservation Connection* and Think Earth curriculum kits for Fiscal Year 2004-05 only.

[2] Only third graders participate in this program.

Think Earth It's Magic

Through West Basin's membership as part of the Think Earth Environmental Education Foundation, Think Earth It's Magic is a collaborative program between West Basin, County Sanitation Districts of Los Angeles County and MWD. Think Earth It's Magic combines Think Earth's award winning environmental education curriculum, which is designed to promote conservation behaviors and stewardship of the environment with an environmental magic show that cleverly ties together what students learn in the classroom. By the end of the 2004-2005 school year, more than 500 elementary school students will have participated in Think Earth It's Magic.

Conservation Connection

We turn on the tap and water flows out. We turn on a lamp and light fills the room. We depend on water and energy. We need water and energy to live in this world. But where do we get the water and energy that we use? And will we always have enough to meet our needs?

Conservation Connection answers those questions, showing the connections between California, our water and energy supply, and us. But providing information is only part of Conservation Connection. The goal of the curriculum is to get students actively involved – in their homes and at school – in conserving water and energy. Within the program, students have the opportunity to survey their family's water and energy use and survey water and energy use at their school.

After gathering data, analyzing their findings and reviewing recommendations, students make, implement and monitor plans to decrease water and energy use. By participating in this action-based curriculum, students will learn to look critically at important environmental issues and take responsibility for finding solutions. By the end of the 2004-2005 school year, more than 500 middle school students will have participated in Conservation Connection.

Think Earth Curriculum Kits

Through West Basin's membership as part of the Think Earth Environmental Education Foundation, all teachers that participate in Planet Protector Water Explorations receive a grade appropriate Think Earth curriculum unit. Think Earth units are usually distributed each March so that teachers have them prior to Earth Day in April. Each Think Earth unit contains a video, two color posters, a teacher's guide and student booklets. The entire Think Earth curriculum is correlated to the California State Content Standards for the following content areas: Language Arts, Science, Social Science and Mathematics. During the past 10 years more than 25,000 students within West Basin's service area have participated in Think Earth.

Water Awareness Month Poster Contest

6th grade student Alex Oetzell from Jefferson School in the City of Redondo Beach with her parents Steve & Vicky Oetzell was honored for the winning poster, "Your Drain's in Pain," depicting the importance of water conservation.

All teachers who have or will participate in Planet Protector Water Explorations are notified each February of the "Water Is Life" Poster Contest, which is sponsored by West Basin and MWD each May. In addition, all teachers at each of West Basin's primary and secondary schools will also be notified. As in previous years, one grand-prize winner is selected and receives a fully-loaded laptop computer during an award ceremony in June. Each grand-prize winner will also have his or her artwork featured in MWD's "Water Is Life" annual calendar. During the past 10 years, more than 25,000 students within West Basin's service area have participated in this program.

6.5.2 Future Programs

Water Wanderings: A Journey Through Water

Water Wonderings is a collaborative classroom visitation program between West Basin and the S.E.A. Lab in Redondo Beach. This collaborative hands-on classroom program will take fourth graders on a 2½-hour journey through California's water. The program will be correlated to many of the fourth grade State standards for social science and science. Included in the program will also be a "touring tide pool," a van outfitted with touch tanks that will enable students to touch live marine creatures and plants. The Program schedule calls for classes to began in October and last through June for this upcoming fiscal year.

SEWER SCIENCE

Staff is currently partnering with the County Sanitation District of Los Angeles County on this exciting high school science program. SEWER SCIENCE is a hands-on laboratory program that teaches students about wastewater treatment. During a week-long lab, students create wastewater, treat it through the use of tanks employing physical, biological and chemical methods, and apply analytical procedures to test its quality. SEWER SCIENCE is correlated to the California State Content Standards for the following high school sciences: chemistry, physics and microbiology. The Program schedule calls for classes to begin in September 2005 and last through June 2006.

6.6 Funding Partnerships

In addition to partnering with MWD on programs, West Basin continually seeks State funding. In 2004 and 2005, the Department of Water Resources and the State Water Resources Control Board provided funding for programs through various chapters of Proposition 50. As a leader in water conservation, West Basin, in partnership with its cities and water retailers, developed several conservation programs and applied to the State's competitive funding process. As funding is awarded, West Basin works with its cities and water purveyors to provide programs to the local communities.

6.6.1 Proposition 50 Programs

In 2005, West Basin, with support from cities, water retailers and environmental groups, applied for and received Proposition 50 – Chapter 7 – Water Use Efficiency Grant Funding for a complete Restroom Retrofit Program in the amount of $294,834. This program will provide older commercial, industrial and institutional facilities that have inefficient devices with a complete restroom retrofit that includes: water-efficient toilets, Waterfree urinals and infrared sink sensor faucets. The program will also provide funding for installation. This new conservation program will be rolled-out in 2006.

In an effort to conserve water outdoors, West Basin also applied for Proposition 50

– Chapter 8 Funding, under the State's Integrated Regional Water Management Grant Program. West Basin partnered with various cities, water purveyors and stakeholders to develop an integrated approach at developing regional programs. Funding is being sought for the purchase and installation of Weather-Based Irrigation Controllers and for the development of "Ocean Friendly Garden" workshops. If successful, West Basin will provide education and devices that will conserve water, reduce urban runoff, reduce imported water and increase local water supply reliability.

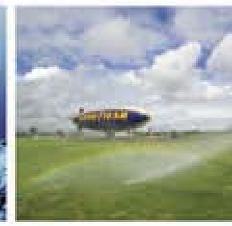
6.7 West Basin's Conservation Master Plan

Water Conservation, along with water recycling, will be used to meet a substantial portion of West Basin's gradually increasing water demands. The goal is to minimize West Basin's need for new imported water sources and enhance this drought-proof resource that has no environmental impacts and is not subject to weather conditions.

Measures such as tiered water pricing, financial incentives for the installation of Ultra-Low-Flush Toilets, water efficient washer machines and large landscape irrigation efficiency programs are just some of the ways West Basin provides leadership and results in the conservation arena. Conservation is a key component of West Basin's water resource planning activities and will be implemented to the fullest extent practicable over the long-term.

6.7.1 Water Conservation Master Plan

West Basin is in the process of developing its own specific Conservation Master Plan (Plan) to meet and exceed the goals of the BMPs and MWD's Conservation Strategy Plan. The goal of the Plan is to assess the conservation potential within West Basin's service area and incorporate local stakeholder input into a group of actions and strategies for achieving long-term targets for conservation. The Plan will be launched and completed by the end of the 2005-06 fiscal year.



Section 7

Rates & Charges

Water Rates & Charges

7.1 Overview

The residential water bill in Southern California is most likely the least expensive of a typical household's major utility bills. In fact, tap water can be purchased for much less than a penny per gallon, which is remarkable, considering investments made by water utilities into regulatory compliance, water use efficiency, infrastructure and other reliability programs. This paradox applies to West Basin's service area as well, although residential water bills vary from one retail agency to another agency depending primarily on the mix of source water purchased and/or produced.

Retail agencies that serve exclusively groundwater, for example, tend to have water rates that are lower than those that serve all imported water or a mix of groundwater and imported water. Imported water purchased from West Basin and provided by MWD carries not only the cost of acquiring, importing, purifying (treating) and distributing the commodity throughout the region but also a long-term action plan for ensuring adequate supplies to meet growing demands through conservation, education and new locally produced supplies.

7.2 MWD Rate Structure

In 2002, the MWD Board adopted a new rate structure to support its strategic planning vision as a regional provider of services, encourage the development of local supplies such as recycled water and conservation, and ensure a reliable supply of imported water. To achieve these objectives, MWD called for voluntary purchase orders from its member agencies, unbundled its water rates, established a tiered supply rate system and added a capacity charge. In all, these new rate structure components provide a better opportunity for MWD and its member agencies to manage their water supplies and proactively plan for future demands.

7.2.1 Purchase Orders

One of the important changes in the new rate structure was the call for voluntary purchase orders among MWD's member agencies. The Purchase Order is an agreement between MWD and a member agency, whereby the member agency agrees to purchase a minimum amount (60% of their highest year's delivery of non-interruptible water times 10) of non-interruptible water during a 10-year period - "Purchase Commitment." The economic incentive for a Purchase Commitment is that it entitles the member agency to purchase annually a set amount of non-interruptible water (Tier 1 Annual Maximum) at the lower Tier 1 rate, which is 90% of it's highest year's delivery of non-interruptible water.

In the case of West Basin, the highest delivery of non-interruptible water was 174,304 AF in 1990. As shown below in Table 7-1, West Basin's Tier 1 Annual Maximum is 156,874 AF with a Purchase Commitment of 1,045,824 AF by the end of 2013.

Table 7-1
West Basin Purchase Order Terms

Initial Base Allocation	Tier 1 Annual Maximum (90% of Base)	Purchase Commitment (60% of Base x 10)
174,304 AF	156,874 AF	1,045,824 AF

Since signing a Purchase Order with MWD, West Basin has remained below its Tier 1 Annual Maximum and has been on track to meet its Purchase Commitment by the year 2013.

7.2.2 Unbundled Rates and Tier 1& 2

To clearly justify the different components of the costs of water on a per acre-foot basis, MWD unbundled its full service water rate. Among the components MWD established are:

Supply Rate Tier 1
Reflects the average supply cost of water from the Colorado River and State Water Project.

Supply Rate Tier 2
Reflects the MWD costs associated with developing new supplies, which is assessed when an agency exceeds its Tier 1 limit of firm deliveries.

System Access Rate
Recovers a portion of the costs associated with the conveyance and distribution system, including capital and operating and maintenance costs.

Water Stewardship Rate
Recovers MWD's cost of providing incentives to member agencies for conservation, water recycling, groundwater recovery and other water management programs approved by the MWD Board.

System Power Rate
Recovers MWD's electricity-related costs, such as the pumping of water through the conveyance and distribution system.

Treatment Surcharge
Recovers the treatment cost and is assessed only for treated water deliveries, whether non-intuerruptible or intuerruptible.

The unbundled MWD water rates for calendar year (CY) 2006 are displayed in Table 7-2.

Table 7-2
Metropolitan Water District
Unbundled Water Rate Components
Adopted for 2006

Category of Water	$/AF
Supply Rate Tier 1	$73
Supply Rate Tier 2	$169
System Access Rate	$152
Water Stewardship Rate	$25
System Power Rate	$81
Treatment Surcharge	$122
Total Tier 1 Treated Rate	**$453**
Total Tier 2 Treated Rate	**$549**

7.2.3 Replenishment Service

Although a majority of the MWD water sold is full service at the Tier 1 rate, there is imported water sold at a discounted rate, better known as Replenishment Service Water. This type of water is used for groundwater replenishment. There are two main types of replenishment water–treated and untreated. Because the replenishment water can be interrupted at anytime, MWD has provided a discount to the rates. However, these rates are not tied to the unbundled rate structure illustrated above. These rates are established by MWD to provide the best incentive to replenish the groundwater basins. Replenishment Service rates for 2006 are shown in Table 7-3.

Table 7-3
Metropolitan Water District
Replenishment Service Rate
Adopted for 2006

Category of Water	$/AF
Replenishment Water Rate Untreated	**$238**
Treated Replenishment Water Rate	**$335**

Within West Basin, the only replenishment water sold is the treated replenishment water for customers participating in the West Basin and WRD In-Lieu program.

7.2.4 MWD Capacity Charge

MWD's new rate structure also established a new charge labeled "Capacity Charge." This charge was developed to recover the costs of providing distribution capacity use during peak summer demands. The aim of this new charge is to encourage member agencies to reduce peak day demands during the summer months (May 1 - September 30) and shift usages to the winter months (October 1 - April 30), which will result in more efficient utilization of MWD's existing infrastructure and defers capacity expansion costs. Currently, MWD's Capacity Charge for 2006 is set at $6,800/cubic feet per second (cfs).

The Capacity Charge is assessed by multiplying West Basin's maximum usage by the rate. The maximum usage is determined by a member agency's highest daily average usage (per cfs) for the past three summer periods, as shown below for West Basin's maximum usage for 2006 – 260.5 cfs.

Table 7-4
West Basin MWD
Capacity Charge for 2006

	Peak Flow 2002	Peak Flow 2003	Peak Flow 2004	3-Year Max
West Basin	256.0 cfs	260.5 cfs	258.5 cfs	**260.5 cfs**

Note: These peak flows are based upon West Basin's coincident peak of all its MWD connections.

7.2.5 Readiness-to-Serve Charge

The Readiness-to-Serve Charge (RTS) recovers a portion of MWD's debt service costs associated with regional infrastructure improvements. The RTS charge is a fixed charge assessed to each member agency regardless of the amount of imported water delivered in the current year. Rather, it is determined by the member agencies' firm imported deliveries for the past 10 years. West Basin meets this obligation through its commodity rates.

7.3 West Basin's Imported Water Rates

As MWD adopted a new rate structure so did West Basin. In 2003, West Basin passed through MWD's Purchase Order by offering customer agencies voluntary purchase agreements and assessing MWD's new Capacity Charge. West Basin also revised the administrative surcharge to be applied uniformly to all classes of imported water sold. Described below are elements of the rate structure that West Basin applies to the delivery of imported water.

7.3.1 Purchase Agreements

In order to meet the Purchase Order commitment with MWD, West Basin established its own purchase contract policy with its customer agencies. West Basin's Imported Water Purchase Agreements mimic the MWD version in terms of an Annual Tier 1 Maximum and Total Purchase Commitment but offer more flexibility to the customer. West Basin requires only a five-year commitment as opposed to a 10-year term. Furthermore, customer agencies have the option to adjust their Tier 1 and Purchase Commitment amounts annually if certain conditions are favorable and can also reduce their commitment amounts by offsetting imported water demand with recycled water purchased from West Basin. For purchases above the Tier 1 limit, or in the absence of a Purchase Agreement, the customer agency pays the Tier 2 rate (currently $81/AF above the Tier 1 rate).

Every customer agency of West Basin signed an imported water Purchase Agreement.

7.3.2 Administrative Surcharge

One of the main revenue sources for West Basin is the Administrative Surcharge applied to all imported water sold. In 2003, West Basin revised the Administrative Surcharge to be uniformly applied to all imported water regardless of the type delivered. Revenue from the surcharge recovers West Basin's administrative costs including planning, outreach and education, and conservation efforts. As of July 1, 2005, West Basin's Administrative Surcharge is at $32/AF.

7.3.3 Readiness-to-Service Surcharge

As described above, MWD levies to West Basin a RTS charge to recover a portion of its debt service costs. Thus, a RTS surcharge is added to West Basin's commodity rates for Non-interruptible and Barrier water to cover this charge. As of January 1, 2006, West Basin's RTS surcharge will be $60/AF.

7.3.4 Water Service Charge

Water utility revenue structures benefit from a mix of fixed and variable sources. West Basin's Water Service Charge recovers a portion of the agency's fixed administrative costs but is a relatively small portion of its overall revenue from water rates. As of July 1, 2005, the Water Service Charge is $20/cfs of a customer agency's meter capacity for imported water meters.

7.3.5 West Basin's Capacity Charge

This charge, as described in Section 7.2.4, is intended to encourage customers to reduce peak day demands during the summer months, which will result in more efficient utilization of MWD's existing infrastructure. West Basin has passed this MWD charge onto its customer agencies by mimicking MWD's methodology. Each customer's Capacity Charge is determined from their highest daily average usage (per cfs) for the past three summer periods. However, because MWD assesses West Basin on the coincident daily peak of all the connections and aggregate of all its customers' daily peak is the non-coincident peak, West Basin is able to lower the Capacity Charge to its customers from $6,800/cfs to $5,700/cfs.

7.3.6 Desalter Water Charges

West Basin also sells the water produced by the Brewer Desalter at the effective MWD rate. This includes the MWD Non-interruptible base rate and an acre-foot equivalent for the Capacity Charge. Currently, the rate for desalter water is $465/AF.

7.4 Recycled Water Rates

West Basin's water recycling program is one of the largest in Southern California, delivering more than 28,000 acre-feet of highly treated recycled water to more than 200 sites annually. The West Basin Water Recycling Facility in El Segundo provides five different qualities of "designer" water to meet the needs of landscape irrigation, cooling towers, refineries and industries within the Los Angeles County South Bay region. The WBWRF also has the potential to expand its delivery up to 100,000 AF of recycled water.

Since 1995, West Basin has encouraged the maximum use of recycled water to industries, cities and landscape irrigation sites through its water quality and economic incentive of its rates and charges. Below is a description of West Basin's recycled water rates and charges.

7.4.1 Recycled Water Rates

West Basin contains seven different rates for recycled water. Each rate differs because of the treatment quality, power and location. All rates, however, are assessed to cover the operation and maintenance costs, and labor and power costs associated with the delivery of recycled water. A majority of these rates are set up in a declining tiered structure so they may further encourage the use of the recycled water, while the others are set up to service one or more customers at a uniform rate.

Most of these rates are set lower than West Basin's imported rates to encourage the usage of recycled water. Only highly treated recycled water deliver to the refineries are set above imported rates. West Basin's recycled water rates for FY 2005-06 are shown in Table 7-5.

Table 7-5
West Basin Recycled Water Rates Fiscal Year 2005-06

Volume (AF/Month)	West Basin Service Area	West Coast Barrier	Industrial R/O (WB Svc Area)	Nitrified (Ind R/O usage)	Industrial R/O Ultra (WB Svc Area)	Torrance / LADWP Service Areas	Palos Verdes Zone Rate
0-25	$312/AF	$430/AF	$568/AF	$292/AF	$750/AF	$354/AF	$548/AF
25-50	$292/AF	$430/AF	$568/AF	$292/AF	$750/AF	$334/AF	$528/AF
50-100	$272/AF	$430/AF	$568/AF	$292/AF	$750/AF	$314/AF	$508/AF
100-200	$252/AF	$430/AF	$568/AF	$292/AF	$750/AF	$294/AF	$488/AF
200+	$232/AF	$430/AF	$568/AF	$292/AF	$750/AF	$274/AF	$468/AF

The "out of service area" rate is assessed to customers outside of West Basin's service area boundaries, which pay an additional $40/AF per tier. This additional charge is applied to make up for the recycled water standby charge they are not levied on their parcels.

7.4.2 Recycled Water Standby Charge

There is a recycled water standby charge that is levied by West Basin to each parcel within the service area. An average rate of $24 per parcel is administered by West Basin to provide a source of non-potable water completely independent of drought-sensitive supplies. The revenue collected from this charge is used to pay the debt service obligations on the West Basin Water Recycling Facilities. Each year the Board holds a public hearing where they adopt West Basin's Engineer's Report and Resolution to assess this charge.

Recycled water at the Good Year Airship Station located in the City of Carson

7.5 Future Water Rate Projections

As the demand for water increases in Southern California so does the cost to administer, treat and distribute imported and recycled water. However, West Basin has worked diligently to ensure that stable and predictable rates are managed for the future. Below are discussions of imported and recycled water rate trends during the next 10 years.

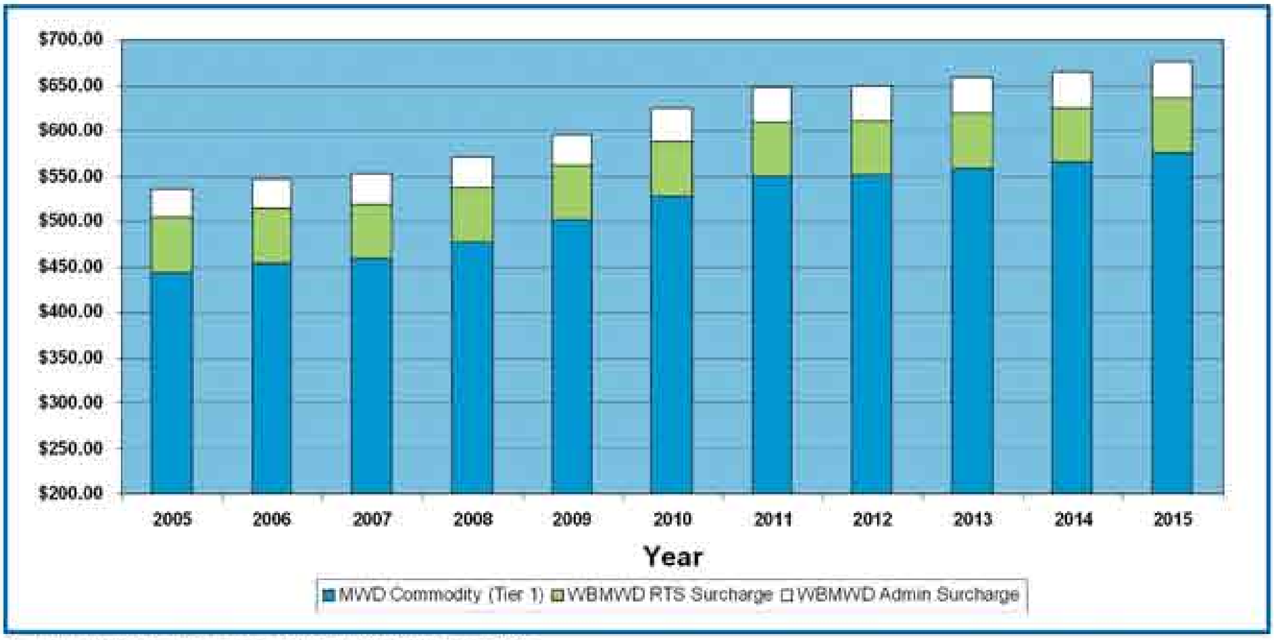
7.5.1 Imported Water Rate Projections

In 2004, the MWD Board adopted its Long Range Financial Plan. This plan was developed to forecast future costs and revenues necessary to support its operations and capital investments. Furthermore, it lays out the financial policy MWD will pursue during the next 10 years. According to projected MWD sales, with investments into local resources, MWD estimates imported water rates will increase 4-6% annually.

West Basin's Administrative Surcharge is projected to increase at an annual average rate of 3%-4%. This increase is determined by West Basin's Long Range Financial analysis and the budget's revenue requirements.

Figure 7-1 (on the following page) displays West Basin's imported water rate projections for the next 10 years.

Figure 7-1
West Basin Imported Water Rates
10-year Projections



Source: MWD 2004 Long Range Financial Plan & West Basin's Financial Plan.

7.5.2 Recycled Water Rate Projections

Similar to imported water rates, recycled water rates are expected to increase because of higher treatment, maintenance and power costs. However, West Basin believes in setting recycled water rates at a competitive level to help offset the use of imported water. To achieve this economic incentive, recycled water rates have been projected by West Basin to increase at a slightly lower level than imported water. The recommended rates are projected to increase for all types of recycled water, by an average of 3% annually. However, these rates may vary depending upon energy and chemical costs.

Section 8

Water Recycling


Water Recycling

8.1 Overview

Recycled water is a cornerstone of West Basin's efforts to augment local supplies and reduce dependence on imported water. Since planning and constructing its recycled water system in the early 1990s, West Basin has become an industry leader in water re-use. Recycled water is used for non-potable applications such as landscape irrigation, commercial and industrial processes, and indirect potable uses such as groundwater replenishment. An additional benefit of West Basin's recycled water is less ocean discharge of treated wastewater into the Santa Monica Bay.

In 2005, West Basin delivered 24,069 AF of recycled water to customer agencies inside and outside its service area. Within West Basin's service area, M&I recycled water totaled 13,065 AF, representing approximately 7% of the District's current total water supplies. According to projections, recycled water sales will represent 17% of the District's total water supplies by the year 2030.

This section will provide an overview of the District's water recycleing system, its treatment process at its El Segundo Plant and a description of its distribution systems. In addition, a description of the District's past, current and projected sales inside and outside of its service area will be discussed, concluding with a discussion of West Basin's system expansion projects and plans to encourage future recycled water use.

8.2 Recycled Water Sources and Treatment

8.2.1 Source Water

The source of West Basin's recycled water is from the City of Los Angeles's Hyperion Wastewater Treatment Plant (Hyperion). The City of Los Angeles has operated Hyperion, located adjacent to West Basin's service area, since 1894. Initially built as a raw sewage discharge plant into the Santa Monica Bay, it has been upgraded through the years to partial secondary treatment (1950) and most recently to full secondary treatment (1998). Hyperion has a dry weather capacity of 450 mgd for full secondary treatment and an 850 mgd wet weather capacity. Hyperion has a daily influent of 362 mgd, or 405,000 AFY, and secondary treatment capacity of 450 mgd. West Basin recycles approximately 24 mgd, or roughly 7.7% of the effluent from Hyperion. Ocean disposal accounts for the balance of the secondary effluent from Hyperion.

West Basin purchases secondary effluent from Hyperion prior to ocean disposal and provides, at a minimum, tertiary treatment and disinfection to meet applicable Title 22 standards. More advanced treatment is provided according to customer specifications. West Basin treats and distributes recycled water at its Water Recycling

Treatment Facility (WBWRF), located in the city of El Segundo, to customer sites in its service area as well as to sites in the City of Torrance and the City of Los Angeles. Figure 8-1 shows the WBWRF, located in the City of El Segundo in Los Angeles County.

Figure 8-1
West Basin's Water Recycling Treatment Facility

8.2.2 Treatment Process

City of Los Angeles' Hyperion Wastewater Treatment Plant

The effluent received from Hyperion is limited by the City of Los Angeles' (City) National Pollutant Discharge Elimination System permit. Although the City strives to provide West Basin with a consistent quality of secondary treated wastewater, the WBWRF has to accommodate inevitable fluctuations in influent quality. Table 8-1 illustrates the amount of historical, current and projected wastewater collected and treated at Hyperion and the amount of recycled water that West Basin treats to Title 22 standards, the minimum treatment standard at the facility. There are other qualities of water that are treated, named "Designer Water," explained in further detail on the next page.

Table 8-1
Wastewater Collected and Treated
(AF/Calendar Year)

	2000	2005	2010	2015	2020	2025	2030
Wastewater collected & treated in service area[1]	355,000	390,000	425,000	465,000	500,000	335,000	570,000
Quantity that meets recycled water standard[2]	21,900	32,500	48,000	58,100	62,000	66,000	70,000

[1] Data supplied by the Hyperion Wastewater Treatment Plant

[2] Data supplied by West Basin's Water Recycling Treatment Facility

Most of West Basin's recycled water undergoes a treatment process to clarify it to quality standards to meet California Code of Regulations Title 22 (Title 22). The level of treatment necessary is approved by the California Department of Health Services (CDHS). Title 22 addresses specific treatment requirements for recycled water and lists approved uses. Approximately 2,000 tests are performed monthly at the WBWRF to ensure water quality meets or exceeds all State and Federal requirements. West Basin's Water Recycling Program is unique in that it provides a variety of products that are developed at one or more facilities to meet specific customer specifications ("designer water"). In all, West Basin produces five different qualities of recycled water:

- *Disinfected Tertiary Water* - Tertiary recycled water is treated secondary water from Hyperion that undergoes coagulation, flocculation, filtration and disinfection to meet Title 22 standards. Tertiary water can be used for a wide variety of industrial and irrigation purposes where high-quality, non-potable water is needed.

- *Nitrified Water* - Nitrified recycled water is tertiary treated water that has been nitrified to remove ammonia, which can be corrosive to pipe material. This water is used in industrial cooling towers.

- *Softened Reverse Osmosis Water* - Softened reverse osmosis water is secondary treated water from Hyperion that has been pretreated with microfiltration and lime softeners and then treated with reverse osmosis. The water is softened because it can be corrosive to pipe material. This water is used in the seawater barrier to protect the South Bay's coastal groundwater reservoirs against saltwater intrusion from the Pacific Ocean and to replenish the groundwater supplies. Softened reverse osmosis water is superior to State and Federal drinking water standards. West Basin is currently undergoing a major capital project to add both ultraviolet light as well as advanced oxidation to the barrier system, further ensuring the quality of this water and making it the most advanced water treatment facility in the world for recycled water.

- *Pure Reverse Osmosis* - Pure reverse osmosis water is secondary treated water from Hyperion that has been pretreated with microfiltration and further treated with reverse osmosis. This water is used for low pressure boilerfeed water for large scale industrial sites such as refineries.

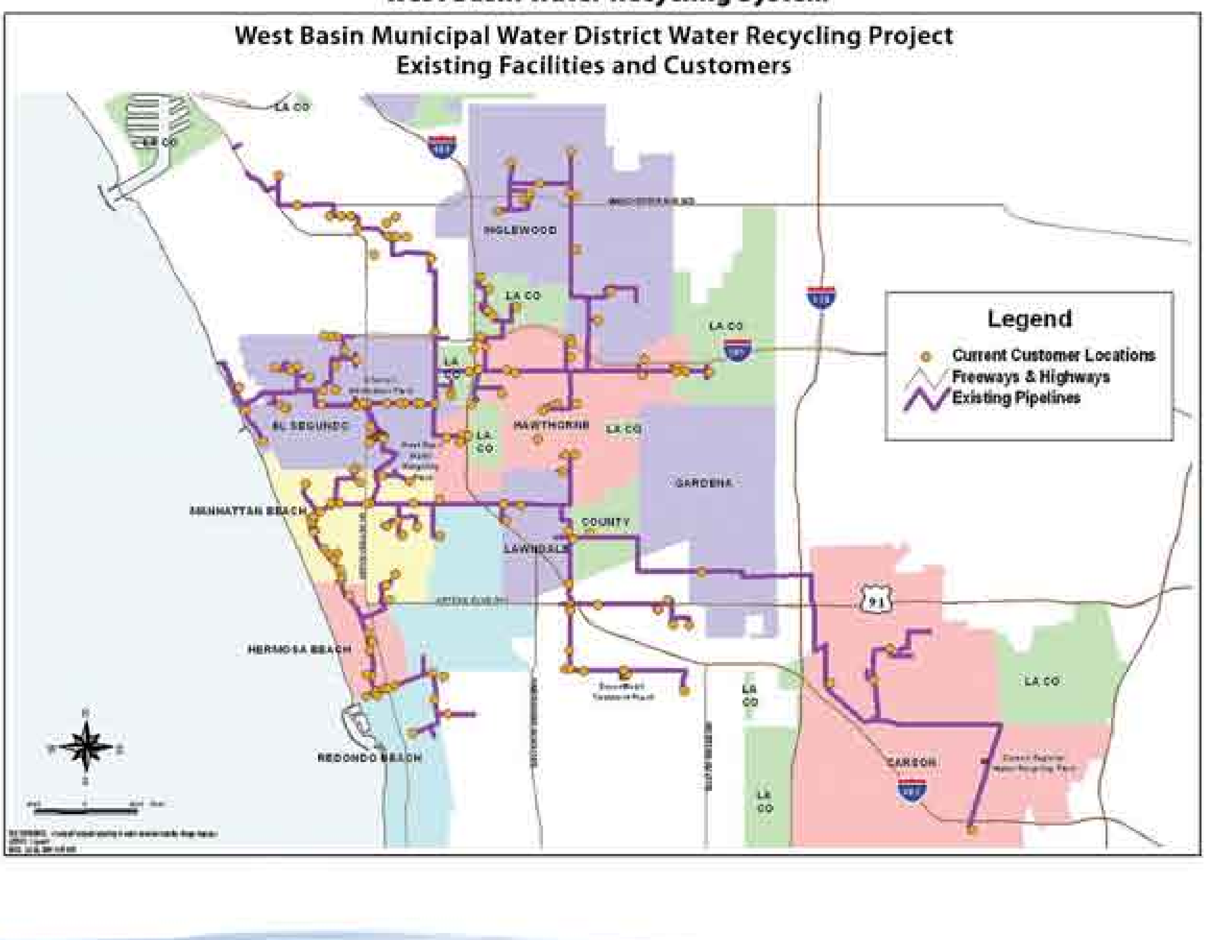
- *Ultra-Pure Reverse Osmosis Water* - Ultra-pure reverse osmosis water is secondary treated water that has been pretreated once with microfiltration and then treated twice with reverse osmosis. Since this water is used for high pressure boilers, it is important that no mineral buildup occurs on the equipment. This water can be used multiple times (cycles) as boilerfeed water before being discharged.

8.3 West Basin's Recycled Water System

8.3.1 Existing System

In 1995, West Basin opened its state-of-the-art water recycling facility in El Segundo, which is still one of the largest recycled water facilities of its type in the nation. West Basin's facility has a current capacity of 35 mgd with a 15 mgd expansion expecting to come online in early 2006. In 2002, West Basin was recognized by the National Water Research Institute as one of the six National Centers for Water Treatment Technologies in the country, and this past year the District celebrated the facilities 10-year anniversary of its continuous operation. To date, West Basin has saved more than 48 billion gallons of potable water that would have otherwise been imported from Northern California and the Colorado River.

Figure 8-2
West Basin Water Recycling System



As Figure 8-2 shows, West Basin's water recycling system serves the cities of Carson, El Segundo, Gardena, Hawthorne, Hermosa Beach, Inglewood, Manhattan Beach, Lawndale, Redondo Beach and unincorporated areas of Los Angeles County. The District also serves the Cities of Torrance and Los Angeles, which are both outside of the District's service area.

All recycled water is produced initially at the WBWRF where it is distributed to either end-use sites or one of several satellite facilities. In all, more than 200 sites currently use more than 8 billion gallons annually.

Victoria Golf Course, located in the City of Carson

The recycled water distribution infrastructure is separate from the drinking water system. All pipes, pumps and other equipment used to transport recycled water are clearly identified as recycled water to distinguish them from the potable drinking water system.

8.3.2 Recycled Water Use by Type

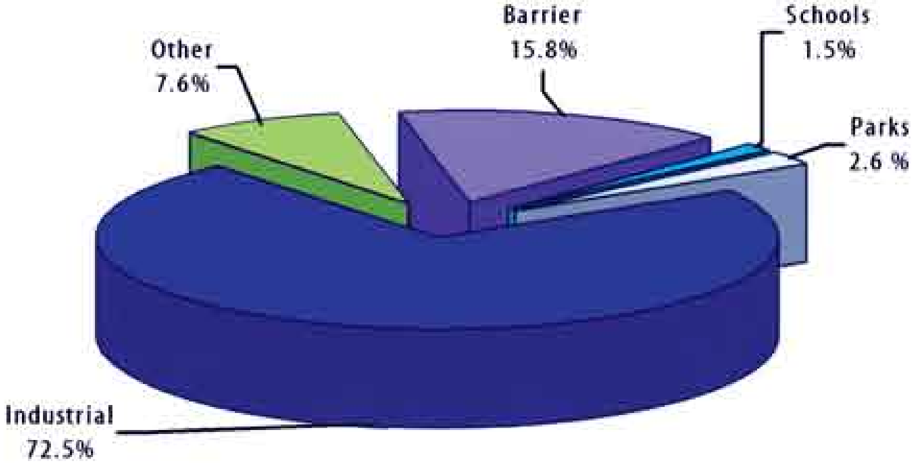
The type of customers West Basin currently delivers recycled water, as shown in Table 8-2, varies from parks and landscape medians to refineries and industries.

Table 8-2
Types of Recycled Water Customers

• Cemetery	• Multi-use
• Industries	• Parks/ Sports Fields
• Golf Courses	• Schools (irrigation)
• Replenishment (Barrier)	• Street Sweeping/ Sewer Flushing
• Landscape & Medians	• Refineries
• Cal-Trans (irrigation)	• Others

Figure 8-3 shows the distribution of West Basin's total FY 2004-05 sales by type of use. The predominate area of recycled water deliveries are to the refineries, making up roughly 72% of the total use. In the upcoming years with expanding the system, the District plans to increase deliveries in both the landscape irrigation and Barrier sector.

Figure 8-3
West Basin Recycled Water Use By Type of Site FY 2004-05

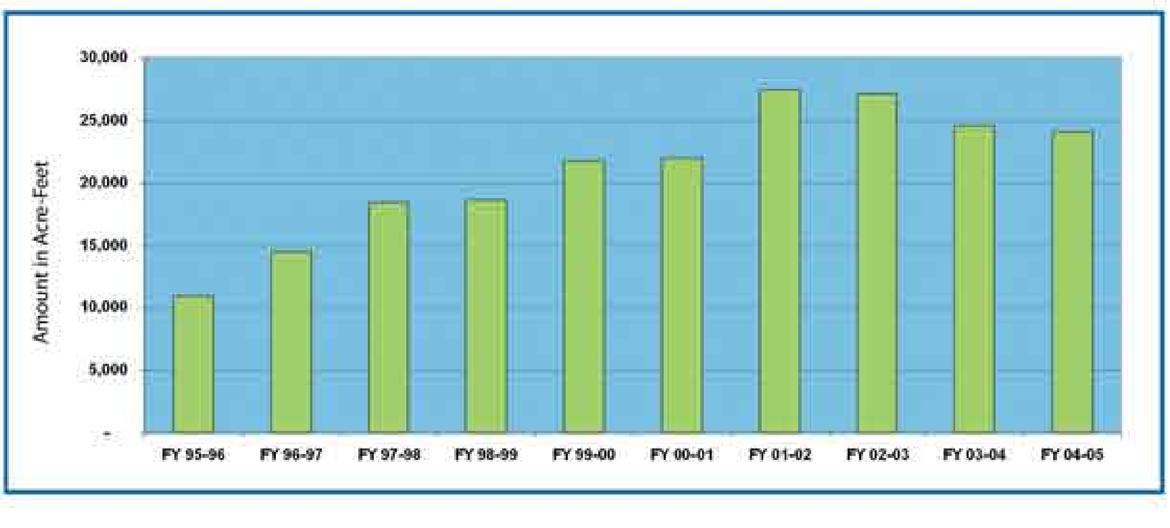


8.3.3 Historical and Current Sales

Historical Water Sales

West Basin's historical recycled water sales for the past 10 years are illustrated in Figure 8-4. Sales increased until 2002-03 and declined in subsequent years due to a change in the source water from Hyperion, which reduced the acceptability of recycled water for the West Coast Barrier Project. After identifying the source of the quality variance, West Basin designed and built a high rate clarifier treatment facility to restore the barrier water to even higher quality standards. The high rate clarifier will go online in early 2006 enabling West Basin to increase barrier use by 5,000 AFY beyond the original level.

Figure 8-4
Historical Recycled Water Sales From FY 1996-2005



The amount of recycled water the District has been able to delivery inside and outside of its service area during the last 10 years have total more than 209,000 AF, replacing enough potable water to supply the needs of approximately 418,000 families of four for an entire year. West Basin anticipates recycled water sales to increase in the future due to system expansions, new applications, increasing public acceptance and economic incentives.

Table 8-3 provides a more detailed breakdown of historical sales by showing each retail customer agency's annual purchases for the past 10 years.

Recycled water filters at West Basin's Water Recycling Facility

Table 8-3
West Basin Historical Recycled Water Sales
FY 1996-2005
(In Acre-Feet)

West Basin	FY 95-96	FY 96-97	FY 97-98	FY 98-99	FY 99-00	FY 00-01	FY 01-02	FY 02-03	FY 03-04	FY 04-05	TOTAL
CWS - Dominguez	-	-	-	4	1,317	3,297	3,165	3,101	3,639	3,616	18,139
CWS - Hawthorne	26	78	75	92	94	90	116	101	112	111	894
CWS - Hermosa Redondo	26	67	88	128	141	133	130	130	144	107	1,095
City of El Segundo	1,709	3,610	3,943	3,756	4,050	3,542	7,632	8,102	8,310	7,868	52,523
City of Inglewood	243	708	516	533	706	622	707	577	638	595	5,845
City of Manhattan Beach	181	197	177	197	230	272	307	254	301	274	2,389
Inglewood Unified School District	-	-	-	12	22	24	31	30	67	60	246
Southern California Water Co.	121	442	279	240	273	237	282	315	432	435	3,055
West Basin Inland Use	502	631	515	330	-	-	-	-	-	-	1,978
Industrial & Irrigation Subtotal	2,808	5,732	5,593	5,293	6,833	8,216	12,371	12,610	13,643	13,065	86,163
WRD (Replenishment-Barrier)	4,609	5,062	8,355	7,081	7,539	6,753	7,290	6,754	3,935	3,799	61,177
West Basin's Service Area Total	7,417	10,794	13,948	12,374	14,372	14,969	19,660	19,364	17,578	16,864	147,339
City of Torrance	-	-	-	-	22	91	117	144	196	186	757
City of Torrance - Mobil	3,466	3,653	4,334	6,157	7,030	6,558	7,212	7,328	6,385	6,735	58,858
LA Dept. of Water and Power	-	-	84	138	268	357	398	277	394	283	2,200
Outside West Basin's Service Area Total	3,466	3,653	4,418	6,295	7,321	7,006	7,727	7,750	6,975	7,205	61,815
TOTAL	10,883	14,447	18,366	18,669	21,693	21,975	27,387	27,114	24,553	24,069	209,154

As discussed above, West Basin's water recycling system services the Cities of Torrance and Los Angeles, which are located outside of the District's boundaries. Therefore, although the total usage within West Basin was 16,863 AF this past year, the total amount of recycled water delivered by West Basin was 24,068 AF.

Table 8-4
Recycled Water Uses 2000 Projections Compared with 2005 Actuals
AF/Fiscal Year

Type of Use	2000 Projection for 2005	2005 Actual Use
Irrigation/Industrial	33,000	20,268
West Coast/Dominguez Barrier	15,000	3,800
Total	**48,000**	**24,068**

In West Basin's 2000 UWMP, the District projected deliveries of recycled water within its service area to reach 33,000 by 2005. As shown in Table 8-4, actual sales in 2005 fell significantly below this target. This was mainly due to setbacks in expanding the water recycling program in the southern area of the District, which resulted in many large industrial customers not being able to connect. In addition, water quality problems at Hyperion impacted deliveries to the West Coast Barrier. However, with the recent plant expansion projected to be online, next year deliveries should place the District back on target.

8.3.4 System Expansions and Projected Sales

Harbor/South Bay Water Recycling Project

Recycled water used at California State University, Dominguez Hills

Currently, the Harbor/South Bay Water Recycling Project (Harbor/South Bay), a federally funded partnership project between West Basin and the U.S. Army Corps of Engineers, is under construction and consists of 16 component projects with 68 miles of combined pipelines. The first two laterals of the overall project, the Victoria Lateral and the California State University at Dominguez Hills (CSUDH) Mainline Extension, were successfully completed in April 2003.

Harbor/South Bay is scheduled for completion in 2010 and is expected to conserve more than 490 million gallons of potable water annually.

The $3 million Victoria Lateral Project added nearly 1.4 miles of pipeline throughout the City of Carson. The project delivers approximately 4 million gallons of recycled water daily for landscape irrigation and industrial application at local sites, which include medians along Avalon Boulevard, the Links at Victoria Golf Course and the Victoria Regional Park.

The $1.8 million California State University at Dominguez Hills (CSUDH) Mainline Extension consists of a recycled water transmission pipeline connecting to the end point of the Victoria Lateral and serving irrigation sites and cooling towers on the CSUDH campus. The pipeline also serves the newly-built Home Depot National Training Center, including the soccer stadium field.

In addition to the completion of the Victoria Lateral Project and CSUDH Mainline Extension, on-going 2005 activities of the Harbor/South Bay Project include: design and construction of the Madrona Lateral and a lateral to serve Los Angeles Southwest College and the pre-design of the Palos Verdes Extension and Lateral V. The customers served by the Palos Verdes Extension will include parks and schools in the City of Torrance along with several golf courses, parks, schools and a cemetery in the Palos Verdes Peninsula area. This project is detailed below.

West Basin Water Recycling Facility Phase IV Expansion

Undergoing its fourth expansion in 10 years, WBWRF will add an additional 5 mgd of barrier water treatment capacity by the end of 2005 and 10 mgd of Title 22 treatment capacity in 2006 to supply the Harbor/South Bay System expansion. The barrier water expansion will enable the blend of seawater barrier injection to increase to 75% recycled water (and 25% potable water) by upgrading the existing 7.5 mgd train with microfiltration pre-treatment, adding a new 5 mgd train of microfiltration and reverse osmosis, and introducing ultraviolet disinfection to the entire 12.5 mgd process. The higher blend of ultra-pure recycled water in the source water for barrier injection will not only improve the quality of the groundwater basin and conserve potable water but also lower water costs to WRD (the purchaser of the recycled water) and enhance ecosystem benefits.

Additional upgrades to the WBWRF will also be implemented, including removal of the lime clarification system, modifications to the solids de-watering system and the addition of clarifiers upstream of the Title 22 Filters.

Madrona / Palos Verdes Lateral Extension

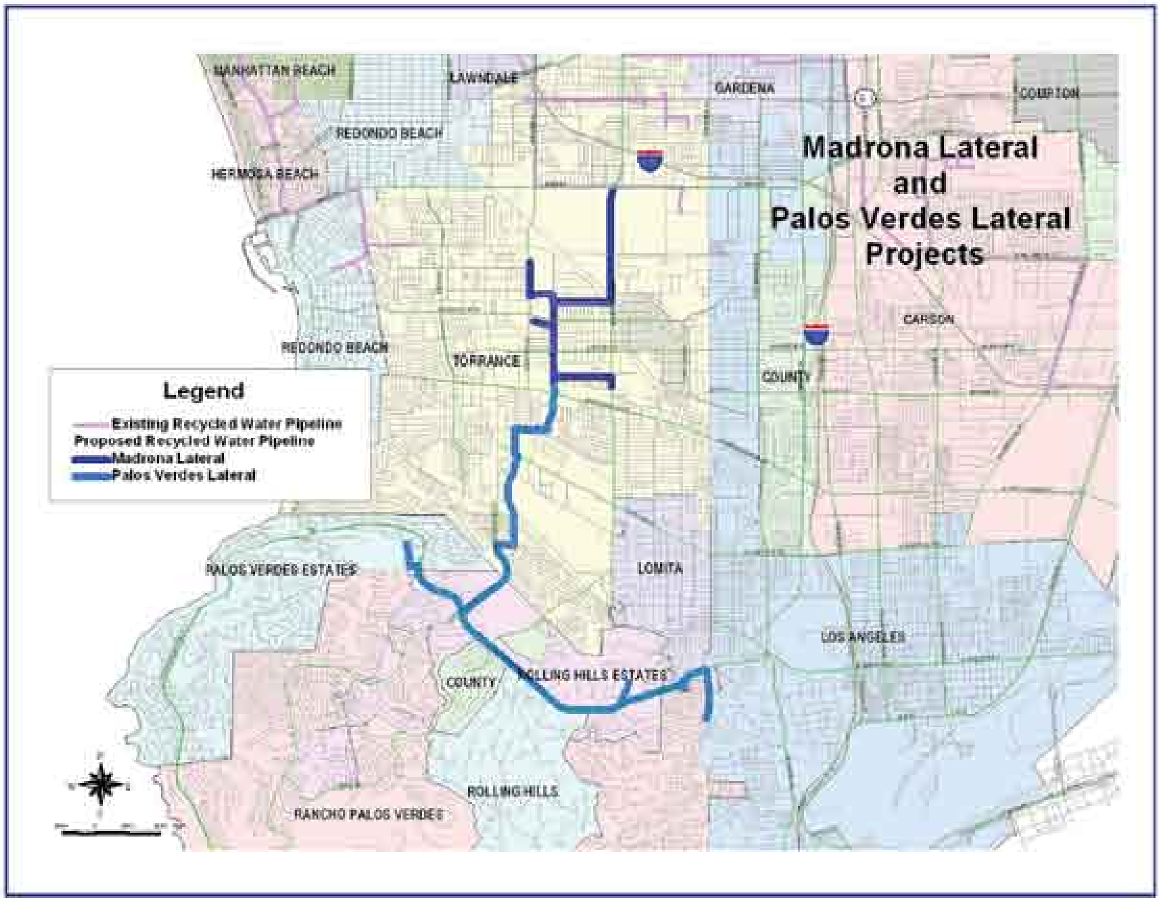
The Madrona Lateral will consist of 20,100 linear feet of pipeline, which will provide recycled water for non-potable use to several sites in the City of Torrance, including Charles Wilson Park and Madrona Middle School. This $9 million project is expected to be completed by late 2005. This lateral represents a stepping stone to the Palos Verdes Peninsula.

The Palos Verdes Lateral will serve several large irrigation customers along the north side of the Palos Verdes Peninsula such as Palos Verdes Golf Club, Rolling Hills Country Club, Los Angeles County Sanitation District landfill and Green Hills Memorial Park (cemetery). This 34,000 linear-foot pipeline is currently in its pre-design phase and is targeted to be completed in early 2007 at a cost of $17 million.

West Basin recently applied for State funding through Proposition 50 for the Madrona / Palos Verdes Lateral project. This construction project is an extension of West Basin's existing water recycling distribution system that will serve the City of Torrance and various cities throughout the Palos Verdes Peninsula. This project includes approximately 64,000 linear feet of pipeline that will ultimately serve up to 17 sites with more than 800 AFY of recycled water to public and private entities. Recycled water for this project will be provided by the WBWRF. Construction on the Madrona Lateral began in January 2005 while design for the Palos Verdes Lateral was underway. The Madrona Lateral is expected to be completed in April 2006 and operational soon thereafter. Construction of the Palos Verdes Lateral is expected to be complete by December 2006 and operational by June 2007.

West Basin will provide recycled water via the Palos Verdes Lateral to the Palos Verdes Peninsula to reduce demand on imported water. The ability for West Basin to produce and distribute this water locally means less impact on fragile ecosystems, less energy to pump water long distances and a drought-proof supply of water. As an added benefit, the cost to produce this water will be less than the cost of imported supplies. An extra 800 AFY of recycled water saves potable water for approximately 1,600 families of four every year and reduces the amount of wastewater that is discharged into the ocean. Figure 8-5 illustrates the Madrona and Palos Verdes Lateral projects in West Basin's service area.

Figure 8-5
Madrona and Palos Verdes Lateral Projects



Projected Sales

As discussed in Section 8.3.3., recycled water sales in fiscal year 2004-05 totaled 24,068 AF. The Phase IV Expansion of the WBWRF and the Harbor/South Bay System Expansion are expected to enable West Basin to add a minimum of 40,000 AF of sales by 2030. One key to further expanding the system, and increasing sales, is West Basin's partnership with the City of Los Angeles. Additional oil refineries within the harbor area of Los Angeles, but proximal to West Basin's existing system, represent a large untapped potential for high-quality recycled water sales. A proven track record with West Basin's existing refinery customers is expected to convince others that recycled water can increase reliability and reduce costs in water management. Roughly 37,500 AFY of projected recycled water sales through 2030 are attributable to the refinery/industrial sector. Table 8-5 illustrates the projected increase of recycled water during the next 25 years.

Table 8-5
Projected Recycled Water & Deliveries by West Basin
(In Acre-Feet)

	2010	2015	2020	2025	2030
Industrial & Irrigation	21,848	32,500	36,250	40,000	43,750
West Coast Barrier (Replenishment)	17,500	17,500	17,500	17,500	17,500
West Basin's Service Area Total	**39,348**	**50,000**	**53,750**	**57,500**	**61,250**
City Torrance	6,650	6,650	6,650	6,650	6,650
City of Los Angeles	1,400	1,400	1,400	1,400	1,400
Outside West Basin's Service Area Total	**8,050**	**8,050**	**8,050**	**8,050**	**8,050**
Total	**47,398**	**58,050**	**61,800**	**65,550**	**69,300**

8.3.5 Potential Recycled Water Use

West Basin is currently acting to fulfill the potential identified in its 2000 Master Plan as well as other opportunities that have emerged since that Plan was completed. Although limited to an extent by economic feasibility of reaching end users that are not near existing infrastructure, the potential for increased use of recycled water continues to grow with greater acceptance of its use in different applications. Fabric and carpet dying, for example, are areas that represent a significant opportunity for increased sales for West Basin.

West Basin will continue to pursue new cost-effective projects both within and outside its service area. Although there are challenges and limitations in connecting customers, such as in the Palos Verdes peninsula, there is great potential. The limitations in connecting customers due to their challenges dictate when and how much recycled water will be sold in the future.

The 2000 Master Plan identified and prioritized areas where recycled water has the potential to expand. In this Plan, a database was established to locate and identify future customers. The approach considered pipeline routing, hydraulic analysis and economic interests to project the growth of the system. Much of these findings evolved in the system expansion projects discussed in section 8.3.4.

8.3.6 Encouraging Recycled Water Use

West Basin's marketing efforts have been successful in changing the perception of recycled water from merely a conservation tool with minimal application to a business enhancement tool that lowers operating costs while increasing the reliability of the water supply. West Basin markets recycled water as a resource that:

- Is less expensive than potable water;
- Is more reliable than imported water in a drought and
- Is consistent with statewide goals for water supply and ecosystem improvement on both the SWP and Colorado River systems.

The target customer is expanding from traditional irrigation users such as golf courses and parks to unconventional commercial and industrial users. Through innovative marketing, recycled water is now being used by oil refineries and for cooling towers. In addition, West Basin investigating recycled water use in fabric dye houses, co-generating plants and commercial laundries.

In addition to West Basin wholesaling recycled water at a rate lower than potable water, West Basin provides other financial incentives as well to encourage recycled water use. Some potential recycled water customers do not have the financial capability to pay for onsite plumbing retrofits necessary to accept recycled water. Therefore, West Basin advances funds for retrofit expenses, which can be reimbursed through the water bills. The onsite plumbing retrofit costs are amortized over a period of time up to 10 years at West Basin's cost of funds. Repayment is made using the differential between potable and recycled water rates so that the customer never pays more than the potable rate. Once the loan is repaid, the rate reverts to the current recycled rate.

Optimizing Recycled Water Use

West Basin's plan for optimizing the use of recycled water is carried out through its Recycled Water Master Plan (Master Plan) and its Recycled Water Marketing Plan (Marketing Plan). The Master Plan is West Basin's guiding document for identifying and prioritizing potential customers in all existing and emerging types of recycled water use.

The Marketing Plan is the companion effort to the Master Plan and revisits the strategies and tools employed by West Basin's staff and consultants in generating interest in recycled water with potential customers and the cities in which they do business. The thrust of the Marketing Plan is to emphasize the benefit of recycled water as a "tool for profitability" for businesses and not just the right thing to do in terms of water conservation and the environment. The Marketing Plan will be updated in FY 2005-2006.

Coordination Efforts

Table 8-6 illustrates the District's coordinated effort among key stakeholders as well as their role in the development of West Basin's 2000 Recycled Water Master Plan.

Table 8-6
Recycled Water Master Plan Coordination

Participating Agencies	Role in Plan Development
1. Water Agencies (Purveyors)	Customer Development, Facilities, Impacts, Rates
2. Wastewater Agencies	Recycled Water Supply, Water Quality, Reliability
3. Groundwater Agencies	Rates,Customer Involvement
4. Planning Agencies	Economic Analysis, Rates, Data Assessment, Customer Assessment, Rates, Community Impacts, Customer Involvement, Conceptual Pipeline Routes, Cost Estimates

1. Water Purveyor Agencies: See Table 8-3.
2. Wastewater Agencies: Hyperion Wastewater Treatment Facility and West Basin Water Recycling Facility
3. Groundwater Agencies: Water Replenishment District of Southern California
4. Planning Agencies: Purveyors and Cities within West Basin's service area

8.3.7 Funding

Capital costs for projects planned for the future have been budgeted to average per fiscal year approximately $8.1 million. These costs will be covered by the sources identified here and other sources as they become available:

- ***MWD Local Resources Program Incentive.*** To qualify, proposed water recycling projects by member agencies must cost more than projected MWD treated non-interruptible water rates and reduce potable water needs. Since founding MWD with other municipal water utilities in 1928, West Basin has remained affiliated as a member agency and is therefore considered for the rebates for up to $250/AF of produced water offered under the program.

- ***Grant Funding.*** West Basin continuously applies for Federal and State grant funding for water recycling projects, as it becomes available. For example, in 2005, West Basin applied for a Water Recycling Construction grant for the Madrona/Palos Verdes Lateral project through Proposition 50. West Basin submitted an application to the State to fund 25% of the $27.5 million cost of the pipeline. An additional source of funding for water recycling projects is through the U.S Army Corps of Engineers Program, which affords qualified conservation programs 75% project funding.

Section 9

Desalination

Section 9 Desalination

Desalination

9.1 Overview

West Basin's expertise in recycled water treatment includes substantial experience in the removal of salt from recycled water supplies. West Basin currently performs extensive research and development, affording them the opportunity to refine their water production and treatment methods as well as educating the public. Desalination of ocean water is the next natural step in the development of a new water source for West Basin's service area.

Ocean water desalination is typically thought to be too expensive for large-scale use. However, due to recent advances in technology, desalination now costs less than half of what it did 10 years ago, making it an attractive and financially viable option. The cost has dropped because newer membranes last longer and are more energy efficient, thus lowering capital and operational costs.

9.2 Desalting Process and Quality of Ocean Water Desalination

A number of issues are considered when evaluating alternative water supply options. Of primary consideration is a project's ability to provide a safe, reliable and cost-effective drinking water supply. Providing a safe drinking water supply to West Basin customers is a task of paramount importance to West Basin. All prudent actions are taken to ensure that water delivered throughout the service area meets or exceeds drinking water standards set by the State's primary water quality regulatory agency, the CDHS. West Basin has performed extensive water quality research at its ocean desalination pilot facility. Test results indicate that the District's treatment approach of utilizing microfiltration pretreatment and reverse osmosis treatment provides a reliable water quality that meets all State and Federal drinking water standards.

The desalting process involves removing salt, minerals and impurities from the ocean water with the latest technologies -- microfiltration and reverse osmosis. The ocean water first passes through microfiltration, which consists of thousands of strands with pores that are 5,000 times smaller than a pinhole. The water then continues on to undergo high pressure reverse osmosis. Reverse osmosis, a common method used to produce bottled water, is a pressure driven process whereby water passes through a thin film membrane that filters out impurities. The water produced at the pilot project consists of approximately 350 parts per million (ppm) of salt, lower than typical tap water in Southern California. West Basin will use the data acquired from the pilot project in the planning and development of a 0.5 MGD demonstration plant.

9.3 West Basin's Ocean Water Desalination Pilot Project

West Basin's ocean water desalination pilot project is located at the El Segundo Power Plant and marks the first use of microfiltration pretreatment and reverse osmosis for ocean water desalination. The pilot project desalts approximately 40 gallons per minute (gpm) of raw ocean water. The goal of the project is two-fold: 1) identify optimal performance conditions and 2) evaluate the water quality. The research findings are being shared among industry partners to determine the viability and suitability of producing potable desalinated ocean water.

El Segundo Power Plant

West Basin's ocean water desalination pilot project was designed to be a regional and national asset and it is an open, collaborative effort that will benefit the entire water industry. To fund the $1.5 million combined cost of the pilot project, West Basin has partnered with major agencies in the water industry, including the American Water Works Association Research Foundation, California Avocado Commission, City of Tampa Bay, Department of Water Resources, East Bay Municipal Utility District, Long Beach Water Department, Los Angeles Department of Water and Power, Metropolitan Water District, National Water Research Institute, San Diego County Water Authority South Florida Water Management District, and United States Bureau of Reclamation.

Since it first began operation, West Basin has strived to identify the optimal operational and water quality parameters utilizing a power plant's pre-condenser cooling water as the pilot plant's feed water source to allow reliable and cost efficient ocean desalination treatment. The District recognizes the environmental benefits and capital cost savings of utilizing an existing open ocean water intake substructure and outfall by co-locating the pilot project at an existing power plant site. Following in the footsteps of West Basin's vast desalting experience using advanced membrane treatment, the ocean water desalination pilot project utilizes microfiltration pretreatment and reverse osmosis treatment as the primary treatment processes. These processes have demonstrated tremendous water quality and operational performance since the commissioning of the project. Figure 9-1 illustrates the microfiltration and reverse osmosis membranes used in the pilot demonstration project.

Figure 9-1
MF-RO Research Pilot Unit

West Basin will continue to conduct piloting research to focus on meeting current and future regulatory and water quality standards utilizing post condenser water at the hosting power plant site. This research information will be used to formulate a comparative index to the cold water research to determine the most efficient and environmentally safe approach in the development of a demonstration and full scale ocean desalination treatment facility.

9.4 Future Ocean Water Desalination Projects

West Basin's next logical step in moving forward with a full scale ocean desalination treatment facility is to develop and construct a 500,000 gpd demonstration project. This demonstration project is necessary to evaluate the water quality performance and treatment stability, assess efficient energy recovery devices, optimize operational performance utilizing full scale process equipment and acquire the necessary data to achieve regulatory compliance and approval. West Basin's ocean water desalination demonstration project will be located within West Basin's service area and in close proximity to the Pacific Ocean. West Basin and its partners will perform the full battery of water quality analyses to ensure that the demonstration project meets all Federal and State Drinking Water Standards.

Additionally, West Basin will construct a research and education center to educate the public on how ocean water desalination is performed and the safe environmental benefits of developing such a precious and reliable water supply resource. In 2005, West Basin was awarded $1,750,000 in State grants administered under the Proposition 50 funds to assist in the research and construction of the District's ocean water desalination demonstration project. Table 9-1 lays out the opportunities for West Basin to desalinate ocean water.

Table 9-1
Opportunities for Desalinated Water

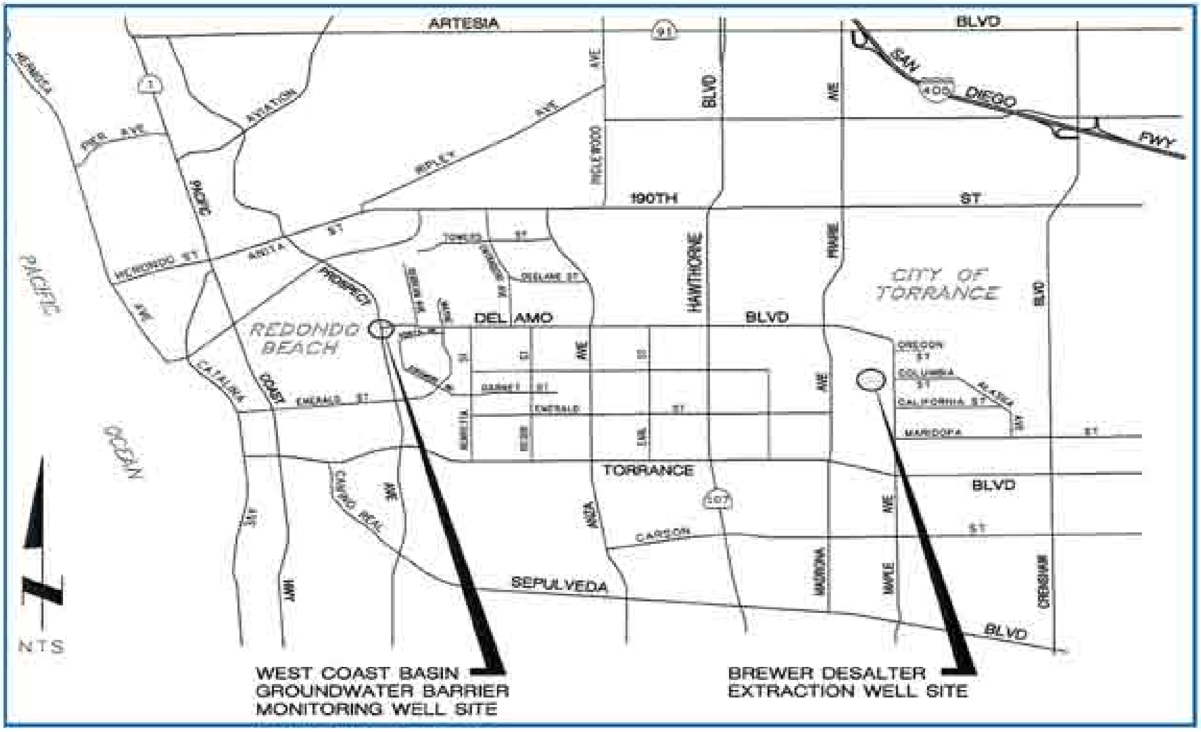
Sources of Water	Yield AFY	Start Date	Type of Use
Ocean Water	20,000	June 2011	Potable

With the knowledge gained by operating the demonstration project, West Basin expects to eventually move forward with the planning, design and construction of a full scale 20,000 AFY ocean water desalination and education facility. West Basin is currently addressing the development of the demonstration project with the Regional Water Quality Control Board and the California Coastal Commission. West Basin anticipates operating the demonstration plant for at least two years while plans are being completed and finalized for the development of a 20,000 AFY full-scale desalination treatment plant. The ultimate goal is to construct a full-scale plant that will diversify the regional water supply and ensure a safe, reliable water source for today and the future.

9.5 Brewer Desalter Treatment Facility

The Brewer Desalter Treatment Facility, located adjacent to the City of Torrance bus maintenance and storage yard, removes chloride from groundwater impacted by seawater intrusion in the WCGB. The brackish groundwater resulted from seawater intrusion prior to construction of the West Coast Basin Groundwater Barrier. The vicinity map provided in Figure 9-2 shows the location of the Brewer Desalter site.

Figure 9-2
Brewer Desalter Location Map



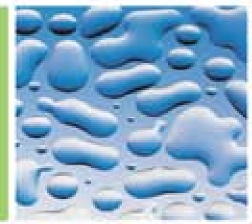
The Brewer Desalter facility treats brackish groundwater produced by an on-site well. The brackish groundwater passes through cartridge filters and finally reverse osmosis. California Water Service Company (CalWater) stores the treated water on-site in a 5-million gallon storage reservoir and ultimately delivers it to consumers for CalWater's distribution system. The Brewer Desalter facility is currently out of service until a new extraction well can be constructed. A new extraction well, located north of the reverse osmosis facility, is expected to be online in early 2006.

Figure 9-3
Brewer Desalter Facility Equipment

Brewer Extraction Well Site, looking west from atop the 5 MG reservoir

Chemical addition tanks located inside the RO building

Brewer Desalter RO treatment onsite



Appendices

Appendix A UWMP Act

Appendix B 2005 UWMP Checklist Form

Appendix C Notice of Public Hearing and Resolution for UWMP Adoption

Appendix D Notice of Preparation

Appendix E Water Shortage Contingency Plan Draft Resolution

Appendix F Best Management Practices Report

Appendix A

Established: AB 797, Klehs, 1983
Amended: AB 2661, Klehs, 1990
AB 11X, Filante, 1991
AB 1869, Speier, 1991
AB 892, Frazee, 1993
SB 1017, McCorquodale, 1994
AB 2853, Cortese, 1994
AB 1845, Cortese, 1995
SB 1011, Polanco, 1995
AB 2552, Bates, 2000
SB 553, Kelley, 2000
SB 610, Costa, 2001
AB 901, Daucher, 2001
SB 672, Machado, 2001
SB 1348, Brulte, 2002
SB 1384, Costa, 2002
SB 1518, Torlakson, 2002
AB 105, Wiggins, 2004
SB 318, Alpert, 2004

CALIFORNIA WATER CODE DIVISION 6
PART 2.6. URBAN WATER MANAGEMENT PLANNING

CHAPTER 1. GENERAL DECLARATION AND POLICY

10610. This part shall be known and may be cited as the "Urban Water Management Planning Act."

10610.2. (a) The Legislature finds and declares all of the following:

(1) The waters of the state are a limited and renewable resource subject to ever-increasing demands.

(2) The conservation and efficient use of urban water supplies are of statewide concern; however, the planning for that use and the implementation of those plans can best be accomplished at the local level.

(3) A long-term, reliable supply of water is essential to protect the productivity of California's businesses and economic climate.

(4) As part of its long-range planning activities, every urban water supplier should make every effort to ensure the appropriate level of reliability in

its water service sufficient to meet the needs of its various categories of customers during normal, dry, and multiple dry water years.

(5) Public health issues have been raised over a number of contaminants that have been identified in certain local and imported water supplies.

(6) Implementing effective water management strategies, including groundwater storage projects and recycled water projects, may require specific water quality and salinity targets for meeting groundwater basins water quality objectives and promoting beneficial use of recycled water.

(7) Water quality regulations are becoming an increasingly important factor in water agencies' selection of raw water sources, treatment alternatives, and modifications to existing treatment facilities.

(8) Changes in drinking water quality standards may also impact the usefulness of water supplies and may ultimately impact supply reliability.

(9) The quality of source supplies can have a significant impact on water management strategies and supply reliability.

(b) This part is intended to provide assistance to water agencies in carrying out their long-term resource planning responsibilities to ensure adequate water supplies to meet existing and future demands for water.

10610.4. The Legislature finds and declares that it is the policy of the state as follows:

(a) The management of urban water demands and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.

(b) The management of urban water demands and efficient use of urban water supplies shall be a guiding criterion in public decisions.

(c) Urban water suppliers shall be required to develop water management plans to actively pursue the efficient use of available supplies.

CHAPTER 2. DEFINITIONS

10611. Unless the context otherwise requires, the definitions of this chapter govern the construction of this part.

10611.5. "Demand management" means those water conservation measures, programs, and incentives that prevent the waste of water and promote the reasonable and efficient use and reuse of available supplies.

10612. "Customer" means a purchaser of water from a water supplier who uses the water for municipal purposes, including residential, commercial, governmental, and industrial uses.

10613. "Efficient use" means those management measures that result in the most effective use of water so as to prevent its waste or unreasonable use or unreasonable method of use.

10614. "Person" means any individual, firm, association, organization, partnership, business, trust, corporation, company, public agency, or any agency of such an entity.

10615. "Plan" means an urban water management plan prepared pursuant to this part. A plan shall describe and evaluate sources of supply, reasonable and practical efficient uses, reclamation and demand management activities. The components of the plan may vary according to an individual community or area's characteristics and its capabilities to efficiently use and conserve water. The plan shall address measures for residential, commercial, governmental, and industrial water demand management as set forth in Article 2 (commencing with Section 10630) of Chapter 3. In addition, a strategy and time schedule for implementation shall be included in the plan.

10616. "Public agency" means any board, commission, county, city and county, city, regional agency, district, or other public entity.

10616.5. "Recycled water" means the reclamation and reuse of wastewater for beneficial use.

10617. "Urban water supplier" means a supplier, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually. An urban water supplier includes a supplier or contractor for water, regardless of the basis of right, which distributes or sells for ultimate resale to customers. This part applies only to water supplied from public water systems subject to Chapter 4 (commencing with Section 116275) of Part 12 of Division 104 of the Health and Safety Code.

CHAPTER 3. URBAN WATER MANAGEMENT PLANS
Article 1. General Provisions

10620.

(a) Every urban water supplier shall prepare and adopt an urban water management plan in the manner set forth in Article 3 (commencing with Section 10640).

(b) Every person that becomes an urban water supplier shall adopt an urban water management plan within one year after it has become an urban water supplier.

(c) An urban water supplier indirectly providing water shall not include planning elements in its water management plan as provided in Article 2 (commencing with Section 10630) that would be applicable to urban water suppliers or public agencies directly providing water, or to their customers, without the consent of those suppliers or public agencies.

(d)

(1) An urban water supplier may satisfy the requirements of this part by participation in areawide, regional, watershed, or basinwide urban water management planning where those plans will reduce preparation costs and contribute to the achievement of conservation and efficient water use.

(2) Each urban water supplier shall coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable.

(e) The urban water supplier may prepare the plan with its own staff, by contract, or in cooperation with other governmental agencies.

(f) An urban water supplier shall describe in the plan water management tools and options used by that entity that will maximize resources and minimize the need to import water from other regions.

10621.

(a) Each urban water supplier shall update its plan at least once every five years on or before December 31, in years ending in five and zero.

(b) Every urban water supplier required to prepare a plan pursuant to this part shall notify any city or county within which the supplier provides water supplies that the urban water supplier will be reviewing the plan and considering amendments or changes to the plan. The urban water supplier may consult with, and obtain comments from, any city or county that receives notice pursuant to this subdivision.

(c) The amendments to, or changes in, the plan shall be adopted and filed in the manner set forth in Article 3 (commencing with Section 10640).

Article 2. Contents of Plans

10630. It is the intention of the Legislature, in enacting this part, to permit levels of water management planning commensurate with the numbers of customers served and the volume of water supplied.

10631. A plan shall be adopted in accordance with this chapter and shall do all of the following:

(a) Describe the service area of the supplier, including current and projected population, climate, and other demographic factors affecting the supplier's water management planning. The projected population estimates shall be based upon data from the state, regional, or local service agency population projections within the service area of the urban water supplier and shall be in five-year increments to 20 years or as far as data is available.

(b) Identify and quantify, to the extent practicable, the existing and planned sources of water available to the supplier over the same five-year increments described in subdivision (a). If groundwater is identified as an existing or planned source of water available to the supplier, all of the following information shall be included in the plan:

(1) A copy of any groundwater management plan adopted by the urban water supplier, including plans adopted pursuant to Part 2.75 (commencing with Section 10750), or any other specific authorization for groundwater management.

(2) A description of any groundwater basin or basins from which the urban water supplier pumps groundwater. For those basins for which a court or the board has adjudicated the rights to pump groundwater, a copy of the order or decree adopted by the court or the board and a description of the amount of groundwater the urban water supplier has the legal right to pump under the order or decree.

For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.

(3) A detailed description and analysis of the location, amount, and sufficiency of groundwater pumped by the urban water supplier for the past five years. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

(4) A detailed description and analysis of the amount and location of groundwater that is projected to be pumped by the urban water supplier. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

(c) Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage, to the extent practicable, and provide data for each of the following:

(1) An average water year.
(2) A single dry water year.
(3) Multiple dry water years.

For any water source that may not be available at a consistent level of use, given specific legal, environmental, water quality, or climatic factors, describe plans to supplement or replace that source with alternative sources or water demand management measures, to the extent practicable.

(d) Describe the opportunities for exchanges or transfers of water on a short-term or long-term basis.

(e)

(1) Quantify, to the extent records are available, past and current water use, over the same five-year increments described in subdivision (a), and projected water use, identifying the uses among water use sectors including, but not necessarily limited to, all of the following uses:

(A) Single-family residential.
(B) Multifamily.
(C) Commercial.
(D) Industrial.
(E) Institutional and governmental.
(F) Landscape.
(G) Sales to other agencies.
(H) Saline water intrusion barriers, groundwater recharge, or conjunctive use, or any combination thereof.
(I) Agricultural.

(2) The water use projections shall be in the same five-year increments described in subdivision (a).

(f) Provide a description of the supplier's water demand management measures. This description shall include all of the following:

(1) A description of each water demand management measure that is currently being implemented, or scheduled for implementation, including the steps necessary to implement any proposed measures, including, but not limited to, all of the following:

(A) Water survey programs for single-family residential and multifamily residential customers.

(B) Residential plumbing retrofit.

(C) System water audits, leak detection, and repair.

(D) Metering with commodity rates for all new connections and retrofit of existing connections.

(E) Large landscape conservation programs and incentives.

(F) High-efficiency washing machine rebate programs.

(G) Public information programs.

(H) School education programs.

(I) Conservation programs for commercial, industrial, and institutional accounts.

(J) Wholesale agency programs.

(K) Conservation pricing.

(L) Water conservation coordinator.

(M) Water waste prohibition.

(N) Residential ultra-low-flush toilet replacement programs.

(2) A schedule of implementation for all water demand management measures proposed or described in the plan.

(3) A description of the methods, if any, that the supplier will use to evaluate the effectiveness of water demand management measures implemented or described under the plan.

(4) An estimate, if available, of existing conservation savings on water use within the supplier's service area, and the effect of the savings on the supplier's ability to further reduce demand.

(g) An evaluation of each water demand management measure listed in paragraph (1) of subdivision (f) that is not currently being implemented or scheduled for implementation. In the course of the evaluation, first consideration shall be given to water demand management measures, or combination of measures, that offer lower incremental costs than expanded or additional water supplies. This evaluation shall do all of the following:

(1) Take into account economic and noneconomic factors, including environmental, social, health, customer impact, and technological factors.

(2) Include a cost-benefit analysis, identifying total benefits and total costs.

(3) Include a description of funding available to implement any planned water supply project that would provide water at a higher unit cost.

(4) Include a description of the water supplier's legal authority to implement the measure and efforts to work with other relevant agencies to ensure the implementation of the measure and to share the cost of implementation.

(h) Include a description of all water supply projects and water supply programs that may be undertaken by the urban water supplier to meet the total projected water use as established pursuant to subdivision (a) of Section 10635. The urban water supplier shall include a detailed description of expected future projects and programs, other than the demand management programs identified pursuant to paragraph (1) of subdivision (f), that the urban water supplier may implement to increase the amount of the water supply available to the urban water supplier in average, single-dry, and multiple-dry water years. The description shall identify specific projects and include a description of the increase in water supply that is expected to be available from each project. The description shall include an estimate with regard to the implementation timeline for each project or program.

(i) Describe the opportunities for development of desalinated water, including, but not limited to, ocean water, brackish water, and groundwater, as a long-term supply.

(j) Urban water suppliers that are members of the California Urban Water Conservation Council and submit annual reports to that council in accordance with the "Memorandum of Understanding Regarding Urban Water Conservation in California," dated September 1991, may submit the annual reports identifying water demand management measures currently being implemented, or scheduled for implementation, to satisfy the requirements of subdivisions (f) and (g).

(k) Urban water suppliers that rely upon a wholesale agency for a source of water, shall provide the wholesale agency with water use projections from that agency for that source of water in five-year increments to 20 years or as far as data is available. The wholesale agency shall provide information to the urban water supplier for inclusion in the urban water supplier's plan that identifies and quantifies, to the extent practicable, the existing and planned sources of water as required by subdivision (b), available from the wholesale agency to the urban water supplier over the same five-year increments, and during various water-year types in accordance with subdivision (c). An urban water supplier may rely upon water supply information provided by the wholesale agency in fulfilling the plan informational requirements of subdivisions (b) and (c), including, but not limited to, ocean water, brackish water, and groundwater, as a long-term supply.

10631.5. The department shall take into consideration whether the urban water supplier is implementing or scheduled for implementation, the water demand management activities that the urban water supplier identified in its urban water management plan, pursuant to Section 10631, in evaluating applications for grants and loans made available pursuant to Section 79163. The urban water supplier may submit to the department copies of its annual reports and other relevant documents to assist the department in determining whether the urban water supplier is implementing or scheduling the implementation of water demand management activities.

10632. The plan shall provide an urban water shortage contingency analysis which includes each of the following elements which are within the authority of the urban water supplier:

(a) Stages of action to be undertaken by the urban water supplier in response to water supply shortages, including up to a 50 percent reduction in water supply, and an outline of specific water supply conditions which are applicable to each stage.

(b) An estimate of the minimum water supply available during each of the next three water years based on the driest three-year historic sequence for the agency's water supply.

(c) Actions to be undertaken by the urban water supplier to prepare for, and implement during, a catastrophic interruption of water supplies including, but not limited to, a regional power outage, an earthquake, or other disaster.

(d) Additional, mandatory prohibitions against specific water use practices during water shortages, including, but not limited to, prohibiting the use of potable water for street cleaning.

(e) Consumption reduction methods in the most restrictive stages. Each urban water supplier may use any type of consumption reduction methods in its water shortage contingency analysis that would reduce water use, are appropriate for its area, and have the ability to achieve a water use reduction consistent with up to a 50 percent reduction in water supply.

(f) Penalties or charges for excessive use, where applicable.

(g) An analysis of the impacts of each of the actions and conditions described in subdivisions (a) to (f), inclusive, on the revenues and expenditures of the urban water supplier, and proposed measures to overcome those impacts, such as the development of reserves and rate adjustments.

(h) A draft water shortage contingency resolution or ordinance.

(i) A mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency analysis.

10633. The plan shall provide, to the extent available, information on recycled water and its potential for use as a water source in the service area of the urban water supplier. The preparation of the plan shall be coordinated with local water, wastewater, groundwater, and planning agencies that operate within the supplier's service area, and shall include all of the following:

(a) A description of the wastewater collection and treatment systems in the supplier's service area, including a quantification of the amount of wastewater collected and treated and the methods of wastewater disposal.

(b) A description of the quantity of treated wastewater that meets recycled water standards, is being discharged, and is otherwise available for use in a recycled water project.

(c) A description of the recycled water currently being used in the supplier's service area, including, but not limited to, the type, place, and quantity of use.

(d) A description and quantification of the potential uses of recycled water, including, but not limited to, agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, and other appropriate uses, and a determination with regard to the technical and economic feasibility of serving those uses.

(e) The projected use of recycled water within the supplier's service area at the end of 5, 10, 15, and 20 years, and a description of the actual use of recycled water in comparison to uses previously projected pursuant to this subdivision.

(f) A description of actions, including financial incentives, which may be taken to encourage the use of recycled water, and the projected results of these actions in terms of acre-feet of recycled water used per year.

(g) A plan for optimizing the use of recycled water in the supplier's service area, including actions to facilitate the installation of dual distribution systems, to promote recirculating uses, to facilitate the increased use of treated wastewater that meets recycled water standards, and to overcome any obstacles to achieving that increased use.

10634. The plan shall include information, to the extent practicable, relating to the quality of existing sources of water available to the supplier over the same five-year increments as described in subdivision (a) of Section 10631, and the manner in which water quality affects water management strategies and supply reliability.

Article 2.5 Water Service Reliability

10635.

(a) Every urban water supplier shall include, as part of its urban water management plan, an assessment of the reliability of its water service to its customers during normal, dry, and multiple dry water years. This water supply and demand assessment shall compare the total water supply sources available to the water supplier with the total projected water use over the next 20 years, in five-year increments, for a normal water year, a single dry water year, and multiple dry water years. The water service reliability assessment shall be based upon the information compiled pursuant to Section 10631, including available data from state, regional, or local agency population projections within the service area of the urban water supplier.

(b) The urban water supplier shall provide that portion of its urban water management plan prepared pursuant to this article to any city or county within which it provides water supplies no later than 60 days after the submission of its urban water management plan.

(c) Nothing in this article is intended to create a right or entitlement to water service or any specific level of water service.

(d) Nothing in this article is intended to change existing law concerning an urban water supplier's obligation to provide water service to its existing customers or to any potential future customers.

Articl 3. Adoption and Implementation of Plans

10640. Every urban water supplier required to prepare a plan pursuant to this part shall prepare its plan pursuant to Article 2 (commencing with Section 10630).

The supplier shall likewise periodically review the plan as required by Section 10621, and any amendments or changes required as a result of that review shall be adopted pursuant to this article.

10641. An urban water supplier required to prepare a plan may consult with, and obtain comments from, any public agency or state agency or any person who has special expertise with respect to water demand management methods and techniques.

10642. Each urban water supplier shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan. Prior to adopting a plan, the urban water supplier shall make the plan available for public inspection and shall hold a public hearing thereon. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned water supplier pursuant to Section 6066 of the Government Code. The urban water supplier shall provide notice of the time and place of hearing to any city or county within which the supplier provides water supplies. A privately owned water supplier shall provide an equivalent notice within its service area. After the hearing, the plan shall be adopted as prepared or as modified after the hearing.

10643. An urban water supplier shall implement its plan adopted pursuant to this chapter in accordance with the schedule set forth in its plan.

10644.

(a) An urban water supplier shall file with the department and any city or county within which the supplier provides water supplies a copy of its plan no later than 30 days after adoption. Copies of amendments or changes to the plans shall be filed with the department and any city or county within which the supplier provides water supplies within 30 days after adoption.

(b) The department shall prepare and submit to the Legislature, on or before December 31, in the years ending in six and one, a report summarizing the status of the plans adopted pursuant to this part. The report prepared by the department shall identify the outstanding elements of the individual plans. The department shall provide a copy of the report to each urban water supplier that has filed its plan with the department. The department shall also prepare reports and provide data for any legislative hearings designed to consider the effectiveness of plans submitted pursuant to this part.

10645. Not later than 30 days after filing a copy of its plan with the department, the urban water supplier and the department shall make the plan available for public review during normal business hours.

CHAPTER 4. MISCELLANEOUS PROVISIONS

10650. Any actions or proceedings to attack, review, set aside, void, or annul the acts or decisions of an urban water supplier on the grounds of noncompliance with this part shall be commenced as follows:

(a) An action or proceeding alleging failure to adopt a plan shall be commenced within 18 months after that adoption is required by this part.

(b) Any action or proceeding alleging that a plan, or action taken pursuant to the plan, does not comply with this part shall be commenced within 90 days after filing of the plan or amendment thereto pursuant to Section 10644 or the taking of that action.

10651. In any action or proceeding to attack, review, set aside, void, or annul a plan, or an action taken pursuant to the plan by an urban water supplier on the grounds of noncompliance with this part, the inquiry shall extend only to whether there was a prejudicial abuse of discretion. Abuse of discretion is established if the supplier has not proceeded in a manner required by law or if the action by the water supplier is not supported by substantial evidence.

10652. The California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) does not apply to the preparation and adoption of plans pursuant to this part or to the implementation of actions taken pursuant to Section 10632. Nothing in this part shall be interpreted as exempting from the California Environmental Quality Act any project that would significantly affect water supplies for fish and wildlife, or any project for implementation of the plan, other than projects implementing Section 10632, or any project for expanded or additional water supplies.

10653. The adoption of a plan shall satisfy any requirements of state law, regulation, or order, including those of the State Water Resources Control Board and the Public Utilities Commission, for the preparation of water management plans or conservation plans; provided, that if the State Water Resources Control Board or the Public Utilities Commission requires additional information concerning water conservation to implement its existing authority, nothing in this part shall be deemed to limit the board or the commission in obtaining that information. The requirements of this part shall be satisfied by any urban water demand management plan prepared to meet federal laws or regulations after the effective date of this part, and which substantially meets the requirements of this part, or by any existing urban water management plan which includes the contents of a plan required under this part.

10654. An urban water supplier may recover in its rates the costs incurred in preparing its plan and implementing the reasonable water conservation measures included in the plan. Any best water management practice that is included in the plan that is identified in the "Memorandum of Understanding Regarding Urban Water Conservation in California" is deemed to be reasonable for the purposes of this section.

10655. If any provision of this part or the application thereof to any person or circumstances is held invalid, that invalidity shall not affect other provisions or applications of this part which can be given effect without the invalid provision or application thereof, and to this end the provisions of this part are severable.

10656. An urban water supplier that does not prepare, adopt, and submit its urban water management plan to the department in accordance with this part, is ineligible to receive funding pursuant to Division 24 (commencing with Section 78500) or Division 26 (commencing with Section 79000), or receive drought assistance from the state until the urban water management plan is submitted pursuant to this article.

10657.

(a) The department shall take into consideration whether the urban water supplier has submitted an updated urban water management plan that is consistent with Section 10631, as amended by the act that adds this section, in determining whether the urban water supplier is eligible for funds made available pursuant to any program administered by the department.

(b) This section shall remain in effect only until January 1, 2006, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2006, deletes or extends that date.

Appendix B

West Basin Municipal Water District
2005 Urban Water Management Plan Checklist Form

Water Code Section	Location in Guide	Items to Address	Location in Plan
10620 (d)(1)	Page 2	Participate in area wide, regional, watershed or basin wide urban water management planning	Page 1-2
10620 (d)(2)	Page 2	Describe the coordination of the plan preparation with other appropriate agencies in the area and anticipated benefits	Page 1-2
10620 (f)	Page 2	Describe how water management tools and/or options to maximize resources & minimize need to import water	Page ES-1-ES-9
10621 (a)	Page 4	Update plan every five years on or before December 31, in years ending in five and zero	Page 1-1
10621 (b)	Page 4	Notify any city or county within service area of UWMP of plan review & revision	Page 1-2
	Page 4	Consult and obtain comments from cities and counties within service area	Page 1-2
10631 (a)	Page 8	Provide current and projected population for water service area in 5-year increments to 20 or 25 years	Page 2-3
	Page 8	Identify source of population data	Page 2-3
	Page 8	Describe climate characteristics that affect water management	Page 2-1-2-2
	Page 8	Describe other demographic factors that affect water management	Page 2-2
10631 (b)	Page 10	Identify existing and planned water supply sources	Page 3-2
	Page 10	Provide current water supply quantities in 5-year increments to 20 or 25 years	Page 4-5
	Page 10	Provide planned water supply quantities in 5-year increments to 20 or 25 years	Page 4-5
10631 (b)(1)	Page 12	Attach copy of any groundwater management plans adopted, including plans adopted pursuant to Part 2.75 or any other specific authorization for groundwater management	N/A
10631 (b)(2)	Page 12	A description of any groundwater basins or basin from which the urban water supplier pumps groundwater	N/A
	Page 12	If the groundwater basin is adjudicated attach a copy of the order or decree	N/A
	Page 12	For basins that are not adjudicated, state whether basins are in overdraft	N/A
	Page 12	If basin is in overdraft or projected to be in overdraft describe plan to eliminate overdraft	N/A
	Page 12	Quantify legal pumping amounts from basin	Page 3-6
10631 (b)(3)	Page 12	Detailed description and analysis of location, amount, and sufficiency of water pumped for past five years	Page 3-7
10631 (b)(4)	Page 12	Detailed description and analysis of location, amount, and sufficiency for 20 or 25 year projection of water to be pumped	Page 3-7
10631 (c)(1)	Page 14	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage for normal water year	Page 4-4
10631 (c)(2)	Page 14	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage for single-dry water year	Page 4-4

West Basin Municipal Water District
2005 Urban Water Management Plan Checklist Form

10631 (c)(3)	Page 14	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage for multiple-dry water years	Page 4-4
10631 (c)	Page 14	Describe the reliability of the water supply due to seasonal or climatic shortages	N/A
	Page 14	Describe the vulnerability of the water supply to seasonal or climatic shortages	N/A
	Page 14	Describe plans to supplement or replace inconsistent sources with alternative sources or DMMs	N/A
10631 (d)	Page 16	Describe opportunities for exchanges or water transfers on a short term or long term basis	Page 3-10
10631 (e) (1-3)	Page 18	Identify and quantify past water use by sector	Page 2-7
	Page 18	Identify and quantify current water use by sector	Page 2-7
	Page 18	Identify and quantify projected water use by sector in five-year increments to 20 or 25 years	Page 2-8
	Page 20	Identify and quantify past, current, and projected water use over five-year increments by sales to other agencies to 20 or 25 years	Page 2-7-2-8
	Page 20	Identify and quantify past, current, and projected water use over five-year increments by additional water uses and losses to 20 years	N/A
10631 (f)	Page 24	See (i)	Appendix F
10631 (g)	Page 40	See (j)	Appendix F
10631 (h)	Page 42	Description of water supply projects and water supply programs that may be undertaken to meet total projected water use with a timeline for each project	Page 8-8-8-10, 9-3-9-4
		Quantify each proposed project's normal-year supply, single dry-year supply, and multi-dry year supply	Page 4-5-4-8
10631 (i)	Page 44	Describe opportunities for development of desalinated water (ocean, brackish water)	Page 3-9 and 9-3 - 9-4
10631 (j)	Page 22	Provide annual report from CUWCC identifying water demand management measures being implemented or scheduled for implementation to satisfy requirements (f) and (g)	Appendix F
10631 (k)	Page 46	Provide wholesale agency with water use projections for that source of water in five-year increments to 20 or 25 years	N/A
	Page 46	Wholesaler provided information identifying and quantifying existing and planned sources of water available to supplier over five-year increments to 20 or 25 years	N/A
	Page 46	Information from wholesaler describing reliability of wholesale supplies and amount to be delivered during normal, single-dry, and multiple-dry years, including factors resulting in inconsistency and information or plans to supplement or replace water sources that are not reliable	N/A
10631.5	Page 48	Include 2003-2004 or 2005 Annual Report submitted to CUWCC and CUWCC coverage report	Appendix F
10632 (a)	Page 50	Provide an urban water shortage contingency plan analysis with stages of action to be taken in response to a water supply shortage	Page 4-8-4-11
	Page 50	Provide water supply conditions for each stage	Page 4-10

	Page 50	Provide in plan a 50% supply shortage	Page 4-9
10632 (b)	Page 52	Estimate the minimum water supply available for each of the next three years based on the driest three-year historical sequence by source	Page 4-8-4-9
10631 (c)	Page 54	Provide a catastrophic supply interruption plan for non-drought related events looking at vulnerability of each source, delivery and distribution systems and actions to minimize impacts of supply interruption	Page 4-11
10632 (d)	Page 56	List mandatory prohibitions against specific water use practices during water shortages and stage when they become mandatory	Page 4-10
10632 (e)	Page 56	List the consumption reduction methods the water supplier will use to reduce water use in the most restrictive stages with up to a 50% reduction	Page 4-10
10632 (f)	Page 56	List excessive use charges or penalties for excessive use	Page 4-10
10632 (g)	Page 58	Describe how actions and conditions impact revenues	Page 4-11
	Page 58	Describe how action and conditions impact expenditures	Page 4-11
	Page 58	Describe measures to overcome the revenue and expenditure impacts	Page 4-11
10632 (h)	Page 60	Provide a draft Water Shortage Contingency resolution or ordinance	Appendix E
10632 (i)	Page 60	Describe mechanisms to determine actual reductions	Page 4-11
10633	Page 62	Identify coordination of the recycled water plan with other agencies	Page 8-14
10633 (a)	Page 64	Describe wastewater collection and treatment systems in supplier's service area including amount collected and treated and quantify volumes	Page 8-1-8-4
10633 (b)	Page 64	Describe methods of wastewater disposal and treatment levels and quantify amount meeting recycled water standards	N/A
10633 (c)	Page 64	Describe current uses of recycled water, including type, place and quantities	Page 8-5-8-6
10633 (d)	Page 66	Describe and quantify potential uses of recycled water and explain technical and economic feasibility	Page 8-12
10633 (e)	Page 66	Describe projected use of recycled water in surface area at 5-year intervals to 20 or 25 years	Page 8-11-8-12
	Page 66	Compare UWMP 2000 projections with UWMP 2005 actual use	Page 8-8
10633 (f)	Page 66	Describe actions that might be taken to encourage recycled water use and projected results	Page 8-12
10633 (g)	Page 66	Provide recycled water use optimization plan that includes actions to facilitate the use of recycled water	Page 8-13
10634	Page 68	Analyze and describe how water quality affects water management strategies and supply reliability for each source of water	Page 5-1-5-6
10635 (a)	Page 70-74	Compare projected normal water supply to projected normal water use over the next 20 or 25 years, in five-year increments	Page 4-5
	Page 70-74	Compare projected single-dry year supply to projected single-dry year water use over the next 20 or 25 years, in 5-year increments	Page 4-6

West Basin Municipal Water District
2005 Urban Water Management Plan Checklist Form

	Page 70-74	Compare projected multiple-dry year supply to projected multiple-dry year demand over the next 20 to 25 years, in 5-year increments (for following five year periods: 2006-2010, 2011-2015, 2016-2020, 2021-2025)	Page 4-6-4-8
10635 (b)	Page 74	Provide Water Service Reliability section of UWMP to cities and counties within which it provides water supplies within 60 days of UWMP submission to DWR	N/A
10642	Page 78	Attach copy of adopted resolution to UWMP	Appendix C
	Page 78	Encourage involvement of social, cultural and economic community groups	Appendix C
	Page 78	Plan available for public inspection	Appendix C
	Page 78	Provide proof of public hearing	Appendix C
	Page 78	Provided meeting notice to any city or county it supplies water within	Appendix C
10643	Page 78	Review recycled water plan in 2000 UWMP and discuss whether it is being implemented as planned	Page 8-12
	Page 78	Discuss whether BMPs in CUWCC BMP Annual Reports submitted in 2000 UWMP were implemented as planned	Page 6-5
10644	Page 78	Provide 2005 UWMP to DWR and cities and counties within supplier area within 30 days of adoption	N/A
10645	Page 78	Provide documentation showing where plan will be available for public review during normal business hours 30 days after submittal to DWR	Appendix C

Appendix C

LEGAL NOTICE

Notice of Hearing

Central and West Basin Municipal Water Districts

PLEASE TAKE NOTICE that the Board of Directors of Central and West Basin Municipal Water Districts will conduct a Public Hearing on **December 19, 2005** at the hours of **11:00 a.m. and 1:00 p.m.,** respctfully; or as soon thereafter as the matter can be heard, in the board room of the District's office located at 17140 S. Avalon Blvd., Carson, California to consider adoption of its 2005 Urban Water Management Plans. This planning document assesses the Districts' water resources, demands, and strategies over the next 25 years, as a requirement set forth by the State Department of Water Resources. The Final Draft 2005 Urban Water Management Plan can be found on the Districts' website at www.westbasin.org or a copy can be requested from the Districts for review. Interested parties are invited to present oral or written comments.

Dated November 30, 2005

Charlene Jenson
Secretary

Publish: December 5, 12, 2005
Whittier Daily News

Ad. No.

Daily Breeze

DB 12-21
Notice of Hearing

Central and West Basin
Municipal Water Districts

PLEASE TAKE NOTICE that the Board of Directors of Central and West Basin Municipal Water Districts will conduct a Public Hearing on December 19, 2005 at the hours of 11:00 a.m. and 1:00 p.m., respctfully; or as soon thereafter as the matter can be heard, in the board room of the District's office located at 17140 S. Avalon Blvd., Carson, California to consider adoption of its 2005 Urban Water Management Plans. This planning document assesses the Districts' water resources, demands, and strategies over the next 25 years, as a requirement set forth by the State Department of Water Resources. The Final Draft 2005 Urban Water Management Plan can be found on the Districts' website at www.westbasin.org or a copy can be requested from the Districts for review. Interested parties are invited to present oral or written comments.

Dated November 30, 2005

Charlene Jenson
Secretary

Pub: December 5, 12, 2005.

CERTIFICATION

State of California	)	
County of Los Angeles	)	SS
West Basin Municipal	)	
Water District	)	

I, Charlene Jensen, Board Secretary of West Basin Municipal Water District and of the Board of Directors thereof, do hereby certify that the foregoing is a full, true and correct copy of Resolution No. 12-05-835 "A RESOLUTION OF THE BOARD OF DIRECTORS OF THE WEST BASIN MUNICIPAL WATER DISTRICT APPROVING THE 2005 URBAN WATER MANAGEMENT PLAN", which was adopted at a Board meeting held on December 19, 2005 by the Board of Directors of the West Basin Municipal Water District.

Dated: December 20, 2005

Charlene T. Jensen
Board Secretary, West Basin
Municipal Water District and to
the Board of Directors thereof

G:\directors\boardmisc\certifications\certifywb resolution

RESOLUTION NO. 12-05-835

A RESOLUTION OF THE BOARD OF DIRECTORS OF WEST BASIN MUNICIPAL WATER DISTRICT APPROVING THE 2005 URBAN WATER MANAGEMENT PLAN

BE IT RESOLVED, by the BOARD OF DIRECTORS that the Board of Directors hereby adopt and sign a Resolution approving the 2005 Urban Water Management Plan, and

BE IT RESOLVED, that the West Basin Municipal Water District hereby agrees and further authorizes that the aforementioned document complies with all applicable requirements set forth in the California Urban Water Management Planning Act of 1983, as amended, and

BE IT FURTHER RESOLVED, that the President of the Board of Directors of the West Basin Municipal Water District is hereby authorized to sign the 2005 Urban Water Management Plan.

PASSED, APPROVED, AND ADOPTED on the 19th day, December 2005.

President

ATTEST:

Secretary

(SEAL)

G:\director\resos\wb835

Appendix D

West Basin Municipal Water District
17140 S. Avalon Blvd • Suite 210 • Carson, CA 90746-1296
telephone 310-217-2411 • fax 310-217-2414

July 8, 2005

To Whom it May Concern:

This letter serves as notification that the West Basin Municipal Water District is currently preparing a 2005 update of its Urban Water management Plan, pursuant to the Urban Water Management Planning Act (Act) of the California Water Code. The Act requires urban water suppliers to update their Urban Water management Plans and submit a complete plan to the California Department of Water Resources every five years.

A draft of West Basin's Plan is currently available for review and comment. A Final Draft will be available for review prior to the scheduled public hearing in October 2005.

Please contact us if you would like to receive a draft Plan. If you would like more information or have any questions, please contact Harvey De La Torre at (310) 660-6233 or via email at harveyd@wcbwater.org.

Thank you,

Art Aguilar, Co-General Manager

Rich Nagel, Co-General Manager

West Basin Municipal Water District
17140 S. Avalon Blvd • Suite 210 • Carson, CA 90746-1296
telephone 310-217-2411 • fax 310-217-2414

June 29, 2005

Dear Central/West Basin Customers Agencies:

2005 Urban Water Management Plan

As you are aware, all California agencies providing water to more than 3,000 customers or supplying more than 3,000 acre-feet of water a year are required to update their Urban Water Management Plans (UWMP) every five years, according to California Water Code Section 10621(a). Central Basin MWD (CBMWD) and West Basin MWD (WBMWD) posted its 2005 Urban Water Management Plan workshop with the Metropolitan Water District of Southern California and California Urban Water Conservation Council on June 28, 2005.

Enclosed you will find the District's DRAFT 2005 UWMP, which will assist you in updating your agency's UWMP. We will be meeting with each agency to discuss our Plan and answer any questions you may have throughout the months of July and August. Staff will be contacting you soon to schedule a date and time the District anticipates completing its FINAL UWMP by September and taking it to the Board for adoption in October. All UWMP's are due to the Department of Water Resources by December 31, 2005.

If you have any questions, please feel free to contact Harvey De La Torre at (310) 660-6233 or Leighanne Reeser at (310) 660-6225.

Sincerely,

Art Aguilar, Co-General Manager

Rich Nagel, Co-General Manager

Enclosures

Appendix E

West Basin Municipal Water District
17140 S. Avalon Blvd • Suite 210 • Carson, CA 90746-1296
telephone 310-217-2411 • fax 310-217-2414

Resolution No. _____

A RESOLUTION OF THE BOARD OF DIRECTORS OF
THE WEST BASIN MUNCIPAL WATER DISTRICT FINDING THE
EXISTENCE OF A WATER SHORTAGE,
ORDERING THE IMPLEMENTATION OF STAGE __ OF
THE WATER SHORTAGE CONTINGENCY PLAN

WHEREAS, the West Basin Municipal Water District (District), a member agency to Metropolitan Water District of Southern California (MWD), has implemented a mandatory reduction program; and

WHEREAS, the Board of Directors has established Stages of Action contingent upon the MWD Water Surplus and Drought Management (WSDM) Plan, which provides for stages of action and an allocation methodology; and

WHEREAS, the WSDM Plan allocation methodology has yet to be determined and the District has established and will follow the following stages of action:

a) Minimum Shortage Stage: Request a voluntary effort among the District customers to reduce imported water deliveries. Pursue an aggressive Public Awareness Campaign to encourage residents and industries to reduce their usage of water.

b) Moderate Shortage Stage: In addition to the Minimum Shortage Stage actions, the District will work with its customer agencies to promote and adopt waste water prohibition and ordinances to discourage unnecessary water usage.

c) Severe Shortage Stage: In addition to the Minimum and Moderate Shortage Stage actions, the District will seek to adopt a rate structure that penalized increased water usage among its customer agencies.

d) Extreme Water Shortage Stage: In addition to the Minimum, Moderate, and Severe Shortage Stage actions, the District will call for the discontinuance of imported water based upon an allocation methodology similar to MWD for each of its customer agencies; and

WHEREAS, the Board of Directors may, upon finding that a water shortage exists, order implementation of a plan which it deems appropriate to address such water shortage and shall establish the Stage if action that it is implementing.

West Basin Municipal Water District
17140 S. Avalon Blvd • Suite 210 • Carson, CA 90746-1296
telephone 310-217-2411 • fax 310-217-2414

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE WEST BASIN MUNICIPAL WATER DISTRICT AS FOLLOWS:

1. That, for the reasons hereinabove set forth, the Board of Directors hereby finds and determines that a Water Shortage exists in the West Basin Water District service area.
2. That the Board of Directors hereby orders implementation of the Water Shortage Contingency Plan, ____________Stage, as set forth above.
3. That reasonable action shall be taken to ensure compliance by the District's customer agencies.

THE FOREGOING RESOLUTION is approved and adopted by the Board of Directors of the West Basin Municipal Water District this __ day of _________, 20__

____
PRESIDENT, WEST BASIN MWD

ATTEST:

____
BOARD SECRETARY, WEST BASIN MWD

Appendix F

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2003**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	no
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	
b. Determine other system verifiable uses (AF)	
c. Determine total supply into the system (AF)	
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.00
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	no
4. Did your agency complete a full-scale audit during this report year?	no
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	no
6. Does your agency operate a system leak detection program?	no
a. If yes, describe the leak detection program:	

B. Survey Data

1. Total number of miles of distribution system line.	0
2. Number of miles of distribution system line surveyed.	0

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No
a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."	

E. Comments

As a water wholesaler, West Basin does not own potable water pipes. We do however provide support to our water retailers as stated in BMP #10. Upon request, we provide DWR's literature on system audits and leak detection.

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2003**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? — yes

a. If YES, describe the program and how it's organized.

The Public Information Program consists of a variety of programs and practices that are used to educate the public about water conservation. Conservation literature is provided to the public at the various one-day ultra-low-flush toilet programs, and at community events. A quarterly newsletter is provided to approximately 20,000 residents. Information is provided at the quarterly Public Information Committee (PIC) meeting, and at the annual "Water Harvest" festival. Information is also provided at various speaking engagements, the web site, and on the telephone. Opportunities are sought to educate the public about the importance of water conservation. Conservation literature is also provided to the retail water agencies upon request.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	yes	21
b. Public Service Announcement	yes	1
c. Bill Inserts / Newsletters / Brochures	yes	2
d. Bill showing water usage in comparison to previous year's usage	no	
e. Demonstration Gardens	yes	1
f. Special Events, Media Events	yes	5
g. Speaker's Bureau	yes	3
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	510850	475550
2. Actual Expenditures	200850	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? — No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

The Budget is made up of several programs including,Education, Public Information Committee Meetings, web-site development and hosting,

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2003**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? yes

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	16	345	0
Grades 4th-6th	yes	15	505	0
Grades 7th-8th	yes	5	160	0
High School	yes	1	35	0

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program? 9/10/1995

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	62500	115500
2. Actual Expenditures	20000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 10: Wholesale Agency Assistance Programs

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2003**

A. Implementation

1. Financial Support by BMP

BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded	BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded
1	No			8	yes	62500	20000
2	No			9	yes	5000	5000
3	No			10	yes	0	0
4	No			11	No		
5	yes	15000000	15000000	12	yes	65000	65000
6	yes	5000	5000	13	yes	0	0
7	yes	510850	200850	14	yes	327350	327350

2. Technical Support

a. Has your agency conducted or funded workshops addressing CUWCC procedures for calculating program savings, costs and cost-effectiveness?	No
b. Has your agency conducted or funded workshops addressing retail agencies' BMP implementation reporting requirements?	No
c. Has your agency conducted or funded workshops addressing:	
1) ULFT replacement	No
2) Residential retrofits	No
3) Commercial, industrial, and institutional surveys	No
4) Residential and large turf irrigation	No
5) Conservation-related rates and pricing	No

3. Staff Resources by BMP

BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP	BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP
1	yes	1	8	yes	1
2	yes	1	9	yes	1
3	yes	1	10	yes	1
4	yes	1	11	yes	1
5	yes	1	12	yes	1
6	yes	1	13	yes	1
7	yes	1	14	yes	1

4. Regional Programs by BMP

BMP	Implementation/ Management Program?	BMP	Implementation/ Management Program?
1	No	8	yes
2	No	9	yes
3	No	10	yes
4	No	11	No
5	No	12	yes
6	yes	13	yes
7	yes	14	yes

B. Wholesale Agency Assistance Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	665700	680700
2. Actual Expenditures	665700	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? yes

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

In reference to BMP 5, the District spends roughly $15 Million on maintaining its water recycling system. Recycled water is 100% water conservation. This system benefits large landscape customers by utilizing recycled water instead of imported or potable water. A1 BMP 5 includes funding for recycled water operations and maintenance. Sections B1 & B2 exclude the budgets for the recycled water program. We consider this program as wholesale agency assistance because we are providing the region with a new source of water, and that the cities and retail water agencies can use to purchase less expensive water.

D. Comments

BMP #6 - MWD provides a $110 incentive per rebate. West Basin budgets $5,000 to further promote program. BMP $9 - MWD funds a region-wide CII rebate program. District budgets $5,000 to further promote program.

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2003**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential

a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$65219297
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$9924917

2. Commercial

a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$

3. Industrial

a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$

4. Institutional / Government

a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$

5. Irrigation

a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$

6. Other

a. Water Rate Structure

b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2003**

A. Implementation

1. Does your Agency have a conservation coordinator?	yes
2. Is this a full-time position?	no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ?	yes
4. Partner agency's name:	Central Basin Municipal Water District
5. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	50%
b. Coordinator's Name	Gus Meza
c. Coordinator's Title	Conservation Coordinator
d. Coordinator's Experience and Number of Years	5 Years Water Conservation Experience
e. Date Coordinator's position was created (mm/dd/yyyy)	4/17/1991
6. Number of conservation staff, including Conservation Coordinator.	1

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	65000	68000
2. Actual Expenditures	57680	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

West Basin MWD shares staff with its sister agency Central Basin MWD on a 50/50 basis. So conservation staff time is one-half person for each Water District.

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2004**

A. Implementation

1. Has your agency completed a pre-screening system audit for this reporting year?	no
2. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	
b. Determine other system verifiable uses (AF)	
c. Determine total supply into the system (AF)	
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.00
3. Does your agency keep necessary data on file to verify the values used to calculate verifiable uses as a percent of total production?	no
4. Did your agency complete a full-scale audit during this report year?	no
5. Does your agency maintain in-house records of audit results or the completed AWWA audit worksheets for the completed audit?	no
6. Does your agency operate a system leak detection program?	no
a. If yes, describe the leak detection program:	

B. Survey Data

1. Total number of miles of distribution system line.	0
2. Number of miles of distribution system line surveyed.	0

C. System Audit / Leak Detection Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

As a water wholesaler, West Basin does not own potable water pipes. We do however provide support to our water retailers as stated in BMP #10. Upon request, we provide DWR's literature on system audits and leak detection.

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2004**

A. Implementation

1. Does your agency maintain an active public information program to promote and educate customers about water conservation? yes

    a. If YES, describe the program and how it's organized.

    The Public Information Program consists of a variety of programs and practices that are used to educate the public about water conservation. Conservation literature is provided to the public at the various one-day ultra-low-flush toilet programs, and at community events. A quarterly newsletter is provided to approximately 20,000 residents. Information is provided at the quarterly Public Information Committee (PIC) meeting, and at the annual "Water Harvest" festival. Information is also provided at various speaking engagements, the web site, and on the telephone. Opportunities are sought to educate the public about the importance of water conservation. Conservation literature is also provided to the retail water agencies upon request.

2. Indicate which and how many of the following activities are included in your public information program.

Public Information Program Activity	Yes/No	Number of Events
a. Paid Advertising	yes	21
b. Public Service Announcement	yes	1
c. Bill Inserts / Newsletters / Brochures	yes	2
d. Bill showing water usage in comparison to previous year's usage	no	
e. Demonstration Gardens	no	
f. Special Events, Media Events	yes	5
g. Speaker's Bureau	yes	3
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	475550	475550
2. Actual Expenditures	353700	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

    a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

The Budget is made up of several programs including,Education, Public Information Committee Meetings, web-site development and hosting,

BMP 08: School Education Programs

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2004**

A. Implementation

1.Has your agency implemented a school information program to promote water conservation? yes

2. Please provide information on your school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	23	477	0
Grades 4th-6th	yes	23	767	0
Grades 7th-8th	yes	4	140	0
High School	yes	1	30	0

3. Did your Agency's materials meet state education framework requirements? yes

4. When did your Agency begin implementing this program? 9/10/1995

B. School Education Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	115500	115500
2. Actual Expenditures	26000	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 10: Wholesale Agency Assistance Programs

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2004**

A. Implementation

1. Financial Support by BMP

BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded	BMP	Financial Incentives Offered?	Budgeted Amount	Amount Awarded
1	No			**8**	yes	115500	26000
2	No			**9**	yes	5000	5000
3	No			**10**	yes	0	0
4	No			**11**	No		
5	No			**12**	yes	65000	65000
6	yes	15000	15000	**13**	yes	0	0
7	yes	475550	200850	**14**	yes	321500	321500

2. Technical Support

a. Has your agency conducted or funded workshops addressing CUWCC procedures for calculating program savings, costs and cost-effectiveness?	No
b. Has your agency conducted or funded workshops addressing retail agencies' BMP implementation reporting requirements?	No
c. Has your agency conducted or funded workshops addressing:	
1) ULFT replacement	No
2) Residential retrofits	No
3) Commercial, industrial, and institutional surveys	No
4) Residential and large turf irrigation	No
5) Conservation-related rates and pricing	No

3. Staff Resources by BMP

BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP	BMP	Qualified Staff Available for BMP?	No. FTE Staff Assigned to BMP
1	yes	1	8	yes	1
2	yes	1	9	yes	1
3	yes	1	10	yes	1
4	yes	1	11	yes	1
5	yes	1	12	yes	1
6	yes	1	13	yes	1
7	yes	1	14	yes	1

4. Regional Programs by BMP

BMP	Implementation/ Management Program?	BMP	Implementation/ Management Program?
1	No	8	yes
2	No	9	yes
3	No	10	yes
4	No	11	No
5	No	12	yes
6	yes	13	yes
7	yes	14	yes

B. Wholesale Agency Assistance Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	680700	680700
2. Actual Expenditures	680700	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? yes

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

In reference to BMP 5, the District spends roughly $16 Million on maintaining its water recycling system. Recycled water is 100% water conservation. This system benefits large landscape customers by utilizing recycled water instead of imported or potable water. A1 BMP 5 includes funding for recycled water operations and maintenance. Sections B1 & B2 exclude the budgets for the recycled water program. We consider this program as wholesale agency assistance because we are providing the region with a new source of water, and that the cities and retail water agencies can use to purchase less expensive water.

D. Comments

BMP #6 - MWD provides a $110 incentive per rebate. West Basin budgets $5,000 to further promote program. BMP $9 - MWD funds a region-wide CII rebate program. District budgets $5,000 to further promote program.

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2004**

A. Implementation

Rate Structure Data Volumetric Rates for Water Service by Customer Class

1. Residential	
a. Water Rate Structure	Uniform
b. Sewer Rate Structure	Service Not Provided
c. Total Revenue from Volumetric Rates	$68006966
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$10658770
2. Commercial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
3. Industrial	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
4. Institutional / Government	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
5. Irrigation	
a. Water Rate Structure	
b. Sewer Rate Structure	
c. Total Revenue from Volumetric Rates	$
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$
6. Other	
a. Water Rate Structure	

b. Sewer Rate Structure			
c. Total Revenue from Volumetric Rates	$		
d. Total Revenue from Non-Volumetric Charges, Fees and other Revenue Sources	$		

B. Conservation Pricing Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	0	0
2. Actual Expenditures	0	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 12: Conservation Coordinator

Reporting Unit:	BMP Form Status:	Year:
West Basin MWD	**100% Complete**	**2004**

A. Implementation

1. Does your Agency have a conservation coordinator?	yes
2. Is this a full-time position?	no
3. If no, is the coordinator supplied by another agency with which you cooperate in a regional conservation program ?	yes
4. Partner agency's name:	Central Basin Municipal Water District

5. If your agency supplies the conservation coordinator:

a. What percent is this conservation coordinator's position?	50%
b. Coordinator's Name	Gus Meza
c. Coordinator's Title	Conservation Coordinator
d. Coordinator's Experience and Number of Years	6 Years Water Conservation Experience
e. Date Coordinator's position was created (mm/dd/yyyy)	4/17/1991

6. Number of conservation staff, including Conservation Coordinator.	1

B. Conservation Staff Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures	68000	68000
2. Actual Expenditures	57680	

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

West Basin MWD shares staff with its sister agency Central Basin MWD on a 50/50 basis. So conservation staff time is one-half person for each Water District.

Glossary

Glossary of Abbreviations and Terms

Agencies

AWWARF	American Water Works Association Research Foundation
CalWater	California Water Service Company
CDHS	California Department of Health Services
Central Basin	Central Basin Municipal Water District
City	City of Los Angeles
CPUC	California Public Utilities Commission
CSDLAC	County Sanitation Districts of Los Angeles County
CUWCC	California Urban Water Conservation Council
CWAC	California Water Awareness Campaign
District	West Basin Municipal Water District
DWR	California Department of Water Resources
Edison	Southern California Edison
EPA	United States Environmental Protection Agency
LACDPW	Los Angeles County Department of Public Works
LACFCD	Los Angeles County Flood Control District
LADWP	Los Angeles Department of Water and Power
MWD	Metropolitan Water District of Southern California
RWQCB	Regional Water Quality Control Board
SCAG	Southern California Association of Governments
USBR	United States Bureau of Reclamation
West Basin	West Basin Municipal Water District
WRD	Water Replenishment District of Southern California

Facilities and Locations

Barrier	Alamitos Barrier
Bay-Delta	San Francisco- San Joaquin Bay Delta
CGB	Central Groundwater Basin
CRA	Colorado River Aqueduct
CSUDH	California State University at Dominguez Hills
CVP	Central Valley Project
EOC	Emergency Operation Center
Hyperion	Hyperion Wastewater Treatment Plant
Pilot Project	West Basin's Desalination Pilot Project
SWP	State Water Project
WBWRF	West Basin Water Recycling Treatment Facility
WCGB	West Coast Groundwater Basin
WRP	Water Recycling Plant

Measurements

AFY	Acre-Feet Per Year
CFS	Cubic Feet Per Second
GPCD	Gallons Per Capita Per Day
GPM	Gallons Per Minute
MAF	Million Acre-Feet
MGD	Million Gallons per Day
TAF	Thousand Acre-Feet
WF	Water Factor

Miscellaneous

BMPs	Best Management Practices
CBIC	Weather0Based Irrigation Program
CII	Commercial, Industrial & Institutional
Harbor/South Bay	Harbor/South Bay Water Recycling Project
HECW	High-Efficiency Clothes Washer Program
HET	High-Efficiency Toilets
IRP	Integrated Resources Plan
Marketing Plan	Recycled Water Marketing Plan
Master Plan	Recycled Water Master Plan
MOU	Memorandum of Understanding
MWD-MAIN	Metropolitan Water District's Municipal and Industrial Needs
NPDES	National Pollutant Discharge Elimination System
PAC	Project Advisory Committee
PIC	Public Information Committee
Plan	Conservation Master Plan
Program	Water Audit and Leak Detection Program
QSA	Quantification Settlement Agreement
RTS	Readiness-to-Serve Charge
SDWP	Safe Drinking Water Program
Title 22	California Code of Regulations Title 22 standards
ULFT	Ultra-Low Flush Toilet
UWMP	Urban Water Management Plan
VOCs	Volatile Organic Compounds
WBIC	Weather-Based Irrigation Controller
WQPP	Water Quality Protection Project
WSDM Plan	Water Surplus and Drought Management Plan




Prepared by: West Basin Municipal Water District - 17140 South Avalon Boulevard, Suite 210 - Carson, CA 90746
www.westbasin.org