PHASE 1
FINAL REPORT

CHINO BASIN RECHARGE MASTER PLAN

PREPARED FOR

CHINO BASIN WATER CONSERVATION DISTRICT
CHINO BASIN WATERMASTER

JANUARY 1998

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January 13, 1998

Chino Basin Water Conservation District
Attention: Barrett Kehl
Post Office Box 31
Montclair, CA 91763

Chino Basin Watermaster
Attention: Traci Stewart
8632 Archibald Avenue, Suite 109
Rancho Cucamonga, CA 91730

Subject: Transmittal of Phase 1 Final Report -- Chino Basin Recharge Master Plan

Dear Barry and Traci:

Transmitted herewith is a copy of our final report for Phase 1 of the Chino Basin Recharge Master Plan. This report is the culmination of research and engineering studies on existing and future recharge capabilities in the Chino Basin for storm water recharge, imported water recharge and reclaimed water recharge. The findings regarding recharge of storm flow and reclaimed water, safe yield, and recommended recharge projects are interesting, timely and controversial.

The objective of the Phase 1 study of the Recharge Master Plan is to determine the potential for artificial recharge given the resources in the Chino Basin. This was accomplished through data collection, research, and a massive computational and engineering assessment. In Section 3 of this report, the current level of storm water recharge was estimated at about 12,000 acre-ft/yr. The potential storm water recharge was estimated to range from about 25,000 to 30,000 acre-ft/yr given proper routine maintenance. Most basins are not maintained to optimize recharge and there is no quantitative information on basin conditions or actual recharge performance. Recharge of storm flows could reach 40,000 acre-ft/yr under ultimate land-use conditions and expansion of conservation storage. Thus, the increase in storm water recharge from recharge improvements could range from 13,000 to 27,000 acre-ft/yr. The present-value benefit from increasing storm water recharge is about $6,500 per acre-ft. Thus, the present-value basin-wide benefit of optimizing storm water recharge could range from about $85,000,000 to $176,000,000.

In Section 4 of this report, the potential capacity and costs for recharge of imported and reclaimed water were developed. Operational plans that specify the amount and scheduling of imported water and reclaimed water recharge were developed. About 17,000 acre-ft/yr of reclaimed water recharge capacity was developed. The potential for imported water recharge ranges from about 119,000 acre-ft/yr to 155,000 acre-ft/yr, assuming that Metropolitan has the capacity to deliver that much water.

In Section 5 of this report, a recommended scope of work and budget-level cost estimates are presented for Phase 2. Phase 2 is focused on developing information on the engineering properties of the basins and institutional issues to optimize recharge. The cost of Phase 2 could range from $408,000 to $623,000, and take from two to four years to complete. Most of the work in Phase 2 consists of field investigations to characterize the physical properties of recharge basins and assess their performance. The benefits to the producers in the basin from optimizing recharge are huge. We recommend that Phase 2 be implemented as soon as practical.

We appreciate the opportunity to serve the District and Watermaster on this very interesting and important study and look forward to working with you in the future.

Very truly yours,

Mark J. Wildermuth P.E.
Water Resources Engineers

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CHINO BASIN WATER CONSERVATION DISTRICT
CHINO BASIN WATERMASTER

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JANUARY 1998

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Section 1

SECTION 1
INTRODUCTION

At the October 11, 1995 Board meeting of the Chino Basin Water Conservation District (Conservation District), the Board requested that *Mark J. Wildermuth, Water Resources Engineers* outline an approach to developing a Chino Basin-wide recharge plan. The Board expressed an interest in developing the recharge plan jointly with the Chino Basin Watermaster (Watermaster). The Watermaster Advisory Committee approved joint participation in December 1995. The discussion presented below is our response to the Board's request. The discussion covers the *issues* that drive the need for a basin-wide recharge plan, the *objectives* of a recharge plan, and the *workplan* to develop and implement a recharge plan. This section also documents the first phase of the workplan.

ISSUES

Water demand in the Chino area exceeds the local supply and Chino Basin water users will be forced to increase purchases of supplemental supplies from Metropolitan Water District of Southern California.

Table 1-1 illustrates the projected water demands and available water supplies to users in the Chino Basin area. Total annual demand will increase from 326,957 acre-ft in 1990 to an estimated 451,502 acre-ft in 2020. The safe yield for Chino Basin groundwater is 140,000 acre-ft/yr. Local supplies including groundwater will range from about 237,000 acre-ft in 1990 to an estimated maximum of about 256,000 acre-ft in 2000. To meet demand, the remainder of the supply will come from imported water purchases from Metropolitan Water District of Southern California (Metropolitan).

The cost to purchase water from Metropolitan will increase substantially in the future due to increased costs to maintain current supply levels and significant capital costs to increase water supply. The present-value cost of one new acre-ft/yr of treated Metropolitan water over the planning period of this study (2001 to 2020) is an estimated $8,700, which is equivalent to an annual cost of about $791 per acre-ft. For replenishment water, the comparable present-value cost is about $6,400 per acre-ft, which is equivalent to an annual cost of about $582 per acre-ft. The present-value cost assumes a one-time new-demand charge of $1,500 per acre-ft (projected to range from $1,000 to $2,400 per acre-ft), plus a 20-year series of increasing commodity and readiness-to-serve charges. The new-demand charge is assumed to start in 2001 computed on the base demand for the year 2000. New recharge of local runoff could substantially offset some of the new imported water cost. For example, an increase in recharge of local runoff of 1,200 acre-ft/yr at existing facilities, such as the yield developed by the Conservation District's new Brooks Street Basin, will save about $10,400,000 over a 20-year period.

Recharge Capacity for Imported Water

The recently completed *Chino Basin Water Resources Management Study* (September 1995) (CBWRMS) concluded that an additional 30,000 acre-ft/yr of recharge capacity for imported water will be needed by the Chino Basin Watermaster in order to meet replenishment obligations. Watermaster, as it is currently empowered, is not encouraged by the court to construct and own spreading basins. Some of the new spreading basin capacity required by Watermaster could be offset by increased recharge of local runoff at existing facilities and new recharge at new facilities.

Yield Lost Due to Land Use Changes and Flood Control Improvements

At the time the Chino Judgment was adopted (1978), about 41 percent of the safe yield was estimated to come from irrigation returns. Since that time, irrigated agriculture has declined and is projected to be almost completely gone by 2020. This has resulted (and will continue to result) in declining irrigation returns to groundwater and a potential decrease in the safe yield. In addition, San Bernardino County, Riverside County and the Army Corps of Engineers have constructed flood control projects that capture and convey runoff to the Santa Ana River effectively eliminating the groundwater recharge that formerly took place in the stream channels and flood plains in the Chino Basin. This may have resulted in a decrease in the safe yield of the Chino Basin.

Water harvesting opportunities exist that can be used to offset the yield lost to urbanization and flood control improvements. Water harvesting consists of capturing and recharging runoff caused by urbanization. Most of the precipitation falling on undeveloped land or land in agricultural use is lost to evapotranspiration. Urbanization dramatically increases runoff due to a decrease in evapotranspiration of rainfall and an increase in impervious land cover and drainage improvements. The potential yield from this additional runoff is numerically equal to the increase in runoff that occurs when the land is converted to urban uses. The actual yield is equal to the additional runoff that is captured and put to beneficial use. In the Chino Basin, the best and least expensive way to put this yield to beneficial use is groundwater recharge.

Groundwater Level and Production Management

Groundwater production at some wells has either dropped off substantially or ceased all together on the west side of the Chino Basin in the area of the City of Chino and the

Chino Institute for Men (CIM). Ground surface ruptures have also occurred in this area. The decrease in production and surface ruptures are symptomatic of localized and perhaps regionalized declines in groundwater levels in this part of the Chino Basin. Groundwater levels have declined in this area due to increases in groundwater production and hydraulic limitations of the aquifers in this area. The aquifers in this part of the basin are semi-confined and confined. The sediments that underlie this area came from the Chino and Puente Hills and are finer-grained and less permeable than the other parts of the basin where the sediments originated from the igneous rocks of the San Gabriel and San Bernardino Mountains. The flow to wells in the City of Chino and CIM area comes in part from percolation of precipitation and applied water over the City of Chino and CIM area, but predominantly from subsurface flow from the north and east. The area west of Chino and CIM contributes little or no groundwater flow to the wells of the City of Chino and CIM area. Groundwater production by the City of Ontario, City of Pomona, Monte Vista Water District and agriculture occurs hydrologically upgradient from the groundwater production of the City of Chino, the City of Chino Hills and CIM – interfering with and essentially starving the Chino and CIM area of groundwater. Groundwater levels in the City of Chino and CIM area have declined causing an increase in the hydraulic gradient toward the City of Chino and CIM area, thereby maintaining subsurface flow into the area. Some wells are not deep enough to produce water at the lower groundwater levels.

One way to help mitigate groundwater level problems in the City of Chino and CIM area is to increase recharge in the west side of the basin. This can be accomplished by increasing the recharge of storm flows in the area overlying and tributary to the City of Chino and CIM area, and by Watermaster shifting replenishment from the San Sevaine and Etiwanda spreading basins to the west side basins.

Reclaimed Water

Urbanization also creates reclaimed water. Most of this water is discharged to the Santa Ana River. Chino Basin Municipal Water District (CBMWD) currently plans to use some of their reclaimed water for direct uses, including non-potable industrial and irrigation uses and for groundwater recharge. Groundwater recharge with reclaimed water is subject to regulatory requirements from the Regional Water Quality Control Board and the Department of Health Services. Planned groundwater recharge projects utilizing reclaimed water as a source of supply must be compatible with the Basin Plan and conform to the proposed DHS regulations for planned recharge projects. In addition to these requirements, there may be conflicts between the use of spreading basins for local runoff, imported water and reclaimed water.

Increasing the yield of the Chino Basin by increased capture of local runoff will improve the dilution of reclaimed water in groundwater and subsequently in domestic wells, and thereby increases the assimilative capacity of the Chino Basin. Increasing the capture of local runoff will reduce the cost of mitigation requirements for reclamation.

The Basin Plan

The Basin Plan assumes that a certain average annual quantity and quality of local runoff will be recharged each year. The volume of reclaimed water that can be used in the basin, without TDS mitigation, is numerically-tied to average annual quantity and quality of local runoff that recharges the basin. A decrease in the recharge of local runoff will result in a decrease in the volume of reclaimed water that will be permitted in the basin without TDS mitigation. Likewise an increase in the recharge of local runoff will result in an increase in the volume of reclaimed water that will be permitted in the basin without TDS mitigation. Therefore, the volume of recharge from local runoff has a significant impact on the future and cost of reclamation.

GOALS AND OBJECTIVES

Given the issues summarized above and the mission of the Conservation District and Watermaster, the objectives of the recharge master plan include:

1. To quantify the current volume of artificial recharge that occurs from runoff originating in the watershed.

2. To identify and rank new opportunities for increasing recharge.

3. To determine the variables that influence the volume of recharge in the Chino Basin and develop a strategy to optimize these variables.

4. To determine the institutional obstacles to expanding recharge of local runoff and develop solutions to overcome these obstacles.

5. To develop cost-effective strategies to increase safe yield of the Chino Basin thereby reducing cost of water supplies to all Chino Basin water users.

OUTLINE OF MASTER PLAN STUDY

A "phased" approach addressing these objectives was adopted by the Conservation District and Watermaster. The phases build upon each other resulting in a programmatic implementation plan and a series of agreements with cooperating entities. The phases are:

> **Phase 1 - Initial Screening and Assessment.** Conduct an assessment of total runoff, of runoff that is currently recharged and of additional recharge that could occur at new spreading basin sites. From this assessment a list of promising spreading basins would be developed. Research questions would be developed for each of the promising sites and a detailed scope of work would be developed for Phase 2.
>
> **Phase 2 - Engineering Assessments of Promising Sites.** Site-specific investigations, percolation rate monitoring and the preparation of cost estimates for developing, maintaining and managing these basins would be developed in this phase. The institutional issues regarding the judgement, ownership of facilities, management of non-Conservation District-owned facilities, disposition of water recharged, Basin Plan modifications and others will be identified. Principles of agreement will be developed that describe the institutional issues and means to resolve these issues through agreements. A detailed scope of work would be developed for Phase 3.
>
> **Phase 3 - Develop an Implementation Plan.** A plan to develop and manage spreading basins would be prepared. The plan would include existing and new basins and a schedule for spreading basin improvements based on developing recharge capacity to match need for increased groundwater yield at minimum cost.

The activities described above are comprehensive and will take three or more years to complete.

PHASE 1 SCOPE OF WORK

The scope of work for Phase 1 consists of five tasks:

Task 1 Describe Existing and Potential Spreading Facilities
Task 2 Develop Recharge Estimates
Task 3 Analysis of Chino Basin Safe Yield
Task 4 Develop Recommendations
Task 5 Prepare Report

Task 1 - Describe Existing and Potential Spreading Facilities. In Task 1, the existing spreading basins and potential sites will be identified. This work should be relatively easy in that these basins have been recently identified in studies by the Chino Basin Water Resources Task Force and Metropolitan. Design drawings (as-built drawings if available) and related reports will be collected that describe the tributary watersheds, inlet works, basin geometry, outlet works and operational characteristics. Initial estimates of percolation rates will be assigned to each basin based on available reports and data.

The proximity to other sources of recharge water, including reclaimed water and imported water from Metropolitan or local non-Chino watersheds, will be described.

Finally, a map will be prepared that shows the location of existing and potential spreading basins, the drainage system tributary to each basin, location of imported water conveyance facilities and the location of reclaimed water conveyance facilities. Tables will be prepared that summarize features of existing and proposed basins, such as percolation area, operating storage, drainage area tributary to the spreading basin, proximity to imported and reclaimed water sources, etc.

Task 2 - Develop Recharge Estimates. Task 2 includes subtasks that produce a series of recharge estimates for each basin. The method used to estimate recharge at these basins will be similar to that used to estimate recharge in the previous study for Montclair, Brooks, Ely, Lower Cucamonga and Chris Basins -- with one exception. The method will be revised to include imported and reclaimed water where appropriate and will keep track of the recharge by source. The recharge estimating method proposed herein estimates the average annual recharge by source water through a 41-year, daily simulation of runoff and inflow to each spreading basin. Monthly and daily flow statistics will be generated to determine which time periods should be reserved for recharge of runoff and other waters. For example, a review of monthly recharge of local runoff will show which periods should be reserved for local runoff and which months could be used for the recharge of reclaimed water -- or if both sources of water can be recharged simultaneously.

The watersheds tributary to each spreading basin will be delineated. Precipitation, evaporation, and the parameters used to estimate runoff will be developed. The spreading basin design data collected in Task 1 will be analyzed to develop rating curves for inlet works, outlet works and storage-area-elevation data.

Water supply plans will be developed for each spreading basin. The water supply plan will define the availability and priority of supply for each source of water that can be recharged in a spreading basin as a function of time. The recharge simulation model will use these plans to determine when and how much imported and reclaimed water will be diverted to spreading basins, how much recharges, how much evaporates and how much is lost to accidental outflow.

The model developed in the previous study needs to be modified to incorporate inflow controls to spreading basins. In the current version a separate code is used to simulate diversions to spreading basins where the basin inlet is a hydraulic control. The inlet from San Antonio Creek to the Montclair Number 1 spreading basin is an example of a spreading basin with an inlet control. Several simulations are necessary to study inlet-controlled basins with the current model. With the proposed modification, only one simulation would be necessary. The model also needs to be modified to handle multiple sources of recharge water.

Once the data is prepared and model modifications are completed, the recharge model will be used to estimate recharge at each spreading basin. Actual percolation rates at spreading basins are unknown. Recharge estimates will be prepared for a range of percolation rates at each spreading basin -- the range representing a reasonable range in percolation rates that could be expected at each basin. The impact of new and proposed spreading basins will be evaluated after the recharge has been estimated for existing basins. Recharge estimates will be prepared using existing land use and ultimate land use.

San Bernardino County Flood Control District currently plans to line San Sevaine channel effectively eliminating recharge in the channel bottom. A simulation run will be done to estimate the reduction in recharge caused by lining the channel and to determine if the proposed retention/spreading basins included in the San Sevaine project mitigate the loss in channel recharge.

Task 3 - Analysis of Chino Basin Safe Yield. The Chino Basin safe yield is the yield that can be reliably developed from the basin given its current state of land use and water resources development, and without significant undesirable effects. Undesirable effects refers to subsidence, water quality deterioration, contravention of existing water rights, deterioration of the economic advantages of groundwater pumping and significant negative impacts on biological resources. The safe yield can be estimated by combining the various hydrologic inflows and outflows (hydrologic components) for the basin. Estimates for the hydrologic components exists from various studies including the engineering work for the Chino Judgment, the Santa Ana Regional Water Quality Control Plan (Basin Plan) and the Chino Basin Water Resources Management Study. The recharge from runoff estimates developed in Task 3 will be more accurate than any previous estimate. The safe yield will be revised by incorporating the recharge estimates from Task 3. Improvements in the Chino Basin safe yield brought about by recharge at basins not formerly considered in the safe yield or from operational improvements will be identified.

Task 4 - Develop Recommendations. Existing and proposed recharge basins will be categorized by recharge performance for each water source. Alternative spreading basin system configurations and water supply plans will be developed. These alternatives will be evaluated with the recharge simulation model. Recommendations will be prepared regarding the recharge value (safe yield improvements), maintenance, percolation monitoring and additional investigations for each spreading basin.

Task 5 - Prepare Report. A draft report will be prepared and submitted to the Conservation District and to the Watermaster Advisory committee describing the work accomplished in Tasks 1 through 4. The draft report will include a recommended scope of work for Phase 2. The findings of the report will be presented to the Conservation District Board and to the Watermaster Advisory committee at a regularly scheduled meeting or at a workshop. A final report will be prepared based on the review comments of the Conservation District and Watermaster.

ORGANIZATION OF REPORT

This report consists of six sections and three appendices. These sections include:

Section 1 - Introduction (this section)

Section 2 - Safe Yield of the Chino Basin and The Need for Increased Recharge - contains a discussion of the safe yield used in the Chino Judgment, the need to revise the yield and the need for additional replenishment water.

Section 3 - Storm Water Recharge - contains an analysis of the recharge at existing facilities, increases in recharge and associated appraisal level costs for recharge facility improvements, recharge capabilities in the southern Chino Basin and estimates of storm water quality at Conservation District basins.

Section 4 - Artificial Recharge of Imported and Reclaimed Water - contains an analysis of the imported and reclaimed water recharge at existing facilities and one new basin, increases in recharge and associated appraisal level costs for recharge facility improvements.

Section 5 - Recommended Phase 2 Work - contains a recommended scope of work and schedule for Phase 2.

Section 6 - References

Appendix A - Recharge Basin Characteristics.

Appendix B - Monthly and Annual Percolation Tables for Each Basin.

Appendix C - Addendum - Analysis of the Change in Recharge in the Etiwanda-San Sevaine System Caused by the Proposed Etiwanda-San Sevaine Project. This is a stand-alone document that should be completed around July 1998.

TABLE 1-1
PROJECTED TOTAL WATER DEMAND AND SUPPLIES IN CHINO BASIN AREA
(acre-ft)

Demand/Source	1990	2000	2010	2020
Total Demand	326,957	399,693	432,901	451,502
Supply Sources				
Local Surface Water	14,430	19,736	19,538	19,544
Non-Chino Groundwater	55,054	64,985	69,981	70,209
Reclaimed Water	6,980	11,694	11,344	11,429
Internal Reuse	15,621	14,848	7,561	3,997
Chino Basin Groundwater	165,621	170,215	196,649	215,027
Colorado River Aqueduct - Direct Use	13,184	6,441	6,605	7,605
State Project Water - Direct Use	56,067	111,774	121,223	123,692
Total Supplies	326,957	399,693	432,901	451,502
Chino Basin Groundwater Replenishment Obligation (1)	20,621	25,215	51,649	75,027
Total Local Supplies	237,085	256,263	253,424	245,178
Total Imported Water Requirement (CRA direct use + SPW direct use + CB replenishment)	89,872	143,430	179,477	206,324

Source - Adapted from Table 2-10, Chino Basin Water Resources Management Study, Final Summary Report, Sep. 1995

(1) -- replenishment for years prior to 2018 based on 145,000 acre-ft/yr threshold; after 2017 the threshold is 140,000 acre-ft/yr. Storage limits are assumed fixed at 300,000 acre-ft.

Section 2

SECTION 2
SAFE YIELD OF THE CHINO BASIN AND THE NEED FOR INCREASED RECHARGE

THE CHINO BASIN JUDGMENT

Groundwater rights in the Chino Basin were defined in the 1978 judgment in the case *Chino Basin Municipal Water District vs. City of Chino et al.* The judgment states that the Chino Basin safe yield is 140,000 acre-ft/yr. Water rights were divided between three pools of producers: the overlying agricultural pool – 82,800 acre-ft/yr; the overlying non-agricultural pool – 7,366 acre-ft/yr; and the appropriative pool – 49,834 acre-ft/yr. The physical solution in the judgment allowed a controlled overdraft of 5,000 acre-ft/yr by the appropriative pool until the year 2017. The unused portion of the yield allocated to the overlying agricultural pool is reallocated to the appropriative pool each year. Table 2-1 shows the current allocation of water rights under the Chino Judgment and the amount estimated to be reallocated from the overlying agricultural pool to the appropriative pool for the years 2000 and 2020. The reallocation of yield from the overlying agricultural pool to the appropriative pool increases the operating yield of the appropriators and helps reduce their replenishment obligations. Future water demand projections from the CBWRMS suggests that approximately 75,000 acre-ft/yr of overlying agricultural pool yield is projected to be reallocated to the appropriative pool by the year 2020.

BASIS FOR SAFE YIELD

Figure 2-1 shows the hydrologic and adjudicated boundaries of the Chino Basin. The hydrologic boundary conforms to hydrologic flow systems in the basin. The adjudicated boundary generally conforms to the hydrologic boundary except near the Cucamonga Basin where the boundary conforms to the boundary of the Cucamonga Basin contained in the Cucamonga Basin judgment. Other differences are slight and are due to slightly different interpretations of fault/barrier locations and other water bearing features. The safe yield of the Chino Basin was established during the 1978 adjudication to be 140,000 acre-ft/yr. The basis for this estimate is described by William J. Carroll in his testimony on December 19 and 20, 1977 during the adjudication. Figure 2-2 shows a schematic diagram used by Carroll in his explanation of the safe yield. Table 2-2 lists the hydrologic components developed by Carroll to estimate the safe yield of the Chino Basin. These components were developed for the period 1965 to 1974, a period that Carroll refers to as the *base period*. The hydrologic components listed in Table 2-2 are described below.

Deep Percolation of Precipitation and Surface Inflow – consists of the deep percolation of precipitation and streamflow. Carroll developed the estimate of 47,500 acre-ft/yr based on an extrapolation of the early Chino Basin modeling results from the DWR.

Deep Percolation of Chino Basin Groundwater Used for Irrigation (domestic and agricultural) – defined as the fraction of water applied for irrigation that percolates through the soil and recharges underlying groundwater. Carroll estimated that about 15 percent of the water used for domestic irrigation would percolate to groundwater; and that 45 percent of the water applied used for agricultural irrigation would percolate to groundwater. The volume of Chino Basin groundwater used for irrigation that percolated to groundwater was estimated by Carroll to be about 61,700 acre-ft/yr over the base period.

Deep Percolation of Imported Water Used for Irrigation (domestic and agricultural) – same as deep percolation of Chino Basin groundwater except that the water used for irrigation is imported and used over the Chino Basin. The volume of imported water used for irrigation that percolated to groundwater was estimated by Carroll to be about 7,000 acre-ft/yr over the base period.

Deep Percolation of Artificial Recharge – consists of the percolation of local runoff in spreading basins. Carroll estimated that the local runoff recharged in SBCFCD controlled facilities to be about 2,800 acre-ft/yr during the base period. The Etiwanda Water Company recharged about 1,000 acre-ft/yr of Deer and Day Creek water in the Chino Basin during the base period.

Recharge of Sewage – defined to be the percolation in ponds of wastewater discharged by municipal wastewater treatment plants. This component almost completely ceased during the base period and was known to be eliminated as a recharge source when the safe yield was estimated. The inclusion of 18,200 acre-ft/yr of recharged sewage as a component of safe yield, as agreed to in the stipulated judgment, was therefore not hydrologically consistent with how the basin was to be operated post judgment.

Subsurface Inflow – defined to be the groundwater inflow to the Chino Basin from adjacent groundwater basins and mountain fronts including:

Bloomington Divide (Riverside Basin)	3,500 acre-ft/yr
San Gabriel Mountain front	2,500 acre-ft/yr
Colton Rialto Basin	500 acre-ft/yr
Cucamonga Basin	100 acre-ft/yr
Claremont and Pomona Basins	100 acre-ft/yr
Jurupa Hills	500 acre-ft/yr
Total	7,200 acre-ft/yr say 7,000.

Subsurface Outflow – defined as the groundwater that rises to the ground surface in Prado Basin to become Santa Ana River flow. Estimates of subsurface outflow were based on studies by DWR, USGS and Carroll. Carroll estimated the subsurface outflow to average about 7,000 acre-ft/yr over the base period.

Extractions – consists of groundwater extractions from the Chino Basin. Carroll estimated the groundwater extractions to average about 180,000 acre-ft/yr during the base period.

In addition to these components, Carroll estimated the change in storage over the base period to be about 40,000 acre-ft/yr, that is the groundwater in storage declined by about 400,000 acre-ft between 1965 and 1974. Carroll estimated the safe yield to be the equal to the average extraction over the base period minus the average annual overdraft during the base period:

safe yield = extraction - overdraft
= 180,000 - 40,000
= 140,000 acre-ft/yr

A more recent estimate the safe yield can be abstracted from the groundwater modeling work done for the *Chino Basin Water Resources Management Study -- Task 6 Memorandum Develop Three Dimensional Groundwater Model* (Montgomery Watson, 1994). The hydrologic components derived from the modeling results for a 30-year period from October 1960 to September 1989 (water years 1961 to 1989), are listed in Table 2-3. Table 2-4 contains a breakdown of some of the recharge components listed in Table 2-3. These components are based on detailed studies of data, and groundwater and surface water modeling of the Chino Basin area. The safe yield based on the CBWRMS results (1961 to 1989) computed in a manner similar to Carroll is:

safe yield	= extraction - overdraft
	= 183,000 - 17,000
	= 166,000 acre-ft/yr

The safe yield based on CBWRMS modeling results for the base period used by Carroll (1965 to 1974) would be:

safe yield	= extraction - overdraft
	= 189,000 - 20,000
	= 169,000 acre-ft/yr

A more conceptually correct estimate of the safe yield would include a reduction for artificial recharge of imported water and other waters that are currently not part of the yield such as recharge of reclaimed water. The adjusted estimates would then be:

Carroll's estimate 1965 to 1974	118,000 acre-ft/yr
CBWRMS estimate 1961 to 1989	151,000 acre-ft/yr
CBWRMS estimate 1965 to 1974	156,000 acre-ft/yr

The significance of revisiting the safe yield of the Chino Basin is that Watermaster may decide to change the safe yield of the basin based on new information such as that developed from the CBWRMS. Safe yield is used to determine the need for replenishment obligation for individual parties to the judgment. New water from the capture and recharge of storm water or other sources will enhance the yield of the basin and thereby reduce the cost of purchasing imported water for replenishment.

FUTURE REPLENISHMENT OBLIGATION UNDER THE JUDGMENT

A replenishment obligation is triggered when an individual producer in the appropriative pool, overlying non-agricultural pool, or the overlying agricultural pool in the aggregate, produce more groundwater than their right (or operating yield for appropriators) as prescribed in the judgment. The replenishment obligation was projected for the period spanning the year 2000 to the year 2020 based on the land use conversions and water demands from the CBWRMS, near-term water demand projections developed in this study and a safe yield of 140,000 acre-ft/yr. The replenishment projection is shown in Table 2-5. The disposition of the current volumes of water held in local storage accounts by members of the appropriative and overlying non-agricultural pools has not been factored into the replenishment projection. Water held in local storage accounts exceeds 200,000 acre-ft and could be used to reduce future replenishment obligations or other purposes. We assumed that after the year 2000 all unused production rights would be used to offset over production. If this does not occur, the replenishment obligation will exceed the projection shown in Table 2-5. The replenishment obligation increases from a low of about 25,000 acre-ft/yr in year 2000 to about 75,000 acre-ft/yr by the year 2020. The implications of other safe yield estimates on replenishment obligations are described in Section 5. The sources of replenishment water include imported water purchased from Metropolitan, local imported water, storm flow recharge and reclaimed water. Under current management practices, only imported water from Metropolitan is used for replenishment. The existing storm water recharge assumed to be part of the safe yield was estimated by Carroll to be 2,800 acre-ft/yr.

The projected cost of purchasing imported water from Metropolitan is summarized in Table 2-6. There are four costs components – basic commodity charge, readiness-to-serve charge, new-demand charge and administrative costs of Watermaster and CBMWD. The basic commodity rate is the purchase price for Metropolitan water. The readiness-to-serve charge is associated with maintaining system capacity. The current readiness-to-serve charge is $47.56 per acre-ft and is estimated to increase to $154 by the year 2020. The new-demand charge is associated with increased system deliveries over an agency's established demand base. The new-demand charge has been postponed until the year 2001. We assumed the new demand charge to be $1,500 per acre-ft. Watermaster administrative fees are for costs associated with overseeing the judgment and importing water to replenish the groundwater basin. CBMWD administrative fees are for billing costs, conservation and water resource management activities within the CBMWD service area. Watermaster and CBMWD fees are estimated to be $10.30 and $5.00 respectively in the year 2001 and increase annually at 3%.

The resulting present-worth cost of avoiding new replenishment purchases from Metropolitan is about $6,400 per acre-ft. That is, Watermaster should be willing to spend up to $6,400 per acre-ft in the year 2000 to develop alternative sources of replenishment water.

OPPORTUNITIES FOR YIELD ENHANCEMENT

Opportunities for yield enhancement come from three sources – increased recharge of local runoff, reclaimed water and imported water. Other local imported sources such as Lytle Creek or the Santa Ana River are either institutionally locked-up, too expensive or are available too far off in the future, and hence are not discussed further. The next two sections describe the opportunities for yield enhancement by increasing recharge of storm water, reclaimed water and imported water.

TABLE 2-1
ESTIMATE OF AGRICULTURAL TRANSFERS AND PRODUCTION RIGHTS THROUGH THE YEAR 2020

Producer	Initial Share		1994/95 Total Ag. Transfer	1994/95 Production Rights	1995/96 Total Ag. Transfer	1995/96 Production Rights	1999/2000 Total Ag. Transfer (1)	1999/2000 Production Rights	2019/20 Total Ag. Transfer (1)	2019/20 Production Rights (2)
Appropriative Pool										
Chino Basin MWD	0	0.0000%	0	0	0	0	0	0	0	0
City of Chino	4,034	7.3567%	3,014	7,048	3,465	7,499	6,342	10,376	13,426	17,092
City of Chino Hills	2,111	3.8498%	1,475	3,586	1,357	3,468	2,811	4,922	2,946	4,865
City of Norco	202	0.3684%	140	342	130	332	138	340	151	335
City of Ontario	11,374	20.7426%	8,155	19,529	8,278	19,652	9,752	21,126	17,943	28,280
City of Pomona	11,216	20.4545%	7,834	19,050	7,211	18,427	7,661	18,877	8,381	18,574
City of Upland	2,852	5.2012%	1,992	4,844	1,834	4,686	1,948	4,800	2,131	4,723
Cucamonga County Water District	3,619	6.5999%	2,528	6,147	2,327	5,946	3,000	6,619	3,232	6,521
Fontana Union Water Company	6,397	11.6661%	4,468	10,865	4,113	10,510	4,369	10,766	4,780	10,594
Fontana Water Company	0	0.0000%	0	0	0	0	542	542	542	542
Jurupa Community Services District	1,593	2.9051%	1,113	2,706	2,435	4,028	3,568	5,161	13,431	14,879
Marygold Mutual Water Company	655	1.1945%	458	1,113	421	1,076	447	1,102	489	1,085
Monte Vista Irrigation Company	677	1.2346%	473	1,150	435	1,112	462	1,139	506	1,121
Monte Vista Water District	4,824	8.7975%	3,370	8,194	3,102	7,926	3,352	8,176	3,662	8,046
Mutual Water Co. of Glen Avon Heights	468	0.8535%	326	794	301	769	320	788	350	775
San Antonio Water Company	1,507	2.7483%	1,052	2,559	969	2,476	1,029	2,536	1,126	2,496
San Bernardino County Prado Parks	0	0.0000%	0	0	0	0	0	0	0	0
Santa Ana River Water Company	1,301	2.3726%	909	2,210	836	2,137	889	2,190	972	2,154
Southern California Water Company	412	0.7514%	287	699	265	677	281	693	308	682
West End Consolidated Water Company	948	1.7289%	662	1,610	610	1,558	648	1,596	708	1,570
West San Bernardino County Water Dist	644	1.1745%	450	1,094	414	1,058	440	1,084	481	1,066
Subtotal Appropriators	54,834	100.0000%	38,705	93,539	38,502	93,336	48,000	102,834	75,565	125,399
Overlying Agricultrual Pool (3)	82,800			44,095		44,298		34,800		7,235
Overlying Non-Agricultural Pool	7,366			7,366		7,366		7,366		7,366
Total	145,000			145,000		145,000		145,000		140,000

(1) -- year 2020 agriucltural transfer from the Chino Basin Water Resources Management Study, Final Runs; year 2020 modified from same.
(2) -- overlying agricultural pool production rights are 82,800 acre-ft/yr; values shown above represent actual or projected production by agricultural pool.
(3) -- appropriative pool production rights reduced after year 2017 to eliminate 5,000 acre-ft/yr overdraft as provided in Judgment.

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Water Resources Engineer

TABLE 2-2
COMPONENTS OF THE SAFE YIELD AS ADOPTED IN THE CHINO BASIN JUDGMENT(a)

Hydrologic Component	Annual Average (acre-ft/yr)	(%)
Inflows to Chino Basin		
Deep Percolation		
Precipitation and Surface Inflow	47,500	33%
Imported Water	7,000	5%
Irrigation		
Domestic	9,800	7%
Agriculture	51,900	36%
Artificial Recharge	3,900	3%
Recharge of Sewage	18,200	13%
Subsurface Inflow	7,000	5%
Total Inflow	145,300	100%
Outflows from Chino Basin		
Subsurface Outflow	7,200	4%
Extractions	180,000	96%
Total Outflow	187,200	100%
Hydrologic Balance		
Estimated Annual Average Change in Storage 1965-1974	-40,000	
Safe Yield (equal to average annual extraction plus annual average change in storage)	140,000	

TABLE 2-3
CIGSM ESTIMATE OF THE HYDROLOGIC BUDGET OF THE CHINO BASIN
(acre-ft)

Year	Deep Percolation of Applied Water & Precipitation	Net Recharge from Stream Flow	Artificial Recharge(1)	Subsurface Inflow from Adj. Basins and Mtns.	Groundwater Pumpage	Change in Storage	End of Period Storage
1961	82,510	-7,071	11,561	42,796	217,536	-87,740	5,202,000
1962	128,586	-4,822	10,785	49,446	201,790	-17,795	5,184,205
1963	89,052	-8,167	12,466	44,218	190,303	-52,734	5,131,471
1964	89,253	-13,229	13,959	42,232	201,234	-69,019	5,062,452
1965	88,310	-9,024	13,902	39,705	190,358	-57,465	5,004,987
1966	132,451	-8,248	14,362	45,717	199,904	-15,622	4,989,365
1967	143,451	-2,428	15,336	51,668	186,264	21,763	5,011,128
1968	101,621	-10,342	14,619	42,048	192,597	-44,651	4,966,477
1969	176,116	4,321	16,927	75,776	190,489	82,651	5,049,128
1970	86,765	-13,076	15,059	49,072	192,103	-54,283	4,994,845
1971	96,328	-10,250	16,179	44,580	197,057	-50,220	4,944,625
1972	91,686	-7,170	14,000	41,697	197,428	-57,215	4,887,410
1973	125,608	431	3,028	49,354	166,826	11,595	4,899,005
1974	100,452	-2,968	3,440	45,024	180,997	-35,049	4,863,956
1975	86,895	1,914	4,601	40,651	191,536	-57,475	4,806,481
1976	76,196	7,107	3,933	36,098	189,637	-66,303	4,740,178
1977	80,801	3,955	3,620	35,882	174,498	-50,240	4,689,938
1978	194,130	6,785	15,484	68,925	163,705	121,619	4,811,557
1979	134,128	-7,278	34,122	55,171	167,410	48,733	4,860,290
1980	169,980	-5,201	17,998	80,324	167,669	95,432	4,955,722
1981	74,789	-8,810	24,398	54,376	174,421	-29,668	4,926,054
1982	94,208	-6,532	23,049	59,171	162,814	7,082	4,933,136
1983	169,139	-5,897	31,792	83,368	151,878	126,524	5,059,660
1984	74,496	-11,399	19,033	60,153	172,420	-30,137	5,029,523
1985	84,821	-8,934	13,388	54,499	176,218	-32,444	4,997,079
1986	94,858	-4,196	16,330	54,755	167,119	-5,372	4,991,707
1987	60,651	-9,595	17,181	44,263	180,778	-68,278	4,923,429
1988	66,741	-5,589	15,636	43,263	180,115	-60,064	4,863,365
1989	66,837	-3,905	7,407	40,351	189,513	-78,823	4,784,542
Statistics for Period 1961 to 1989							
Average	105,547	-5,159	14,607	50,848	183,263	-17,421	4,950,473
Max	194,130	7,107	34,122	83,368	217,536	126,524	5,202,000
Min	60,651	-13,229	3,028	35,882	151,878	-87,740	4,689,938
Statistics for Period 1965 to 1974							
Average	114,279	-5,875	12,685	48,464	189,402	-19,850	4,961,093
Max	176,116	4,321	16,927	75,776	199,904	82,651	5,049,128
Min	86,765	-13,076	3,028	39,705	166,826	-57,465	4,863,956

Source: Revised and final calibration simulations for the CBWRMS; previously unpublished. The results listed above are slightly different than reported by Montgomery Watson (1993) and supersede previously reported values.

(1) -- artificial recharge equals sum of reclaimed water and imported water recharge

TABLE 2-4
CIGSM-ESTIMATED DISTRIBUTION OF SURFACE RECHARGE IN THE CHINO BASIN

(acre-ft)

Year	Recharge in Santa Ana River Tributaries	Recharge in Santa Ana River Riverside Narrows to Norco	Recharge in Santa Ana River Norco to Prado Dam	Subtotal Stream Recharge	Streamflow Recharge in Spreading Basins	Imported Water Recharge				Subtotal Recharge in Spreading Basins	Reclaimed Water Recharge
						CBWCD	Watermaster	County	Subtotal Imported Recharge		
1961	747	1244	-9,062	-7,071	11,561	0	0	0	0	11,561	8,900
1962	4,880	1296	-10,998	-4,822	10,785	0	0	0	0	10,785	8,000
1963	2,149	3258	-13,574	-8,167	12,466	0	0	0	0	12,466	9,800
1964	1,598	1414	-16,241	-13,229	13,959	0	0	0	0	13,959	11,300
1965	2,452	2727	-14,203	-9,024	10,900	3,002	0	0	3,002	13,902	10,900
1966	4,117	525	-12,890	-8,248	14,362	0	0	0	0	14,362	11,600
1967	6,168	2823	-11,419	-2,428	14,810	526	0	0	526	15,336	12,400
1968	2,631	2789	-15,762	-10,342	12,390	2,229	0	0	2,229	14,619	12,000
1969	13,376	2864	-11,919	4,321	16,927	*0*	*0*	*0*	0	16,927	14,200
1970	2,397	5292	-20,765	-13,076	15,059	0	0	0	0	15,059	14,300
1971	2,450	3930	-16,630	-10,250	16,179	0	0	0	0	16,179	15,400
1972	1,890	3331	-12,391	-7,170	14,000	0	0	0	0	14,000	14,000
1973	5,402	2711	-7,682	431	3,028	0	0	0	0	3,028	2,600
1974	3,305	3217	-9,490	-2,968	2,600	840	0	0	840	3,440	2,600
1975	3,112	5135	-6,333	1,914	2,600	2,001	0	0	2,001	4,601	2,600
1976	2,198	6041	-1,132	7,107	3,000	933	0	0	933	3,933	3,000
1977	3,019	3237	-2,301	3,955	3,100	520	0	0	520	3,620	3,100
1978	13,277	5079	-11,571	6,785	8,506	0	6,978	0	6,978	15,484	3,200
1979	5,121	3095	-15,494	-7,278	21,601	0	12,512	9	12,521	34,122	3,000
1980	9,500	5372	-20,073	-5,201	3,300	0	14,437	261	14,698	17,998	3,300
1981	1,634	4255	-14,699	-8,810	8,833	0	15,248	317	15,565	24,398	3,500
1982	3,478	4548	-14,558	-6,532	3,800	0	19,042	207	19,249	23,049	3,800
1983	8,012	784	-14,693	-5,897	18,604	0	13,188	0	13,188	31,792	3,900
1984	1,405	5771	-18,575	-11,399	5,256	0	13,777	0	13,777	19,033	0
1985	1,553	4651	-15,138	-8,934	1,200	0	12,188	0	12,188	13,388	0
1986	2,984	6533	-13,713	-4,196	0	0	16,330	0	16,330	16,330	0
1987	1,176	2819	-13,590	-9,595	3,572	0	13,609	0	13,609	17,181	0
1988	2,156	4519	-12,264	-5,589	0	0	15,636	0	15,636	15,636	0
1989	1,590	4253	-9,748	-3,905	0	0	7,407	0	7,407	7,407	0
					Statistics for Period 1961 to 1989						
Average	3,923	3,569	-12,652	-5,159	8,703	347	5,529	27	5,903	14,607	6,117
Max	13,376	6,533	-1,132	7,107	21,601	3,002	19,042	317	19,249	34,122	15,400
Min	747	525	-20,765	-13,229	0	0	0	0	0	3,028	0
					Statistics for Period 1965 to 1974						
	4,419	3,021	-13,315	-5,875	12,026	660	0	0	660	12,685	11,000
	13,376	5,292	-7,682	4,321	16,927	3,002	0	0	3,002	16,927	15,400
	1,890	525	-20,765	-13,076	2,600	0	0	0	0	3,028	2,600

Source: Revised and final calibration simulations for the CBWRMS; previously unpublished. The results listed above are slightly different than reported by Montgomery Watson (1993) and supersede previously reported values.

TABLE 2-5
PROJECTED CHINO BASIN REPLENISHMENT OBLIGATION
AT CURRENT SAFE YIELD
(acre-feet)

Producer	Projected Over/(Under) Production																				
	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Appropriative Pool																					
CBMWD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CBWM	0	0	4,300	6,911	6,911	6,911	6,911	6,911	6,911	6,911	6,911	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
City of Chino	(3,507)	(3,741)	(4,011)	(3,756)	(3,501)	(3,246)	(2,991)	(2,736)	(2,481)	(2,226)	(1,661)	(1,103)	(545)	13	570	1,128	1,686	2,244	2,801	3,359	3,771
CCWD (inc. FUWC)	(4,122)	(2,859)	(1,212)	(717)	(221)	(726)	(230)	265	760	1,256	(3,588)	(1,506)	(1,424)	(1,342)	(1,260)	(1,178)	(1,096)	(1,015)	(933)	(851)	(764)
FWC	12,613	12,832	13,130	13,298	13,465	13,633	13,801	13,969	14,136	14,304	15,070	15,463	15,855	16,248	16,640	17,033	17,426	17,818	18,211	18,603	18,996
JCSD(inc Glen Avon)	7,166	6,933	3,660	(855)	(912)	(969)	(1,026)	(1,083)	(1,139)	(1,196)	(1,253)	(795)	(158)	478	1,114	1,750	2,386	3,023	3,659	4,295	4,931
Marygold MWC	(977)	(975)	(974)	(972)	(970)	(969)	(967)	(966)	(964)	(962)	(961)	(953)	(945)	(938)	(930)	(923)	(915)	(907)	(900)	(892)	(885)
MVWD	2,653	3,234	3,861	3,875	3,890	3,905	3,919	3,934	3,948	3,963	3,978	4,019	4,061	4,102	4,144	4,186	4,227	4,269	4,310	4,352	4,394
Monte Vista IC	(966)	(965)	(963)	(961)	(960)	(958)	(956)	(955)	(953)	(951)	(950)	(942)	(934)	(926)	(918)	(910)	(903)	(895)	(887)	(879)	(871)
City of Norco	461	1,016	1,251	2,392	2,653	2,914	3,176	3,437	3,698	3,959	3,340	3,381	3,422	3,463	3,505	3,546	3,587	3,628	3,669	3,710	3,751
City of Ontario	10,423	10,389	10,389	12,366	13,993	15,970	17,948	19,925	21,902	23,879	25,857	26,780	27,703	28,626	29,549	30,472	31,395	32,318	33,241	34,164	35,087
City of Pomona	(0)	(24)	(75)	(51)	(26)	(2)	22	47	71	96	120	250	380	510	641	771	901	1,031	1,161	1,291	1,421
San Antonio WC	(1,958)	(1,954)	(1,950)	(1,947)	(1,943)	(1,939)	(1,935)	(1,932)	(1,928)	(1,924)	(1,920)	(1,903)	(1,885)	(1,868)	(1,850)	(1,833)	(1,816)	(1,798)	(1,781)	(1,763)	(1,746)
SB County Parks	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
City of Chino Hills(b)	(693)	(258)	(173)	(92)	(10)	72	154	235	317	399	3,514	3,525	3,536	3,546	3,557	3,568	3,578	3,589	3,599	3,610	3,641
SARWC	(329)	(333)	(338)	(342)	(347)	(352)	(356)	(361)	(365)	(370)	(374)	(354)	(335)	(315)	(295)	(275)	(255)	(235)	(215)	(195)	(175)
So. Cal. WC	(160)	(143)	(126)	(109)	(92)	(75)	(58)	(41)	(24)	(7)	10	31	51	72	93	114	135	155	176	197	218
City of Upland	492	536	580	787	995	1,203	1,410	1,618	1,826	2,034	2,241	2,288	2,335	2,382	2,430	2,477	2,524	2,571	2,618	2,665	2,712
WECWC	(203)	(201)	(199)	(196)	(194)	(192)	(189)	(187)	(185)	(182)	(180)	(169)	(158)	(147)	(136)	(125)	(114)	(103)	(92)	(81)	(70)
West SB County WD	(257)	(240)	(222)	(204)	(187)	(169)	(152)	(134)	(116)	(99)	(91)	(68)	(44)	(21)	3	26	50	73	97	120	59
Arrowhead MTN	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)
Los Serranos	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)
Pyrite	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)
Subtotal	20,398	23,006	26,686	29,186	32,304	34,772	38,240	41,707	45,175	48,643	49,823	54,705	57,675	60,645	63,615	66,585	69,555	72,525	75,495	78,466	81,229
Overlying (Non Ag) Pool																					
Ameron	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)	(98)
Concock	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)	(318)
Kaiser	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)	(710)
Quaker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SB County	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
SCE	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593
Angelica	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Mira Loma Space Center	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)
Sunkist	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)	(1,108)
Swan Lake	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)	(159)
Praxair	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)	(257)
CSI	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
West Venture	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)	(16)
GE	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Subtotal	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)	(1,421)
Over/(Under) Production Totals	18,977	21,586	25,265	27,765	30,884	33,352	36,819	40,287	43,755	47,222	48,403	53,284	56,254	59,224	62,194	65,165	68,135	71,105	74,075	77,045	79,809

TABLE 2-6
METROPOLITAN WATER RELATED COSTS AND PRESENT WORTH ANALYSIS

Commodity Rate/Charges	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	Total
Metropolitan Imported Water (as of 1/97)																						
Untreated Water	$365	$370	$373	$373	$378	$383	$390	$397	$404	$409	$414	$419	$424	$429	$439	$439	$439	$444	$444	$444	$444	
Untreated Water - seasonal	$274	$285	$288	$288	$293	$298	$305	$312	$319	$324	$329	$334	$339	$344	$354	$354	$354	$359	$359	$359	$359	
Treated Water	$447	$454	$462	$467	$477	$487	$497	$507	$517	$527	$537	$547	$557	$567	$577	$577	$577	$582	$582	$582	$582	
MWD Readiness-To-Serve Charge ($/AF)	$58	$61	$64	$67	$71	$74	$78	$82	$86	$90	$95	$100	$104	$110	$115	$121	$127	$133	$140	$147	$154	
MWD New Demand Charge ($/AF)(a)	$1,500																					
Replenishment/Purchase Charges	$15.30	$15.76	$16.23	$16.72	$17.22	$17.74	$18.27	$18.82	$19.38	$19.96	$20.56	$21.18	$21.81	$22.47	$23.14	$23.84	$24.55	$25.29	$26.05	$26.83	$27.63	
Effective Replenishment Rate(b)	$289	$301	$304	$305	$310	$316	$323	$331	$338	$344	$350	$355	$361	$366	$377	$378	$379	$384	$385	$386	$387	
Present Worth Analysis for One Acre-foot of Water																						
Replenishment Water																						
Commodity/Charges	$1,847	$362	$368	$372	$381	$390	$401	$413	$424	$434	$444	$455	$465	$476	$492	$499	$506	$518	$525	$533	$541	$10,847
Present Worth(c)	$1,546	$287	$278	$268	$262	$257	$253	$250	$247	$244	$241	$238	$236	$233	$234	$230	$226	$225	$222	$219	$217	$6,413
Annual Series(d)	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	$582	
Treated Water																						
Commodity/Charges(e)	$2,015	$526	$537	$546	$559	$573	$587	$602	$616	$631	$646	$661	$676	$692	$708	$714	$721	$732	$740	$747	$736	$14,964
Present Worth(c)	$1,687	$417	$405	$393	$384	$377	$371	$365	$359	$354	$350	$346	$342	$339	$336	$329	$322	$318	$313	$307	$295	$8,710
Annual Series(d)	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	$791	

(a) MWD New Demand Charge is a one time per acre-foot charge on new water deliveries to an agency.
(b) Effective Replenishment Rate equals the MWD Untreated Seasonal Rate plus the associated CBWM replenishment charges and the CBMWD administrative fees. Inflated at 3%.
(c) Present Worth is based on an interest rate of 6.5% over the 20 year period.
(d) Annual savings equal an annuity calculated from the water's present worth value at 6.5% over the 20 year period
(e) Treated water is not subject to the CBWM replenishment charges, but includes the CBMWD administrative fees.

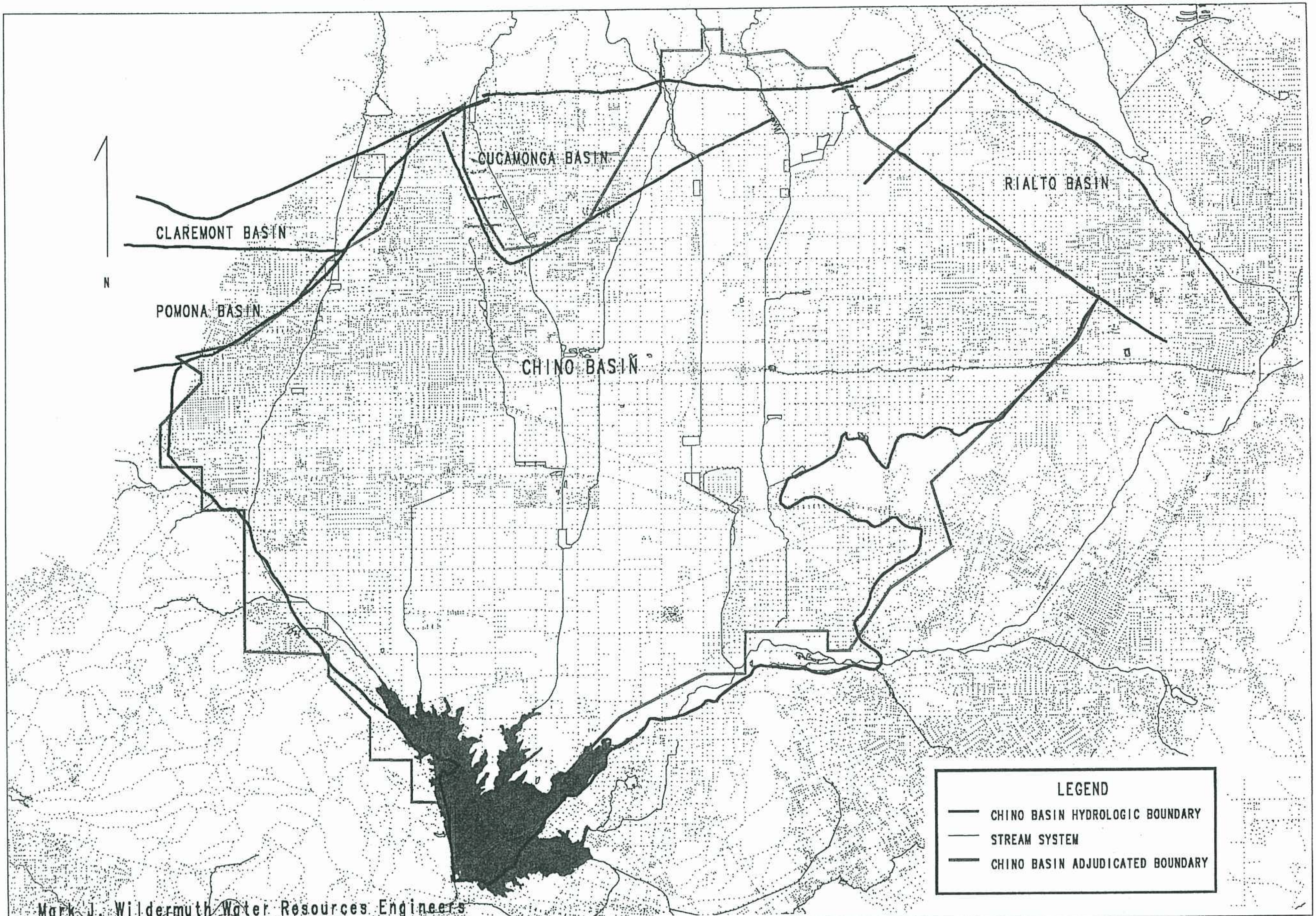
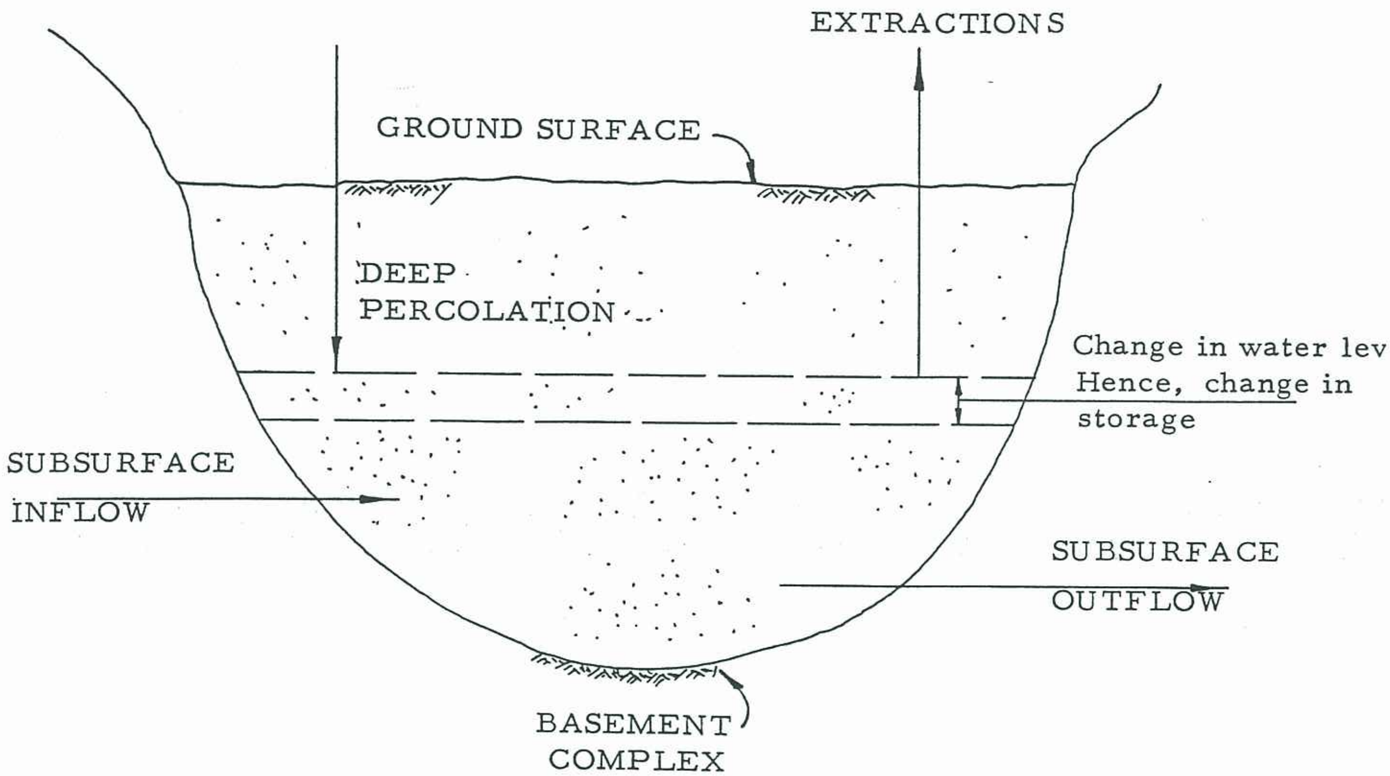


FIGURE 2-1 CHINO BASIN AND SURROUNDING GROUNDWATER BASINS

\\JGATE_C\ARCDATA\..\..\mp_2-1.sml

FIGURE 2-2
SCHEMATIC DIAGRAM OF HYDROLOGIC EQUATION
from William J. Carroll testimony, December 19 and 20, 1977 (Exhibit 5)



BASIN CROSS-SECTION

HYDROLOGIC EQUATION

Inflow = Outflow + Change in Storage

Deep Percolation + Subsurface Inflow =
Extractions + Subsurface Outflow + Change in Storage

Section 3

SECTION 3
STORM WATER RECHARGE

The Conservation District and San Bernardino County Flood Control District (SBCFCD) own and/or operate most flood control and conservation facilities within the Chino groundwater basin. Conservation and incidental recharge occurring in these facilities replenishes the Chino Basin. This section describes the existing recharge at these facilities, the potential for increased recharge and an estimate of the expected water quality of this recharge. Increases in storm water recharge may increase the safe yield. An increase in safe yield will be allocated to producers in the appropriative pool based on the individual producers initial share of the safe yield (CBMWD v. City of Chino, et al. Case No. 164327, Section VI -- Physical Solution, Sub-section B -- Pooling, Item 44, p.25).

EXISTING FACILITIES

Existing recharge facilities in the Chino Basin consists of existing flood retention and spreading basins and those basins that will be constructed within the next five years. Figure 3-1 shows the Chino Basin, major water related facilities, and the Chino Basin boundary. Existing flood retention and spreading basins analyzed in this study are listed in Table 3-1. The drainage system for each basin is also listed in Table 3-1. The different drainage system names correspond to the various creek systems within the study area.

CBWCD Spreading Basins

The Conservation District owns the College Heights, Montclair, Ely No. 3 and the Brooks Street Basins. The Conservation District has maintenance agreements with the SBCFCD to maximize conservation at Lower Cucamonga West and East Basins and at the Chris Basin.

SBCFCD Basins

The SBCFCD owns or has easements to operate the remaining flood retention and spreading basins in the Chino Basin with the exception of the Upland Basin. Most of the basins are used primarily for flood protection with recharge being an incidental benefit.

Other Basins

There are several other flood retention basins, groundwater recharge basins, and diversions within the San Antonio, Cucamonga, Day and Dear Creek watersheds that do not recharge the Chino Basin. These include: San Antonio spreading grounds operated by the Pomona Valley Protective Association (PVPA), Cucamonga Creek spreading grounds, Day Creek debris basin and conservation basins, and the Deer Creek debris basin. These facilities recharge the Claremont Heights and Cucamonga groundwater basins. The City of Upland owns a storm water disposal basin just north of Montclair No.1, hereafter referred to as the Upland Basin. The Upland Basin recharges the Chino Basin with storm waters from southern part of the City of Upland.

METHODOLOGY USED TO ESTIMATE RECHARGE AT FLOOD RETENTION/SPREADING BASINS

The recharge that occurs in a spreading basin in any time period can be estimated by solving the continuity equation:

$$\Delta S = I - O$$

Substituting individual inflow and outflow terms:

$$S_{t+1} - S_t = (QI_{t,t+1} - QO_{t,t+1}) * \Delta t + (R_{t,t+1} - P_{t,t+1} - E_{t,t+1}) * A_{t,t+1} * \Delta t$$

Where:

S_t	is the storage in a spreading basin at time *t*
$QI_{t,t+1}$	is rate of runoff into a spreading basin during the period *t* to *t+1*
$QO_{t,t+1}$	is the rate of outflow from a spreading basin during the period *t* to *t+1*
$R_{t,t+1}$	is the precipitation rate that falls on the spreading basin during the period *t* to *t+1*
$P_{t,t+1}$	is the percolation rate from the spreading basin during the period *t* to *t+1*
$E_{t,t+1}$	is the evaporation rate from the water surface in the spreading basin during the period *t* to *t+1*
Δt	duration of the time period *t* to *t+1*
$A_{t,t+1}$	average surface area of the water surface in the spreading basin during the period *t* to *t+1*

The daily percolation rate can be estimated by rearranging terms and solving for $P_{t,t+1}$

$$P_{t,t+1} = [S_t - S_{t+1} + (QI_{t,t+1} - QO_{t,t+1}) * \Delta t + (R_{t,t+1} - E_{t,t+1}) * A_{t,t+1} * \Delta t] / A_{t,t+1} * \Delta t$$

Every inflow and outflow term must be measured to estimate the recharge from the continuity equation. This requires flow measuring equipment for each storm drain and diversion into each spreading basin, measuring the discharge from each spreading basin outlet, measuring the water surface elevation in each spreading basin, the precipitation over each spreading basin and the evaporation from each spreading basin. The continuity equation would be solved each day that water is observed in the spreading basin. This approach would yield the volume of water recharged and the percolation rate in units of acre-ft/day and feet/day, respectively. After many years of monitoring, the average annual recharge from each spreading basin could be estimated.

An alternative to monitoring is to use simulation to estimate the terms in the continuity equation, and to estimate annual recharge to the groundwater basin from the overlying facilities. Simulation, as used herein, consists of using a surface flow model (in this case a computer program) with long term historical data to estimate all the inflow and outflow terms contained in the continuity equation. Runoff into each spreading basin is estimated from precipitation, evaporation, soils, land use and drainage system data. Discharge from each spreading basin is estimated based on the outlet works hydraulic characteristics and the water surface elevation in the basin. The model computes daily estimates of inflow, outflow, evaporation, percolation, and storage in each spreading basin. These results are then aggregated to annual estimates and annual recharge statistics are computed. A range in percolation rates is assumed and the average annual recharge is expressed as a range based on the range of percolation rates. A significant advantage of the simulation approach is that the Conservation District and Watermaster will not have to wait 20 or more years to develop enough data on spreading basin performance to estimate the average annual volume of water conserved at Conservation District facilities. The use of models also allows the Conservation District and Watermaster to evaluate the impact on recharge from adding new facilities, modifying existing facilities and operations, and scheduling of maintenance.

Simulation Model Description

Two existing models developed in a recent study entitled *Annual Recharge Estimates at Chino Basin Conservation District Spreading Basins,* by *Mark J. Wildermuth, Water Resources Engineer* (October 1995) were modified and used in this study -- a runoff model and a routing model.

Runoff Model. Daily runoff is estimated for the watershed tributary to each spreading basin using a combination of methods:

> Valley floor areas use a modified version of the method described in *Urban Hydrology for Small Watersheds* (SCS, 1986).
>
> Mountain areas use daily flow data from the USGS, translated to ungaged basins using areal proration.

The mountain areas consist of the watersheds located in the San Gabriel Mountains. The mountain watershed hydrologic processes are similar to valley floor processes with the exceptions that the mountain watersheds can produce sustained base flows, delayed runoff due to snow pack storage and temporary groundwater storage in the mountain watersheds. The measured daily flows from the mountain areas are stationary, that is, their daily flow statistics are not changing over time due to influences from land development or other anthroprogenic activities.

By contrast the valley floor areas have been in a constant state of change as the land was converted from natural to agricultural and then to urban uses. There is no stationary stream flow data in the valley floor area that can be used to estimate flow into spreading basins.

Valley floor runoff is estimated in the SCS method from the equation:

$$Q = (P - I_a)^2 / [(P - I_a) + S]$$

Where:

Q	is runoff in inches
P	is the rainfall in inches
S	is the potential maximum retention after runoff begins, and
I_a	is the initial abstraction in inches.

The SCS, through studies of many small watersheds, found that I_a could be approximated by:

$$Ia = 0.2 * S$$

Thus, runoff becomes a function of P, the precipitation, and S, the potential maximum retention. S is related to the soil and cover conditions of a watershed through the *Curve Number* (CN).

$$S = [1000/CN] - 10$$

CN must be determined from soils and land use data. Soils data are contained in soil surveys prepared by the Department of Agriculture, Soil Conservation Service.

The watershed tributary to each spreading basin is subdivided into hydrologic areas based on the daily flow estimation method used and tributary area. Daily flows for the hydrologic areas tributary to a spreading basin are combined and become the daily inflow to a spreading basin. Some spreading basins have hydraulic limitations on their ability to capture local runoff such as Montclair Number 1, Brooks Street, the Lower Cucamonga basins, Lower Day, and the future Jurupa basin. In these cases, rating curves were used to estimate the daily flow that could be diverted into each basin. The results of the runoff model are written to binary files that are subsequently used as input to the routing model.

Runoff Model Data Requirements. The hydrologic data collected for this study include:

- precipitation data
- daily evaporation data
- daily flow data for mountain watersheds
- SCS soil surveys
- drainage maps
- as-built or design plans for all the flood retention/recharge spreading basins and flood control facilities

Routing Model. The routing model routes the flows between nodes. The routing plan is based on a nodal pattern that describes the inflows from the hydrologic areas of the runoff model and the directional flow logic dictated by the flood control channels and retention basins. Flows are routed through the retention and spreading basins using the *modified Puls* reservoir routing scheme described in most hydrology text books (see for example, page 246, *Introduction to Hydrology* (Viessman, Lewis and Knapp, 1989)). The routing model can also estimate the percolation in stream channels, although this feature was not used in this study. The daily, monthly, and annual recharge volumes at spreading basins are computed in the routing model. The results of the routing model are written to output files that are imported into spreadsheets for analysis.

Routing Model Data Requirements. The data required for the routing model include:

- storage-area-elevation and outflow elevation curves for each basin (Appendix A)
- daily percolation rates for each basin
- daily evaporation data
- Channel geometry where inflow to spreading basins is by diversion structure

Computational Time Step and Simulation Period

The computational time step or period used in this study is one day. This period was selected because of modeling accuracy issues and data availability. The use of long periods such as weeks, months, seasons or years will lead to gross over-estimates of the recharge at spreading basins. This occurs with long time steps because the estimated inflow is smeared out uniformly over the computational period. The long period runoff will be less than the long period recharge rate of the spreading basins. This results in over-estimation of actual recharge in the basin. Runoff generally comes from storms that last less than one day and almost always less than two to three days. Table 3-2 illustrates this point for the Los Angeles area. During the rainy season of October through March, the Los Angeles area will have about 12 storms with an average volume of 0.7 inches occurring over a 12-hour period. The time between storms is about 10 days. These statistics should translate comparably to the Chino Basin. In the watershed in this study, the time of concentration is on the order of a couple of minutes to a few hours. Ideally, the computational time period should be on the order of the time of concentration.

Data availability also drives the selection of the time period. Daily flow data is available from the USGS in digital format. Smaller time periods are not generally available. The availability of spatially representative, long-term rainfall data in digital format is limited to daily data. Thus, the computational time step of one day was selected as a compromise between computational accuracy and data availability.

The simulation period used in this study is October 1, 1933 to September 30, 1974, a period of 41 years or 14,974 days of continuous simulation. This period was selected to maximize the data available for this study and is the intersection between precipitation data available for a greater part of the study area (1934 to 1995) and the daily streamflow data available for the mountain watersheds (1929-1974).

Development of Model Data

The data used in the model and sources of data are summarized below.

Hydrologic Data. The hydrologic data for the Chino Basin area includes daily precipitation, daily discharge, daily evaporation and percolation rates. These data were collected from SBCFCD, USGS, Riverside County Flood Control District (RCFCD), and the County of Los Angeles.

<u>Precipitation Data.</u> Eight rain gauges in the basin, with historical data covering a majority of the simulation period, were selected for the model. The gauges and their elevation are listed in Table 3-2 and their locations are shown in Figure 3-2. The data used in this study were obtained from County of San Bernardino for gages 1026, 1034, 1067, 1192, 2017, 2194, 7619, and the County of Riverside for gage 1021.

Daily Discharge Data. Daily discharge data was obtained from the USGS for San Antonio Creek (11073000 and 11073200) and Cucamonga Creek (11073470).

Evaporation Rates. Evaporative losses from water stored in flood control/recharge basins is based on evaporation data collected at Puddingstone Reservoir located in the City of Pomona. The County of Los Angeles operates and collects data at this station daily.

Percolation Rates. A range of daily percolation rates was developed for each spreading basin based on a combination of previously published values from Table 9 in *Recharge in the Upper Santa Ana Valley, Southern California*, USGS Open File Report, Moreland, 1972; the *Artificial Recharge (AR) Module,* data files developed *by Mark J. Wildermuth, Water Resources Engineer* for the *Chino Basin Water Resources Management Study, 1994,* and engineering judgment. The range in percolation rates at each basin is intended to represent a range in percolation rates that could be expected between maintenance periods. Most of the basins studied herein are maintained improperly from a conservation perspective – the basins are either not maintained at all or have their bottoms occasionally ripped or disked.

Drainage Data. The surface water drainage delineation was based on topography and the location of flood control structures that exist or will be constructed in the next five years. In general, storm waters flow south towards the Santa Ana River through creeks and flood control channels. To model these storms flow, smaller sub-areas, within the larger watershed, were delineated as shown on Figure 3-3. Sub-area boundaries follow the area's drainage topography and discharge either into flood spreading basins or the larger creek channels. Drainage maps were obtained from San Bernardino County, City of Upland, City of Montclair, City of Ontario, City of Chino, City of Rancho Cucamonga, and City of Fontana. The existing drainage patterns were converted to the routing network shown in Figure 3-4.

Land Use Data. Existing and future land uses within the watershed are based on available SCAG information for 1993 and the CBWRMS for ultimate conditions. Land uses for the area are based on the Anderson code system that numerically distinguishes various land use types. Land use was used to estimate the amount of pervious and impervious areas within each hydrologic area. Pervious areas consist of agricultural uses, urban landscaping, fields and undeveloped areas that allow some precipitation to infiltrate into the ground. Impervious areas consist of roofs, streets, parking lots and other areas that do not allow percolation of precipitation or runoff. The spatial distribution of land uses for 1993 and the ultimate conditions are shown in Figures 3-5 and 3-6.

Soils and Hydrologic Soil Type Data. Hydrologic soil type delineations for the watershed are based on the SCS soil survey for this area and are contained in *Soil Survey of San Bernardino County, Southwestern Part* (SCS, 1977); *Soil Survey of Western*

Riverside County (SCS, 1971); *Soil Survey of the Pasadena Area, California* (SCS, 1917), and the *San Bernardino County Flood Control Manual.* The SCS soil classification system rates soils by runoff potential as an A, B, C or D. This range of soil types is from:

- type "A" soil, low runoff potential and high percolation rates, to
- type "D" soil, high runoff potential and low percolation rates.

Table 3-3 lists the four soil categories and their engineering characteristics relative to modeling storm runoff. Figure 3-7 is a map showing the spatial distribution of hydrologic soil types in the watershed.

Hydrologic soil type and land use are used to develop the curve number (CN). The CN reflects the soil's ability to retain rainfall from storm events. CN's are lower for well draining sandy soils and higher for poor draining silty clay soils. The CN was estimated for the pervious part of each land use within the drainage areas. A composite CN was calculated for the pervious areas based on the various soil types and land uses and ranged from a low of 39 to a high of 78. The impervious areas were assumed to have a CN of 98. Tables 3-4 and 3-5 list the hydrologic areas, drainage areas for both the impervious and pervious sections and the calculated CN's for 1993 land use and ultimate land use conditions, respectively.

Operational Characteristics. The operation of the retention and spreading basins is based on storage-area-elevation and outflow curves. Operational data for each basin was taken from existing engineering documents, if available, or developed from as-built construction drawings. Operational data for the Montclair, Brooks Street, Ely and Lower Cucamonga/Chris basins were obtained from the *October 1995 Annual Recharge Estimates at Chino Basin Conservation District Spreading Basins, by Mark J. Wildermuth, Water Resources Engineer.* Mr. Hiny Peters of the SBCFCD provided data for the proposed operation of the proposed Rich, San Sevaine, and Jurupa Basins from their planned San Sevaine improvement project. Operational data for the remaining spreading basins were developed as part of this study. All the curves used as part of this study are contained in Appendix A.

Anecdotal information regarding the operation of the San Antonio dam was obtained from Cecil McCallister of the PVPA. Anecdotal information regarding the operation of the Montclair basins was obtained from Jim Theirl of Watermaster and Frank Ballance of the County of San Bernardino.

RECHARGE ESTIMATES

Recharge estimates were developed for 1993 and ultimate land use conditions for a range of percolation rates that are believed representative of percolation at each basin given the underlying geology and time since maintenance. The estimates presented herein assume that the basins are maintained for recharge. Most of the basins are not properly maintained for recharge. Therefore, the estimates presented below represent the potential recharge of existing basins.

Recharge Estimates in Existing Basins

The daily recharge at each basin was estimated using the daily runoff and routing model. Monthly and annual recharge estimates were developed by aggregating daily recharge values. Other statistics include standard deviation, coefficient of variance, maximum, and minimum, the frequency of recharge occurring in a given month, and the fraction of annual recharge that occurs in a given month. These statistics are included in Table 3-6.

Statistics for the spreading basins shown on Table 3-6 illustrate recharge occurrence and variability for the spreading basins' recharge activities over the 41-year period. The monthly averages, maximums and minimums show the relative magnitude and range of recharge occurring at the spreading basins. Calculated average percent totals for each month is the percentage of annual recharge that occurs during that month for the spreading basin. The standard deviation and the coefficient of variation describe the variability within each month and year.

A range of percolation rates, low, medium and high, was developed for each basin to reflect the range of percolation rates expected between maintenance periods. Table 3-8 contains the estimated recharge for this range of percolation rates. Recharge at Conservation District facilities ranges from 6,500 to 8,400 acre-ft/yr under existing conditions to 6,900 to 9,200 acre-ft/yr under ultimate conditions. Similarly, recharge for the entire Chino groundwater basin ranges from 24,900 to 30,300 acre-ft/yr and 28,500 to 35,600 acre-ft/yr. The average estimated increase in percolation between the low and high percolation rates is about 25 percent even though the range in percolation rates range from 50 percent or more of the low percolation rate. This occurs because decreasing percolation rates can be compensated by increasing operational storage – the basins will use more storage and hold water longer when percolation rates drop between maintenance cycles.

Increase in Recharge Through Expansion in Conservation Storage

A sensitivity analysis was done to quantify potential recharge increases by the enlargement of conservation storage at each spreading basin. Table 3-8 contains the estimated increase in recharge associated with increased conservation storage. Annual average recharge at some basins decline when conservation storage was increased at upstream basins. This occurs because an increase in recharge upstream of a basin reduces the inflow to downstream basins—particularly for small frequent storms. Basins that show a net increase in recharge with incremental increase in conservation storage indicates potential for increased conservation.

The costs associated with expanding conservation storage were estimated assuming conservation storage could be expanded only by excavation. Low and high unit costs for expanding conservation storage were estimated. The cost components included:

- High cost—includes engineering, administration, excavation and disposal costs. Engineering and administration costs are estimated at $2,000 per acre-ft. Excavation and disposal costs are estimated at $8,000 per acre-ft (~$5/cubic yard).

- Low cost--engineering and administration. Engineering and administration costs are estimated at $2,000 per acre-ft.

These costs were amortized costs at 6.5% over the 20-year planning period. The low cost scenario assumes there is a nearby market for fill material. The range in cost for each basin is listed in Table 3-8. The cost of water conserved ranges from $2 per acre-ft to $2,600 per acre-ft.

Increased recharge at these basins will partly offset the need for additional imported water from Metropolitan. Current estimates for imported replenishment water from the Metropolitan are contained in Table 2-6. The estimated 20-year present worth of new water from Metropolitan is about $6,400 per acre-ft or $582 per acre-ft. Increased recharge from expansion of conservation storage with an annualized cost under $582 per acre-ft, is considered cost effective.

Practical Conservation Storage Enlargement Projects

The potential for increased recharge identified in Table 3-8 was studied in detail to maximize conservation subject to physical basin expansion limits, available runoff and acceptable costs. Physical limits include a minimum bottom foot-print area of one acre to allow for operating heavy equipment in the bottom of the basin, new excavation depth limited to 20 feet, and a requirement, where known, for at least 20 feet of permeable sediment beneath each basin. Available runoff into the spreading basins is based on 41 years of rainfall data, estimated runoff and physical facilities transporting runoff into the basins. Acceptable costs for new recharge are also assumed to be costs less than $582 per acre-ft.

The maximum increase in recharge from expanding conservation storage was estimated by running several recharge simulations for each basin starting at the upstream end of the

Chino Basin and working through the entire Chino Basin. The average annual recharge and associated costs were estimated subject to the limiting criteria described above. This analysis is summarized in Figures 3-8 to 3-14 and Table 3-9. The results in Figures 3-8 to 3-14 and Table 3-9 show that under the low cost scenario, basin size and runoff constraints govern projects with costs clearly under the annualized $582 per acre-ft limit. Under the high cost scenario, the $582 per acre-ft limit governs all the basins except basins in the West Cucamonga Creek system and the Declez Basin.

Table 3-10 shows that recharge can economically be increased from 3,000 acre-ft/yr to 3,700 acre-ft/yr considering both physical and financial limits at each basin and basin system. The overall program costs, under the high cost scenario in Table 3-10, is below the target price of $582 per acre-ft. Table 3-10 summarizes the increase in recharge for the watershed. Recharge within the basin increases from about 3,000 acre-ft/yr to 3,700 acre-ft/yr under the economic premise that the overall costs of new recharge from basin improvements is less than the purchase of replenishment water from Metropolitan.

Modifications to Increase Conservation Storage. Conservation storage can be accomplished through either excavation or revised operation of the basins. Excavation involves studying a basin's recharge patterns, and conscientiously selecting areas from which material can be extracted to increase storage capacity and maintain percolation capacity as described in Section 5. Revised operation of the spreading basins to maintain water in storage for percolation is another viable alternative. Depending on the basin, facilities may or may not be in place to allow this type of operation. The key issue for this type of conservation storage is developing institutional arrangements with the SBCFCD to modify flood control operations to hold more water in storage from smaller, more frequent storm events while ensuring the same level of flood protection. Modifying flood control operations could be less costly than excavation or could be done in conjunction with excavation in select areas to further increase conservation storage.

RECHARGE ESTIMATES FOR NEW SPREADING BASINS IN SOUTHERN CHINO BASIN

During the early part of this study, the Conservation District expressed concern about well production problems and ground fissuring in the vicinity of the City of Chino and CIM. The Conservation District requested that we investigate the feasibility of constructing new basins in the southern part of the Chino Basin that could be built as the area transitions from agricultural uses to urban uses. The sediments in this area contain finer-grained materials than sediments in the northern half of the Chino Basin. In the past, recharge in this area has generally been written off as infeasible due to low percolation rates and the amount of land required to recharge significant quantities of water.

Potential Recharge Sites

Figure 3-15 shows the lower Chino Basin and six potential recharge sites. These recharge sites were selected low in the Chino Basin but still high enough such that recharge in these basins could theoretically be recovered in wells. A range of basin sizes and percolation rates were modeled to determine potential recharge. Table 3-11 summarizes the results of the models runs for 5-acre to 50-acre basins. Percolation rates were assumed to vary between 0.1 to 0.5 feet/day. The runoff and routing models were used to estimate recharge at these recharge sites. Estimated recharge for these basins ranges from 463 acre-ft/yr to 5,610 acre-ft/yr of recharge depending on basin size and percolation rates.

Recharge Cost Estimates

Costs estimates for recharge in the lower Chino area are based on two alternatives. The first considers the basins for conservation only. The cost for their design and construction would be incurred solely by the Conservation District. The second alternative assumes that the basins are primarily used for flood control and the SBCFCD incurs the design and construction costs and half the land costs and Conservation District pays the remaining land cost. Figures 3-16 to 3-27 contains the cost projections for each of the spreading basins for the two alternatives and shows the sensitivity associated with land values. Capital costs include land costs, engineering, inlets, outlets and earth work. Capital costs were amortized at 6.5% over 20 years.

Basins with annualized recharge costs of less than $582/acre-ft are considered viable. All basins under alternative two are considered viable projects, even at low percolation rates. In alternative one, Basins 2, 4, 5, and 6 are viable. Basins 1 and 3 are only viable at the higher percolation rates and lower land prices.

Hydrogeologic studies and land cost appraisals are required to determine which basins are economically feasible. Hydrogeologic studies are necessary to estimate percolation rates and to ensure that the storm water recharged in these basins can be put to beneficial use in the Chino Basin. It may not be possible to capture the new recharge from these basins. New wells would have to be constructed to intercept the new recharge, otherwise the new recharge water will end up as rising water in the Santa Ana River.

STORM WATER QUALITY AT EXISTING BASINS

Very little water quality data exists for storm waters entering conservation basins in the Chino Basin. The Conservation District and Watermaster conducted limited water quality sampling in the Montclair, Ely, Lower Cucamonga West and Chris basins in 1996 and expanded the program 1997 to include basins throughout the Chino Basin. The laboratory results are included in Appendix B. With the exception of the Lower Cucamonga West basin, the water quality measured in these basins was excellent. Table 3-13 summarizes the range in total dissolved solids (TDS) and nitrate. The average TDS is about 110 mg/L (secondary drinking water MCL is 500 mg/L) and the average nitrate is about 1 mg/L as nitrogen (primary drinking water MCL is 10 mg/L). At the time of sampling, the Lower Cucamonga West basin was filled with dry weather flow or nuisance water and was not noticeably percolating. It should also be noted in Appendix B that during the 1997 sampling, Ely basin samples were taken from Ely #1 which contained General Electric groundwater discharge -- elevating many of the tested constituents.

TABLE 3-1
RECHARGE FACILITIES WITHIN THE CHINO BASIN WATERSHED

Facility	Owner	Drainage System
15th Street	SBCFCD	West Cucamonga Creek System
7th Street	SBCFCD	West Cucamonga Creek System
8th Street	SBCFCD	West Cucamonga Creek System
Brooks	CBWCD	San Antonio Creek System
Church	SBCFCD	Deer Creek System
Declez	SBCFCD	San Sevaine Creek System
Ely Basins	SBCFCD (No.1 & 2) & CBWCD (No.3)	West Cucamonga Creek System
Etiwanda Basin	SBCFCD	Etiwanda Creek System
Etiwanda Sp. Gr.	SBCFCD	Etiwanda Creek System
Hickory Basin	SBCFCD	San Sevaine Creek System
Jurupa Basin	SBCFCD	San Sevaine Creek System
Chris Basin	CBWCD	Lower Deer Creek
Lower Cucamonga East	SBCFCD	Cucamonga Creek
Lower Cucamonga West	SBCFCD	Cucamonga Creek
Lower Day	SBCFCD	Day Creek System
Montclair 1	CBWCD	San Antonio Creek System
Montclair 2	CBWCD	San Antonio Creek System
Montclair 3	CBWCD	San Antonio Creek System
Montclair 4	CBWCD	San Antonio Creek System
Rich Basin	SBCFCD	San Sevaine Creek System
Riverside	SBCFCD	Day Creek System
San Sevaine No. 1	SBCFCD	San Sevaine Creek System
San Sevaine No. 2	SBCFCD	San Sevaine Creek System
San Sevaine No. 3	SBCFCD	San Sevaine Creek System
San Sevaine No. 4	SBCFCD	San Sevaine Creek System
San Sevaine No. 5	SBCFCD	San Sevaine Creek System
Turner No. 5	SBCFCD	Deer Creek System
Turner No. 8	SBCFCD	Deer Creek System
Turner No.9	SBCFCD	Deer Creek System
Turner No.'s 3 and 4	SBCFCD	Deer Creek System
Upland Basin	City of Upland	San Antonio Creek System
Victoria Basin	SBCFCD	San Sevaine Creek System
Wineville	SBCFCD	Day Creek System

TABLE 3-2
STORM CHARACTERISTICS IN LOS ANGELES, CALIFORNIA

	For Entire Year	October to March
	Annual	
Number of Storms	17	12
Total Volume (in)	10	12
	Average Event	
Time Between Events (days)	22	9.5
Duration (hrs)	12	12
Volume (in)	0.65	0.7
Intensity (in/hr)	0.063	0.065

From Driscoll, in Chapter 1, *Stormwater Runoff and Receiving Systems -- Impact, Monitoring and Assessment*, Edited by Herricks, CRC Press,1995

TABLE 3-3
RAINFALL GAUGES USED WITHIN THE CHINO BASIN WATERSHED

Gauge	Local Name	Elevation	Location	Annual Average Rainfall	Period of Record
1067	Chino Substation-Edison	670	Chino	(In Final Report)	1927-1983
1034	Claremont/ Pomona College	1,196	Claremont	(In Final Report)	1896-1989
7619	San Antonio Canyon Sierra Power House	2,394	Upland	(In Final Report)	1901-1973
1192	Cucamonga County Water District	1,225	Rancho Cucamonga	(In Final Report)	1937-1992
1026	Ontario Fire Station	986	Ontario	(In Final Report)	1934-1992
1021	Mira Loma Space Center	827	Mira Loma	(In Final Report)	1943-1992
2194	Fontana Union Water Company (Town Site)	1,289	Lytle Creek	(In Final Report)	1926-1988
2017	Fontana 5N (Getchell)	2,020	Fontana	(In Final Report)	1927-1992

TABLE 3-4
SCS SOIL TYPES AND ENGINEERING PRINCIPLES

Soil Type	Soil Constituents	Engineering Properties
A	Deep, well to excessively drained sands or gravel	Low Runoff Potential, high infiltration rates, and high transmission rate.
B	Moderately deep to deep, moderately well to well drained soils with moderately fine to moderately course textures.	Moderate infiltration rates when wetted Moderate rate of transmission
C	Layers that impede downward flow or soils with moderately fine to fine texture	Slow infiltration rates when wetted Slow rate of transmission
D	Clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material	High runoff potential, very slow rate of water transmission

TABLE 3-5
HYDROLOGIC AREA'S PERVIOUS AND IMPERVIOUS ACRAGES AND ASSOCIATED CN'S
UNDER 1993 LAND-USE CONDITIONS

Hydrologic Area	Pervious Area (acres)	Pervioius Area CN	Impervious Area (acres)	Imperious Area CN
101	10,685	78	613	98
102	1,193	39	697	98
103	443	39	514	98
104	914	41	161	98
105	247	42	215	98
106	551	39	369	98
107	88	39	122	98
108	109	40	325	98
109	141	41	260	98
110	808	39	1,643	98
111	110	40	183	98
112	106	39	155	98
201	6,577	74	439	98
202	1,506	60	134	98
203	848	49	713	98
204	2,496	49	1,284	98
206	602	43	695	98
207	1,396	54	1,510	98
208	1,278	43	1,973	98
209	1,308	46	1,559	98
210	1,817	40	2,392	98
301	2,238	66	119	98
302	494	61	59	98
303	123	60	6	98
304	165	59	10	98
305	557	39	279	98
306	642	42	551	98
307	574	39	501	98
308	642	53	821	98
309	2,047	46	1,109	98
310	766	54	798	98
311	1,337	44	1,691	98
312	3,966	61	1,599	98
401	2,863	71	151	98
402	928	60	52	98
403	825	39	208	98
404	120	39	26	98
405	163	39	131	98
406	428	39	68	98
407	197	39	120	98
408	797	39	243	98
409	997	39	322	98
410	985	53	262	98
411	1,434	46	1,111	98
412	958	48	449	98
413	638	60	469	98
414	462	61	395	98
501	2,029	67	107	98
502	1,091	60	57	98
503	1,841	61	97	98
504	80	60	11	98
505	1,854	40	301	98
506	1,491	41	348	98
507	1,142	45	215	98
508	1,327	40	151	98
509	1,764	40	266	98
510	814	39	191	98
511	1,954	41	414	98
512	1,105	39	384	98
513	853	41	266	98
514	2,061	39	1,891	98
515	2,334	39	3,736	98
516	1,080	61	133	98
601	4,200	51	2,482	98

TABLE 3-6
HYDROLOGIC AREA'S PERVIOUS AND IMPERVIOUS ACRAGES AND ASSOCIATED CN'S UNDER ULTIMATE LAND-USE CONDITIONS

Hydrologic Area	Pervious Area (acres)	Perviolus Area CN	Impervious Area (acres)	Imperious Area CN
101	10454	79	844	98
102	928	39	961	98
103	322	39	635	98
104	480	41	595	98
105 (a)	207	42	255	98
106	448	39	471	98
107	44	39	166	98
108 (b)	109	41	325	98
109 (a)	68	42	333	98
110	720	39	1,731	98
111	75	42	217	98
112	60	39	201	98
201	6509	74	507	98
202	920	61	719	98
203(a)	252	49	1,309	98
204	1170	50	2,610	98
206(b)	602	45	695	98
207	1305	55	1,601	98
208(a,b)	1278	43	1,973	98
209	804	48	2,063	98
210	1250	40	2,959	98
301	2201	66	156	98
302	274	61	278	98
303	75	60	54	98
304	151	59	24	98
305(b)	557	39	279	98
306(b)	642	40	551	98
307(b)	574	39	501	98
308(b)	642	53	821	98
309	927	46	2,228	98
310	587	54	977	98
311(a)	792	44	2,236	98
312	2170	61	3,395	98
401	2862	71	151	98
402	905	60	76	98
403(b)	825	39	208	98
404(b)	120	39	26	98
405(b)	163	39	131	98
406	380	39	116	98
407	72	39	245	98
408	231	39	808	98
409	670	39	650	98
410	389	54	858	98
411(a)	1339	46	1,207	98
412(a)	592	48	815	98
413	468	60	639	98
414	235	61	622	98
501	2012	67	125	98
502	1050	61	97	98
503	1780	62	158	98
504(b)	80	60	11	98
505	1203	40	952	98
506	1302	41	536	98
507	887	46	471	98
508	737	40	741	98
509	1306	40	723	98
510	240	39	764	98
511	831	41	1,537	98
512	473	39	1,016	98
513	569	41	549	98
514	1761	39	2,191	98
515	1829	39	4,241	98
516(b)	1080	61	133	98
601(a)	1,401	51	5,281	98

(a) CN increased to match 1993 condition.
(b) Previous area reduced and Impervious area increased to match 1993 condition.

TABLE 3-7
RECHARGE PERFORMANCE UNDER EXISTING LAND-USE AND BASIN CONDITIONS

Basin	Statistic	Basin Recharge Activity												Totals
		October	November	December	January	February	March	April	May	June	July	August	September	
Montclair 1	Average (AF)	32	96	156	161	181	156	88	15	2	1	3	12	902
	Avg. % of Total	3.6%	10.6%	17.2%	17.8%	20.1%	17.3%	9.7%	1.6%	0.2%	0.1%	0.4%	1.4%	100.0%
	% Occurrence	68.3%	90.2%	92.7%	97.6%	92.7%	92.7%	92.7%	63.4%	19.5%	12.2%	24.4%	31.7%	
	Std Deviation	46	100	121	118	171	142	101	24	4	4	9	37	376
	Coeff of Var.	143.2%	104.1%	78.0%	73.1%	94.3%	90.9%	115.4%	162.4%	278.1%	467.9%	285.8%	301.7%	
	Max	166	412	413	456	600	553	415	90	21	24	51	181	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Montclair 2	Average (AF)	7	23	56	62	50	47	10	0	0	0	0	5	260
	Avg. % of Total	2.8%	8.8%	21.6%	23.9%	19.1%	18.0%	3.8%	0.0%	0.0%	0.0%	0.0%	2.0%	100.0%
	% Occurrence	7.3%	12.2%	41.5%	39.0%	34.1%	24.4%	7.3%	0.0%	0.0%	0.0%	0.0%	2.4%	
	Std Deviation	32	90	102	115	85	120	44	0	0	0	0	34	242
	Coeff of Var.	444.0%	390.3%	182.4%	185.7%	171.1%	256.8%	452.6%	N/A	N/A	N/A	N/A	640.3%	
	Max	159	517	421	477	279	547	243	0	0	0	0	217	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Montclair 3	Average (AF)	15	46	72	74	83	69	40	5	1	0	1	6	414
	Avg. % of Total	3.6%	11.1%	17.5%	17.8%	20.0%	16.8%	9.7%	1.3%	0.2%	0.1%	0.3%	1.5%	100.0%
	% Occurrence	68.3%	90.2%	92.7%	95.1%	92.7%	92.7%	87.8%	61.0%	19.5%	12.2%	22.0%	31.7%	
	Std Deviation	22	48	57	59	80	67	47	10	2	2	4	19	179
	Coeff of Var.	145.1%	104.9%	78.9%	79.6%	96.2%	96.8%	116.3%	183.0%	283.6%	455.3%	286.2%	304.8%	
	Max	77	218	188	245	269	279	203	40	9	10	22	93	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Montclair 4	Average (AF)	20	53	86	95	97	79	35	4	1	0	1	10	482
	Avg. % of Total	4.2%	11.0%	17.8%	19.7%	20.2%	16.4%	7.3%	0.9%	0.1%	0.1%	0.2%	2.1%	100.0%
	% Occurrence	70.7%	90.2%	92.7%	97.6%	95.1%	92.7%	90.2%	61.0%	19.5%	12.2%	22.0%	31.7%	
	Std Deviation	43	77	82	98	105	101	47	8	2	1	3	39	246
	Coeff of Var.	211.0%	144.9%	95.1%	103.7%	108.3%	127.9%	132.4%	186.2%	275.1%	459.4%	285.3%	375.2%	
	Max	205	337	292	433	366	471	212	32	7	8	17	205	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Upland	Average (AF)	29	96	180	181	171	146	66	10	1	1	2	11	893
	Avg. % of Total	3.3%	10.7%	20.1%	20.3%	19.2%	16.3%	7.3%	1.1%	0.1%	0.1%	0.3%	1.2%	100.0%
	% Occurrence	68.3%	90.2%	92.7%	95.1%	92.7%	92.7%	90.2%	63.4%	22.0%	12.2%	24.4%	29.3%	
	Std Deviation	53	155	186	235	191	186	87	19	3	3	7	46	486
	Coeff of Var.	179.1%	162.5%	103.3%	130.1%	111.8%	127.5%	133.3%	191.3%	283.7%	471.2%	285.6%	424.2%	
	Max	229	877	766	1,173	764	894	371	79	15	17	36	286	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	

TABLE 3-7 (CONT'D)
RECHARGE PERFORMANCE UNDER EXISTING LAND USE AND BASIN CONDITIONS

Basin	Statistic	Basin Recharge Activity												
		October	November	December	January	February	March	April	May	June	July	August	September	Totals
Brooks	Average (AF)	41	130	192	222	217	213	121	21	3	2	6	14	1,182
	Avg. % of Total	3.5%	11.0%	16.2%	18.8%	18.4%	18.0%	10.3%	1.7%	0.3%	0.1%	0.5%	1.2%	100.0%
	% Occurrence	63.4%	90.2%	92.7%	95.1%	92.7%	90.2%	90.2%	51.2%	22.0%	9.8%	14.6%	31.7%	
	Std Deviation	63	126	138	150	180	170	108	35	11	7	19	40	439
	Coeff of Var.	154.2%	97.1%	71.8%	67.4%	82.9%	79.7%	89.1%	171.0%	304.0%	391.4%	296.9%	281.1%	
	Max	233	499	457	587	598	664	410	147	50	39	85	207	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Etiwanda	Average (AF)	72	177	273	359	408	459	301	171	112	81	70	69	2,550
	Avg. % of Total	2.8%	6.9%	10.7%	14.1%	16.0%	18.0%	11.8%	6.7%	4.4%	3.2%	2.7%	2.7%	100.0%
	% Occurrence	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
	Std Deviation	42	298	322	452	455	618	347	151	91	65	64	65	1,960
	Coeff of Var.	58.3%	168.6%	117.8%	126.1%	111.3%	134.7%	115.1%	88.3%	81.9%	80.6%	92.6%	94.1%	
	Max	186	1,762	1,815	2,365	2,295	3,119	1,878	571	373	257	331	376	
	Min	13	28	35	58	35	55	34	29	17	12	13	13	
San Sevaine 1	Average (AF)	100	155	229	273	323	358	331	243	162	116	95	89	2,476
	Avg. % of Total	4.1%	6.3%	9.3%	11.0%	13.1%	14.4%	13.4%	9.8%	6.5%	4.7%	3.9%	3.6%	100.0%
	% Occurrence	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
	Std Deviation	58	104	143	139	190	251	233	210	135	94	76	62	1,330
	Coeff of Var.	57.3%	67.1%	62.3%	50.7%	58.9%	70.3%	70.6%	86.1%	83.4%	80.4%	79.9%	69.6%	
	Max	268	509	604	642	685	759	734	757	560	369	291	290	
	Min	22	40	50	81	51	81	48	41	25	18	20	20	
San Sevaine 2	Average (AF)	0	19	34	38	70	95	51	6	0	0	0	2	315
	Avg. % of Total	0.0%	6.1%	10.6%	12.1%	22.3%	30.2%	16.2%	2.0%	0.0%	0.0%	0.0%	0.5%	100.0%
	% Occurrence	2.4%	22.0%	41.5%	41.5%	43.9%	36.6%	24.4%	12.2%	0.0%	0.0%	2.4%	2.4%	
	Std Deviation	0	53	50	67	118	173	131	22	0	0	0	10	421
	Coeff of Var.	640.3%	278.0%	149.0%	174.8%	167.4%	181.7%	257.7%	347.9%	N/A	N/A	640.3%	640.3%	
	Max	1	246	202	257	515	570	515	117	0	0	2	67	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Rich	Average (AF)	45	73	110	132	148	161	149	107	70	49	40	38	1,122
	Avg. % of Total	4.0%	6.5%	9.8%	11.7%	13.2%	14.4%	13.3%	9.6%	6.2%	4.3%	3.6%	3.4%	100.0%
	% Occurrence	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
	Std Deviation	28	48	69	64	83	107	102	90	60	40	33	28	576
	Coeff of Var.	61.9%	65.9%	62.1%	48.5%	55.9%	66.4%	68.2%	83.9%	86.3%	82.9%	83.5%	74.3%	
	Max	119	230	279	288	298	330	319	327	249	156	125	124	
	Min	8	17	20	33	19	32	19	17	10	6	7	7	

TABLE 3-7 (CONT'D)
RECHARGE PERFORMANCE UNDER EXISTING LAND USE AND BASIN CONDITIONS

Basin	Statistic	Basin Recharge Activity												Totals
		October	November	December	January	February	March	April	May	June	July	August	September	
San Sevaine 3	Average (AF)	6	28	47	52	74	89	47	6	1	0	1	3	353
	Avg. % of Total	1.7%	7.9%	13.2%	14.9%	20.9%	25.2%	13.3%	1.7%	0.2%	0.1%	0.2%	0.8%	100.0%
	% Occurrence	65.9%	82.9%	92.7%	95.1%	90.2%	90.2%	95.1%	61.0%	31.7%	9.8%	17.1%	34.1%	
	Std Deviation	11	47	45	54	95	128	89	13	2	2	2	10	305
	Coeff of Var.	177.4%	168.1%	96.3%	103.0%	129.1%	143.8%	189.1%	207.7%	228.8%	558.6%	381.6%	369.7%	
	Max	43	220	158	219	427	473	373	65	7	12	14	56	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
San Sevaine 4	Average (AF)	0	5	10	11	17	21	8	0	0	0	0	1	72
	Avg. % of Total	0.0%	7.1%	13.6%	14.9%	23.2%	28.8%	11.0%	0.6%	0.0%	0.0%	0.0%	0.8%	100.0%
	% Occurrence	0.0%	17.1%	36.6%	34.1%	36.6%	31.7%	17.1%	2.4%	0.0%	0.0%	0.0%	2.4%	
	Std Deviation	0	16	15	19	30	40	24	3	0	0	0	4	87
	Coeff of Var.	N/A	301.2%	153.5%	178.1%	178.1%	193.4%	307.1%	640.3%	N/A	N/A	N/A	640.3%	
	Max	0	69	58	74	141	149	111	17	0	0	0	23	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
San Sevaine 5	Average (AF)	0	0	0	1	1	1	0	0	0	0	0	0	4
	Avg. % of Total	0.0%	6.9%	12.9%	15.0%	23.0%	30.8%	10.4%	0.3%	0.0%	0.0%	0.0%	0.7%	100.0%
	% Occurrence	0.0%	12.2%	31.7%	26.8%	36.6%	31.7%	12.2%	2.4%	0.0%	0.0%	0.0%	2.4%	
	Std Deviation	0	1	1	1	2	2	1	0	0	0	0	0	5
	Coeff of Var.	N/A	306.0%	175.8%	222.7%	192.2%	212.4%	361.0%	640.3%	N/A	N/A	N/A	640.3%	
	Max	0	4	3	6	8	11	7	1	0	0	0	1	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Victoria	Average (AF)	7	25	41	48	49	44	21	3	1	0	1	3	243
	Avg. % of Total	2.8%	10.5%	16.8%	19.6%	20.2%	18.1%	8.6%	1.2%	0.3%	0.1%	0.4%	1.3%	100.0%
	% Occurrence	65.9%	82.9%	92.7%	95.1%	90.2%	90.2%	92.7%	56.1%	29.3%	7.3%	17.1%	31.7%	
	Std Deviation	12	34	36	47	50	42	27	5	2	2	3	10	110
	Coeff of Var.	174.0%	134.1%	87.6%	98.6%	101.2%	95.4%	130.1%	174.6%	241.1%	568.0%	399.5%	333.0%	
	Max	51	143	141	212	199	153	122	20	8	12	21	47	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Hickory	Average (AF)	27	71	103	120	112	119	74	17	4	1	4	10	662
	Avg. % of Total	4.1%	10.7%	15.5%	18.1%	17.0%	17.9%	11.2%	2.5%	0.7%	0.2%	0.6%	1.5%	100.0%
	% Occurrence	61.0%	87.8%	90.2%	97.6%	92.7%	90.2%	90.2%	48.8%	26.8%	7.3%	19.5%	31.7%	
	Std Deviation	39	59	70	79	84	87	64	30	12	7	12	29	230
	Coeff of Var.	142.4%	83.3%	68.6%	65.6%	74.5%	73.6%	86.3%	175.5%	280.0%	463.2%	285.8%	285.3%	
	Max	144	249	275	338	269	396	277	133	59	41	55	165	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	

TABLE 3-7 (CONT'D)
RECHARGE PERFORMANCE UNDER EXISTING LAND USE AND BASIN CONDITIONS

Basin	Statistic	Basin Recharge Activity												Totals
		October	November	December	January	February	March	April	May	June	July	August	September	
Jurupa	Average (AF)	88	271	387	471	467	513	271	82	21	3	12	36	2,622
	Avg. % of Total	3.4%	10.3%	14.8%	17.9%	17.8%	19.6%	10.3%	3.1%	0.8%	0.1%	0.5%	1.4%	100.0%
	% Occurrence	75.6%	95.1%	100.0%	100.0%	97.6%	97.6%	100.0%	97.6%	56.1%	17.1%	31.7%	43.9%	
	Std Deviation	131	232	275	299	373	380	250	107	53	14	35	112	961
	Coeff of Var.	148.1%	85.6%	70.9%	63.5%	79.9%	74.0%	92.4%	131.8%	254.6%	448.8%	279.4%	311.7%	
	Max	442	967	956	1,243	1,311	1,529	1,025	418	277	76	184	612	
	Min	0	0	0	1	0	0	0	0	0	0	0	0	
Declez	Average (AF)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Avg. % of Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% Occurrence	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Std Deviation	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coeff of Var.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	Max	0	0	0	0	0	0	0	0	0	0	0	0	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Lower Day	Average (AF)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Avg. % of Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% Occurrence	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Std Deviation	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coeff of Var.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	Max	0	0	0	0	0	0	0	0	0	0	0	0	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Wineville	Average (AF)	74	188	279	317	368	382	240	100	65	37	34	46	2,132
	Avg. % of Total	3.5%	8.8%	13.1%	14.9%	17.3%	17.9%	11.3%	4.7%	3.1%	1.8%	1.6%	2.1%	100.0%
	% Occurrence	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
	Std Deviation	76	184	191	203	311	324	210	81	66	30	32	58	1,033
	Coeff of Var.	103.5%	97.8%	68.3%	63.9%	84.5%	84.8%	87.3%	80.7%	101.3%	79.4%	94.3%	127.9%	
	Max	282	808	635	864	1,123	1,097	852	354	339	116	164	274	
	Min	8	12	16	35	17	26	22	12	8	6	6	6	
Riverside	Average (AF)	34	98	197	272	283	244	85	14	44	0	1	22	1,293
	Avg. % of Total	2.7%	7.6%	15.2%	21.0%	21.9%	18.9%	6.5%	1.1%	3.4%	0.0%	0.1%	1.7%	100.0%
	% Occurrence	58.5%	85.4%	92.7%	97.6%	95.1%	90.2%	90.2%	51.2%	24.4%	4.9%	14.6%	26.8%	
	Std Deviation	89	183	256	344	362	394	215	47	162	1	3	92	933
	Coeff of Var.	259.3%	187.2%	130.0%	126.5%	128.2%	161.5%	254.1%	327.9%	366.0%	518.2%	348.6%	418.4%	
	Max	436	851	1,074	1,440	1,272	1,498	1,208	252	826	4	11	534	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	

TABLE 3-7 (CONT'D)
RECHARGE PERFORMANCE UNDER EXISTING LAND USE AND BASIN CONDITIONS

Basin	Statistic	Basin Recharge Activity												Totals
		October	November	December	January	February	March	April	May	June	July	August	September	
Church	Average (AF)	61	139	194	218	231	250	168	70	31	22	21	30	1,434
	Avg. % of Total	4.3%	9.7%	13.5%	15.2%	16.1%	17.4%	11.7%	4.9%	2.2%	1.5%	1.4%	2.1%	100.0%
	% Occurrence	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
	Std Deviation	65	104	118	118	161	178	130	56	24	17	19	40	565
	Coeff of Var.	105.5%	74.9%	61.0%	54.0%	69.8%	71.1%	77.2%	80.2%	75.5%	80.5%	92.6%	134.1%	
	Max	228	439	412	468	573	619	605	232	96	67	100	196	
	Min	3	6	9	18	11	14	13	6	6	4	4	4	
Turner 9	Average (AF)	13	40	54	65	62	63	38	11	1	0	2	4	354
	Avg. % of Total	3.7%	11.3%	15.3%	18.3%	17.5%	17.9%	10.8%	3.1%	0.4%	0.1%	0.5%	1.1%	100.0%
	% Occurrence	58.5%	85.4%	87.8%	97.6%	92.7%	95.1%	92.7%	56.1%	17.1%	9.8%	12.2%	26.8%	
	Std Deviation	20	33	36	37	44	42	34	16	4	1	6	13	121
	Coeff of Var.	156.2%	82.0%	66.3%	56.3%	70.3%	65.7%	90.2%	142.7%	285.2%	498.9%	353.9%	325.0%	
	Max	74	128	129	143	143	169	162	56	19	7	25	73	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Turner 8	Average (AF)	10	48	85	89	103	85	36	6	0	0	0	5	468
	Avg. % of Total	2.2%	10.2%	18.3%	19.1%	22.1%	18.1%	7.7%	1.3%	0.0%	0.0%	0.0%	1.0%	100.0%
	% Occurrence	19.5%	58.5%	65.9%	80.5%	75.6%	70.7%	48.8%	12.2%	0.0%	0.0%	0.0%	7.3%	
	Std Deviation	29	74	88	95	119	110	71	23	0	0	0	20	267
	Coeff of Var.	276.1%	154.8%	103.6%	106.9%	115.4%	129.7%	195.4%	390.6%	N/A	N/A	N/A	429.5%	
	Max	158	318	299	351	399	441	304	139	0	0	0	117	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Turner 5	Average (AF)	2	4	14	19	14	13	3	1	0	0	0	1	72
	Avg. % of Total	2.3%	5.6%	19.9%	26.2%	19.7%	18.4%	4.5%	1.9%	0.0%	0.0%	0.0%	1.5%	100.0%
	% Occurrence	2.4%	7.3%	26.8%	26.8%	24.4%	19.5%	4.9%	2.4%	0.0%	0.0%	0.0%	2.4%	
	Std Deviation	10	16	26	35	28	37	16	9	0	0	0	7	70
	Coeff of Var.	640.3%	399.4%	182.9%	186.4%	200.2%	277.0%	482.4%	640.3%	N/A	N/A	N/A	640.3%	
	Max	67	79	79	124	100	153	94	57	0	0	0	46	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Turner 3 & 4	Average (AF)	2	9	29	39	14	19	0	1	0	0	0	0	113
	Avg. % of Total	1.8%	8.1%	25.6%	34.5%	12.7%	16.5%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	100.0%
	% Occurrence	2.4%	7.3%	22.0%	26.8%	17.1%	14.6%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	
	Std Deviation	13	43	70	85	37	63	0	5	0	0	0	0	139
	Coeff of Var.	640.3%	462.5%	240.5%	217.5%	259.1%	338.3%	N/A	640.3%	N/A	N/A	N/A	N/A	
	Max	86	251	262	343	172	305	0	30	0	0	0	0	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	

TABLE 3-7 (CONT'D)
RECHARGE PERFORMANCE UNDER EXISTING LAND USE AND BASIN CONDITIONS

Basin	Statistic	Basin Recharge Activity												Totals
		October	November	December	January	February	March	April	May	June	July	August	September	
15th Street	Average (AF)	28	86	139	153	171	150	85	14	1	1	3	13	845
	Avg. % of Total	3.4%	10.2%	16.4%	18.1%	20.2%	17.8%	10.1%	1.6%	0.2%	0.1%	0.4%	1.6%	100.0%
	% Occurrence	65.9%	87.8%	90.2%	97.6%	92.7%	92.7%	92.7%	58.5%	19.5%	12.2%	24.4%	36.6%	
	Std Deviation	44	91	104	104	152	127	95	21	4	3	9	38	345
	Coeff of Var.	153.2%	105.1%	75.1%	68.2%	88.7%	84.6%	111.3%	155.4%	329.0%	526.9%	297.8%	288.5%	
	Max	146	384	347	394	526	458	373	83	24	22	52	165	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
8th Street	Average (AF)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Avg. % of Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% Occurrence	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Std Deviation	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coeff of Var.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	Max	0	0	0	0	0	0	0	0	0	0	0	0	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
7th Street	Average (AF)	17	40	56	66	61	67	42	10	2	1	3	6	369
	Avg. % of Total	4.5%	10.8%	15.2%	17.8%	16.5%	18.1%	11.4%	2.7%	0.5%	0.2%	0.7%	1.6%	100.0%
	% Occurrence	63.4%	92.7%	92.7%	92.7%	92.7%	92.7%	95.1%	46.3%	19.5%	14.6%	14.6%	29.3%	
	Std Deviation	22	32	36	43	45	44	38	16	6	3	7	14	118
	Coeff of Var.	131.6%	81.1%	64.3%	65.8%	74.5%	66.6%	90.1%	158.1%	281.0%	410.7%	268.7%	234.9%	
	Max	72	129	134	187	163	190	176	61	27	20	27	68	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Ely	Average (AF)	108	367	510	582	614	581	309	51	4	1	10	45	3,183
	Avg. % of Total	3.4%	11.5%	16.0%	18.3%	19.3%	18.2%	9.7%	1.6%	0.1%	0.0%	0.3%	1.4%	100.0%
	% Occurrence	63.4%	90.2%	92.7%	95.1%	92.7%	92.7%	90.2%	46.3%	22.0%	14.6%	14.6%	29.3%	
	Std Deviation	173	362	377	378	510	484	321	87	15	5	32	135	1,222
	Coeff of Var.	160.3%	98.7%	73.9%	65.0%	83.1%	83.4%	104.0%	171.8%	335.1%	432.4%	317.1%	297.7%	
	Max	560	1,454	1,308	1,502	1,689	1,777	1,279	313	77	31	153	570	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	
Lower Cucamonga East/Chris	Average (AF)	30	93	126	151	145	146	92	29	7	1	3	13	835
	Avg. % of Total	3.5%	11.2%	15.1%	18.1%	17.4%	17.4%	11.0%	3.4%	0.8%	0.1%	0.4%	1.5%	100.0%
	% Occurrence	61.0%	85.4%	95.1%	97.6%	95.1%	95.1%	95.1%	56.1%	22.0%	9.8%	14.6%	31.7%	
	Std Deviation	48	70	85	75	89	85	76	42	21	3	10	38	269
	Coeff of Var.	162.2%	75.3%	67.3%	49.5%	61.1%	58.0%	82.2%	146.3%	322.9%	511.2%	346.5%	298.8%	
	Max	165	228	288	292	279	304	288	137	110	17	46	215	
	Min	0	0	0	0	0	0	0	0	0	0	0	0	

TABLE 3-7 (CONT'D)
RECHARGE PERFORMANCE UNDER EXISTING LAND USE AND BASIN CONDITIONS

Basin	Statistic	Basin Recharge Activity												
		October	November	December	January	February	March	April	May	June	July	August	September	Totals
Lower Cucamonga West	Average (AF)	110	191	260	328	325	348	314	255	151	98	70	74	2,523
	Avg. % of Total	4.4%	7.6%	10.3%	13.0%	12.9%	13.8%	12.5%	10.1%	6.0%	3.9%	2.8%	2.9%	100.0%
	% Occurrence	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
	Std Deviation	85	85	118	107	101	110	122	138	137	112	64	61	812
	Coeff of Var.	77.4%	44.4%	45.4%	32.4%	31.0%	31.5%	38.8%	54.1%	91.3%	115.0%	90.6%	82.5%	
	Max	388	373	447	446	418	450	435	450	427	399	284	275	
	Min	10	22	38	68	42	54	47	22	14	10	10	10	
Totals	Average (AF)	980	2,570	3,920	4,597	4,861	4,917	3,026	1,252	684	416	384	567	28,175
	Avg. % of Total	3.5%	9.1%	13.9%	16.3%	17.3%	17.5%	10.7%	4.4%	2.4%	1.5%	1.4%	2.0%	100.0%
	% Occurrence	80.9%	91.2%	93.1%	95.4%	93.8%	93.0%	94.2%	91.0%	90.5%	97.3%	88.9%	73.0%	
	Std Deviation	76	167	187	210	256	277	185	121	103	74	52	62	864
	Coeff of Var.	7.7%	6.5%	4.8%	4.6%	5.3%	5.6%	6.1%	9.7%	15.1%	17.8%	13.7%	11.0%	

TABLE 3-8
RECHARGE PERFORMANCE FOR
SPREADING BASINS

Facility	Owner	Low: Perc Rate (ft/day)	Low: Average Annual Recharge Existing (acre-ft/yr)	Low: Average Annual Recharge Ultimate (acre-ft/yr)	Average: Perc Rate (ft/day)	Average: Average Annual Recharge Existing (acre-ft/yr)	Average: Average Annual Recharge Ultimate (acre-ft/yr)	High: Perc Rate (ft/day)	High: Average Annual Recharge Existing (acre-ft/yr)	High: Average Annual Recharge Ultimate (acre-ft/yr)
San Antonio Creek System										
Upland Basin	City of Upland	3	893	1,071	4	893	1,072	5	893	1,072
Montclair 1	CBWCD	3	851	969	4	902	1,035	5	943	1,086
Montclair 2	CBWCD	3	282	368	4	262	349	5	243	331
Montclair 3	CBWCD	3	389	337	4	413	353	5	431	367
Montclair 4	CBWCD	3	495	561	4	486	556	5	480	552
Brooks	CBWCD	2	1,019	1,047	3	1,182	1,219	4	1,310	1,354
West Cucamonga Creek System										
15 th Street	SBCFCD	1	742	742	2	845	845	3	942	945
8th Street	SBCFCD	1	0	0	2	0	0	3	0	0
7th Street	SBCFCD	1	247	247	2	368	368	3	489	489
Ely Basin (1)	SBCFCD & CBWCD	1	2,749	2,898	2	3,182	3,445	3	3,436	3,715
Cucamonga Creek										
Lower Cucamonga West	SBCFCD(2)	0.25	1,917	1,953	0.5	2,524	2,567	1.0	2,783	2,930
Lower Cucamonga East plus Chris Basin	SBCFCD(2)	0.25	649	739	0.5	835	1,025	1.0	1,079	1,380
Deer Creek System										
Church	SBCFCD	1	1,160	1,161	2	1,435	1,434	3	1,608	1,607
Turner No.9	SBCFCD	1	267	278	2	356	375	3	417	444
Turner No. 8	SBCFCD	1	458	537	2	464	555	3	454	550
Turner No. 5	SBCFCD	1	79	98	2	72	87	3	66	81
Turner No.'s 3 and 4	SBCFCD	1	154	194	2	113	148	3	89	118
Day Creek System										
Lower Day	SBCFCD	0.5	0	0	1.0	0	0	1.5	0	0
Wineville	SBCFCD	0.5	1,778	2,038	1.0	2,132	2,591	1.5	2,346	2,971
Riverside	SBCFCD	0.5	1,387	2,173	1.0	1,293	2,153	1.5	1,185	2,040
Etiwanda Creek System										
Etiwanda Sp. Gr.	SBCFCD									
Etiwanda Basin	SBCFCD	4	2,527	3,317	5	2,550	3,349	6	2,570	3,375
San Sevaine Creek System										
San Sevaine No. 1	SBCFCD	2	2,212	2,284	3	2,476	2,557	4	2,621	2,732
San Sevaine No. 2	SBCFCD	2	358	399	3	315	359	4	292	331
Rich Basin	SBCFCD	1	914	975	2	1,120	1,229	3	1,224	1,369
San Sevaine No. 3	SBCFCD	2	414	626	3	353	651	4	344	685
San Sevaine No. 4	SBCFCD	2	89	165	3	72	156	4	68	147
San Sevaine No. 5	SBCFCD	2	4	6	3	4	6	4	4	7
Victoria Basin	SBCFCD	2	183	295	3	244	481	4	273	612
Hickory Basin	SBCFCD	2	495	507	3	663	707	4	827	862
Jurupa Basin	SBCFCD	2	2,223	2,511	3	2,622	3,177	4	2,873	3,495
Declez	SBCFCD	0.5	0	0	1.0	0	0	1.5	0	0
CBWCD Facilities			6,509	6,930		7,653	8,241		8,403	9,226
Others Facilities			18,426	21,566		20,523	24,608		21,887	26,421
Total			24,935	28,496		28,176	32,849		30,290	35,647

Notes (1) – Ely basins 1 and 2 owned by SBCFCD; Ely basin 3 is owned by CBWCD.
(2) Basin owned by SBCFCD; CBWCD manages recharge efforts and pays for basin maintenance.

TABLE 3-9
RECHARGE OF LOCAL RUNOFF AND MARGINAL COST OF IMPROVEMENTS

Facility	Owner/ Operator	Average Annual Recharge (acre-ft/yr)	Increase in Recharge per Unit Increase in Conservation Storage (acre-ft/acre-ft)	Low Unit Cost of New Recharge ($/acre-ft)	High Unit Cost of New Recharge ($/acre-ft)
San Antonio Creek System					
Upland Basin	City of Upland	893	0	na	na
Montclair 1	CBWCD	902	1	$182	$908
Montclair 2	CBWCD	262	-1	na	na
Montclair 3	CBWCD	413	1	$182	$908
Montclair 4	CBWCD	486	0	na	na
Brooks	CBWCD	1,182	3	$57	$284
System		4,138	1	$227	$1,134
West Cucamonga Creek System					
15 th Street	SBCFCD	845	1	$142	$709
8th Street	SBCFCD	0	91	$2	$10
7th Street	SBCFCD	368	-13	na	na
Ely Basins	SBCFCD & CBWCD	3,182	-46	na	na
System		4,395	8	$22	$111
Cucamonga Creek					
Lower Cucamonga West	SBCFCD	2,524	0	na	na
Lower Cucamonga East plus Chris Basin	SBCFCD	835	2	$73	$366
System		3,358	2	$73	$363
Deer Creek System					
Church	SBCFCD	1,435	3	$53	$267
Turner No.9		356	3	$62	$309
Turner No. 8		464	-3	na	na
Turner No. 5		72	1	$175	$873
Turner No.'s 3 and 4		113	0	na	na
System		2,440	1	$220	$1,101
Day Creek System					
Lower Day	SBCFCD	0	16	$11	$57
Wineville	SBCFCD	2,132	-8	na	na
Riverside	SBCFCD	1,293	-6	na	na
System		3,425	1	$250	$1,249
Etiwanda Creek System					
Etiwanda Sp. Gr.	SBCFCD	**	na	na	na
Etiwanda Basin	SBCFCD	2,550	0	$4,538	$22,689
System		2,550	0	$4,538	$22,689
San Sevaine Creek System					
San Sevaine No. 1	SBCFCD	2,476	2	$97	$483
San Sevaine No. 2	SBCFCD	315	0	$478	$2,388
Rich Basin	SBCFCD	1,120	0	$1,134	$5,672
San Sevaine No. 3	SBCFCD	353	1	$138	$688
San Sevaine No. 4	SBCFCD	72	1	$146	$732
San Sevaine No. 5	SBCFCD	4	6	$32	$158
Victoria Basin	SBCFCD	244	2	$101	$504
Hickory Basin	SBCFCD	663	7	$27	$137
Jurupa Basin	SBCFCD	2,622	4	$47	$235
System		7,870	3	$71	$355
Declez	SBCFCD	0	9	$19	$97
System		0	9	$19	$97
CBWCD Facilities		7,653			
Others Facilities		20,523			
Total		28,176			

** Included in Etiwanda Basin

One acre-ft new storage=	1,613	cubic yards of new excavation	
Excavation cost	$8,066.67	plus mobilization, demobilization, admin and engr costs	
High capital cost is	$10,000.00	per acre-ft. 20 yrs at 7%	$907.56 per year
Low Capital Cost is	$2,000	per acre-ft. 20 yrs at 7%	$181.51 per year

TABLE 3-10
EXPANDED RECHARGE OF LOCAL RUNOFF AND MARGINAL COST OF IMPROVEMENTS FOR BASINS OR BASIN SYSTEMS WITH THE POTENTIAL FOR NEW RECHARGE

Basin	Storage Volume Increase (Acre-feet)		Groundwater Yield Increase (Acre-feet)		Cost for Storage/Yield Increase(a) ($)		Unit Cost for Storage/Yield Increase(a) ($/AF)	
	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost
Brooks Street Basin	91.2	22.9	89.4	37.1	$16,554	$20,783	$185	$560
West Cucamonga Creek System								
15th Street	37.0	37.0	—	—	—	—	—	—
8th Street	104.0	104.0	—	—	—	—	—	—
7th Street	5.0	5.0	—	—	—	—	—	—
Ely Basin	5.0	5.0	—	—	—	—	—	—
System Subtotal	151.0	151.0	525.1	525.1	$27,405	$137,024	$52	$261
Cucamonga Creek System								
Lower Cucamonga East/ Chris	211.2	158.5	—	—	—	—	—	—
Lower Cucamonga West	5.0	0.0	—	—	—	—	—	—
System Subtotal	216.2	158.5	297.6	257.1	$39,243	$143,849	$132	$560
Church Street Basin	233.6	184.4	332.4	298.9	$42,409	$167,355	$128	$560
Day Creek System								
Lower Day	126.3	0.0	—	—	—	—	—	—
Wineville	5.0	0.0	—	—	—	—	—	—
Riverside	5.0	0.0	—	—	—	—	—	—
System Subtotal	136.3	0.0	46.9	N/A	$24,746	N/A	$529	N/A
San Sevaine Creek System								
San Sevaine No.1	70.9	70.9	—	—	—	—	—	—
San Sevaine No.2	48.7	48.7	—	—	—	—	—	—
Rich Basin	76.6	76.6	—	—	—	—	—	—
San Sevaine No.3	42.0	42.0	—	—	—	—	—	—
San Sevaine No.4	5.0	0.0	—	—	—	—	—	—
San Sevaine No.5	499.5	331.8	—	—	—	—	—	—
Victoria Basin	104.1	54.1	—	—	—	—	—	—
Hickory Basin	71.1	71.1	—	—	—	—	—	—
Jurupa Basin	774.0	50.0	—	—	—	—	—	—
System Subtotal	1,691.7	745.0	1,734.0	1,209.4	$307,067	$676,135	$177	$560
Declez Basin	139.9	139.9	701.7	701.7	$25,388	$126,941	$36	$181
Total	2,659.9	1,401.7	3,727.1	3,029.2	$482,811	$1,272,087	$130	$420

(a) Capital and Unit costs based on Table 3-9.

TABLE 3-11
EXPANDED RECHARGE OF LOCAL RUNOFF AND MARGINAL COST OF IMPROVEMENTS FOR THE WATERSHED CONSIDERING THE POTENTIAL FOR NEW RECHARGE

Basin	Storage Volume Increase (Acre-feet)		Groundwater Yield Increase (Acre-feet)		Cost for Storage/Yield Increase(a) ($)		Unit Cost for Storage/Yield Increase(a) ($/AF)	
	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost
Brooks Street Basin	91.2	67.2	89.4	73.6	$16,554	$61,011	$185	$829
West Cucamonga Creek System								
15th Street	37.0	37.0	—	—	—	—	—	—
8th Street	104.0	104.0	—	—	—	—	—	—
7th Street	5.0	5.0	—	—	—	—	—	—
Ely Basin	5.0	5.0	—	—	—	—	—	—
System Subtotal	151.0	151.0	525.1	525.1	$27,405	$137,024	$52	$261
Cucamonga Creek System								
Lower Cucamonga East/ Chris	211.2	211.2	—	—	—	—	—	—
Lower Cucamonga West	5.0	0.0	—	—	—	—	—	—
System Subtotal	216.2	216.2	297.6	297.6	$39,243	$196,215	$132	$659
Church Street Basin	233.6	233.6	332.4	332.4	$42,409	$212,043	$128	$638
Day Creek System								
Lower Day	126.3	0.0	—	—	—	—	—	—
Wineville	5.0	0.0	—	—	—	—	—	—
Riverside	5.0	0.0	—	—	—	—	—	—
System Subtotal	136.3	0.0	46.9	N/A	$24,746	N/A	$529	N/A
San Sevaine Creek System								
San Sevaine No.1	70.9	70.9	—	—	—	—	—	—
San Sevaine No.2	48.7	48.7	—	—	—	—	—	—
Rich Basin	76.6	76.6	—	—	—	—	—	—
San Sevaine No.3	42.0	42.0	—	—	—	—	—	—
San Sevaine No.4	5.0	5.0	—	—	—	—	—	—
San Sevaine No.5	499.5	431.8	—	—	—	—	—	—
Victoria Basin	104.1	80.0	—	—	—	—	—	—
Hickory Basin	71.1	71.1	—	—	—	—	—	—
Jurupa Basin	774.0	465.0	—	—	—	—	—	—
System Subtotal	1,691.7	1,433.1	1,734.0	1,561.5	$307,067	$1,300,645	$177	$833
Declez Basin	139.9	139.9	701.7	701.7	$25,388	$126,941	$36	$181
Total	2,659.9	2,241.0	3,727.1	3,491.9	$482,811	$2,033,880	$130	$582

(a) Capital and Unit costs based on Table 3-9.

TABLE 3-12
ESTIMATED STORM WATER RECHARGE IN NEW LOWER CHINO SPREADING BASINS

Basin	Area (acres)	Annual Recharge (acre-ft/yr)	
		Perc.=0.1 ft/d	Perc.=0.5 ft/d
LC1	5	77	182
	50	490	574
LC2	5	84	232
	50	922	1,350
LC3	5	69	131
	50	471	580
LC4	5	81	214
	50	804	1,169
LC5	5	71	145
	50	551	747
LC6	5	81	213
	50	800	1,190
Totals	5	463	1,117
	50	4,038	5,610

TABLE 3-13
SURFACE WATER TDS AND NITRATE MEASUREMENTS IN CBWCD FACILITIES 3/96 TO 5/96

Basin	TDS (mg/L)	Nitrate (mg/L) as Nitrogen
Montclair No. 1	40 - 152	0.5 - 0.7
Ely Basin No. 3	36 - 156	0.7 - 1.8
Lower Cucamonga West	384 - 404	0.2 - 3.4
Chris	76 - 175	0.5 - 0.7
Average excluding Lower Cucamonga West	51 - 161	0.5 - 1.1
Values to assume in Recharge Master Plan	110	1.0
Chino II Subbasin Objective	330	6.0
Drinking Water MCL	500	10.0

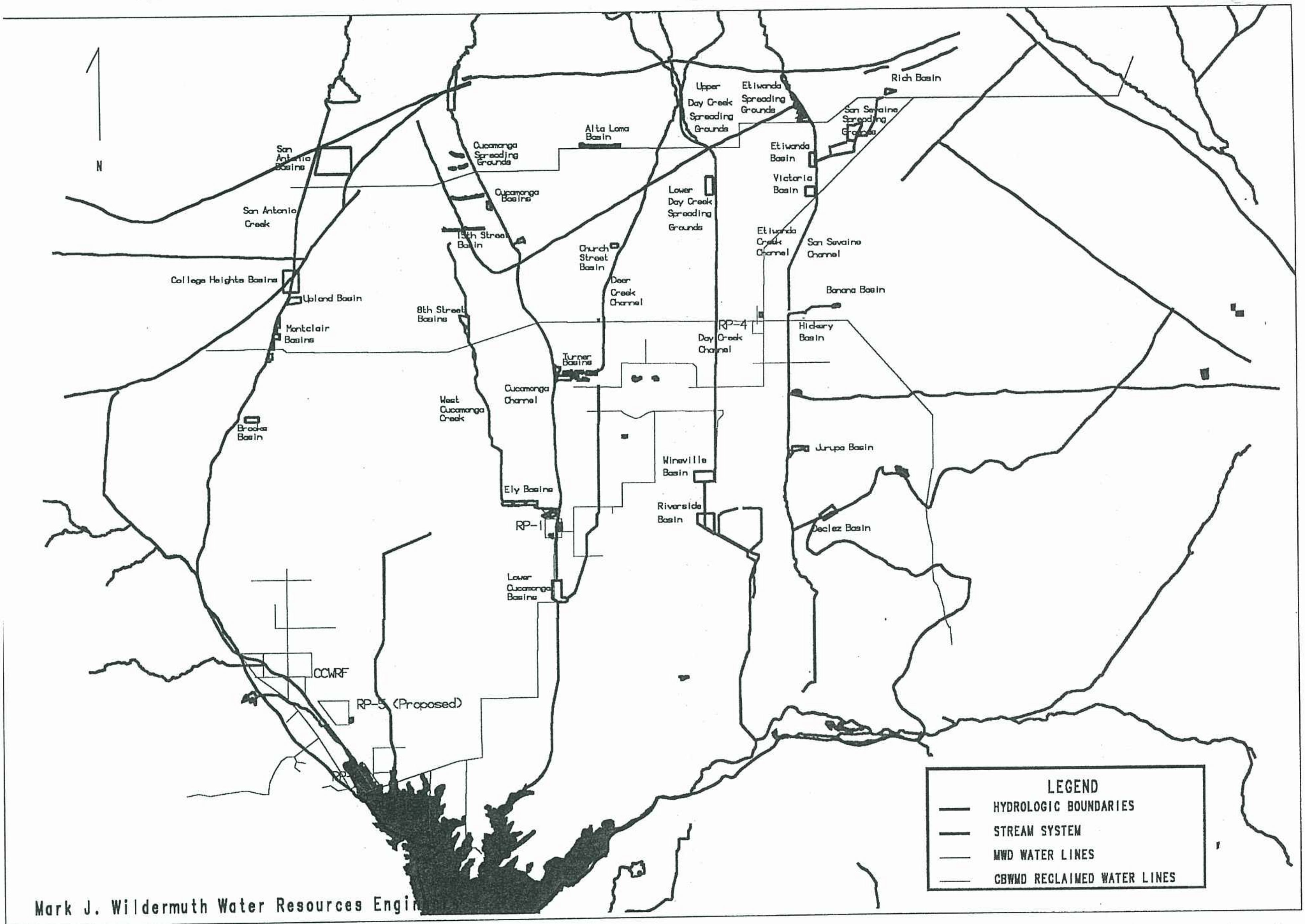


FIGURE 3-1 CHINO BASIN AREA WATER FACILITIES

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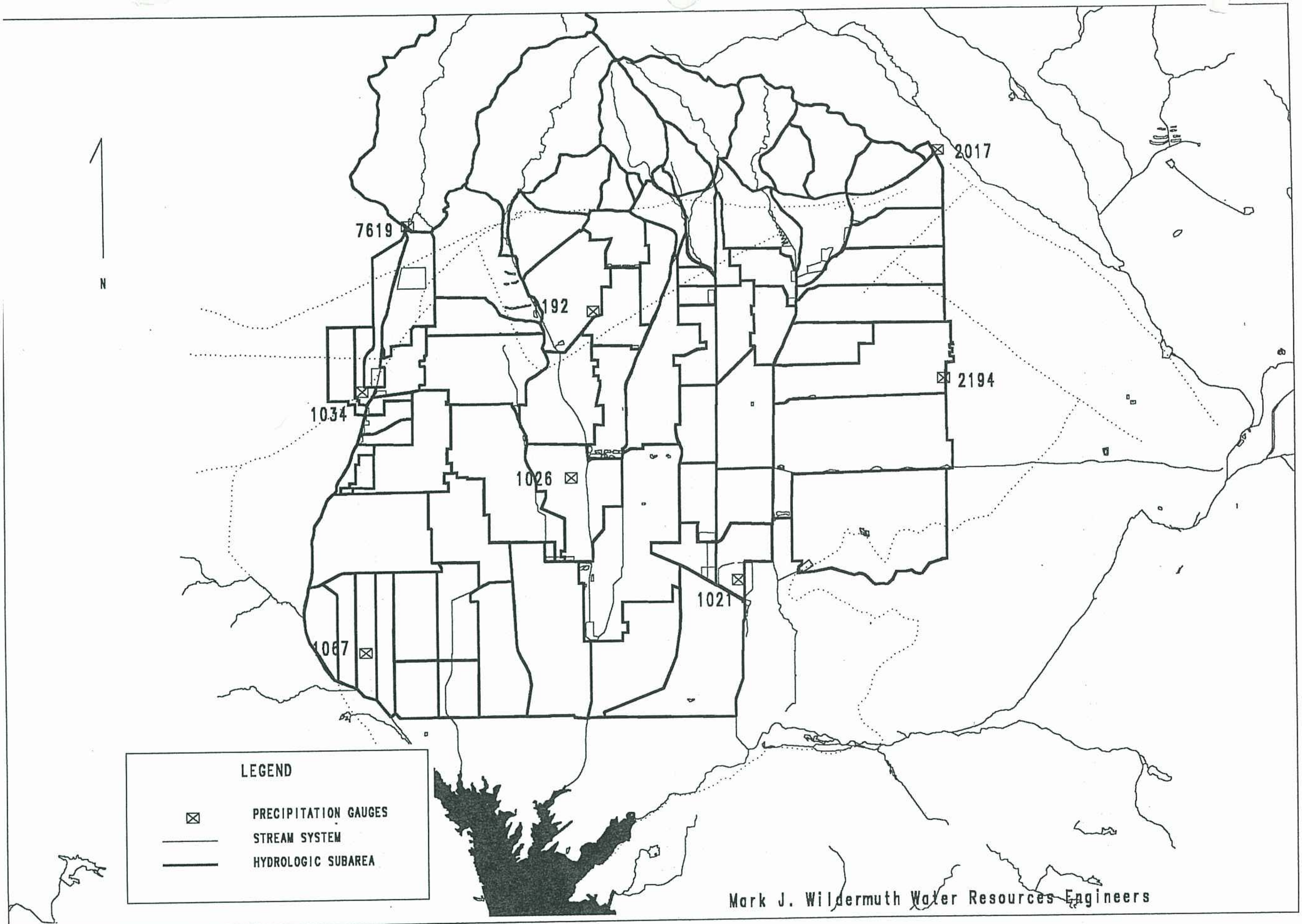

FIGURE 3-2 CHINO BASIN AREA PRECIPITATION GAUGES

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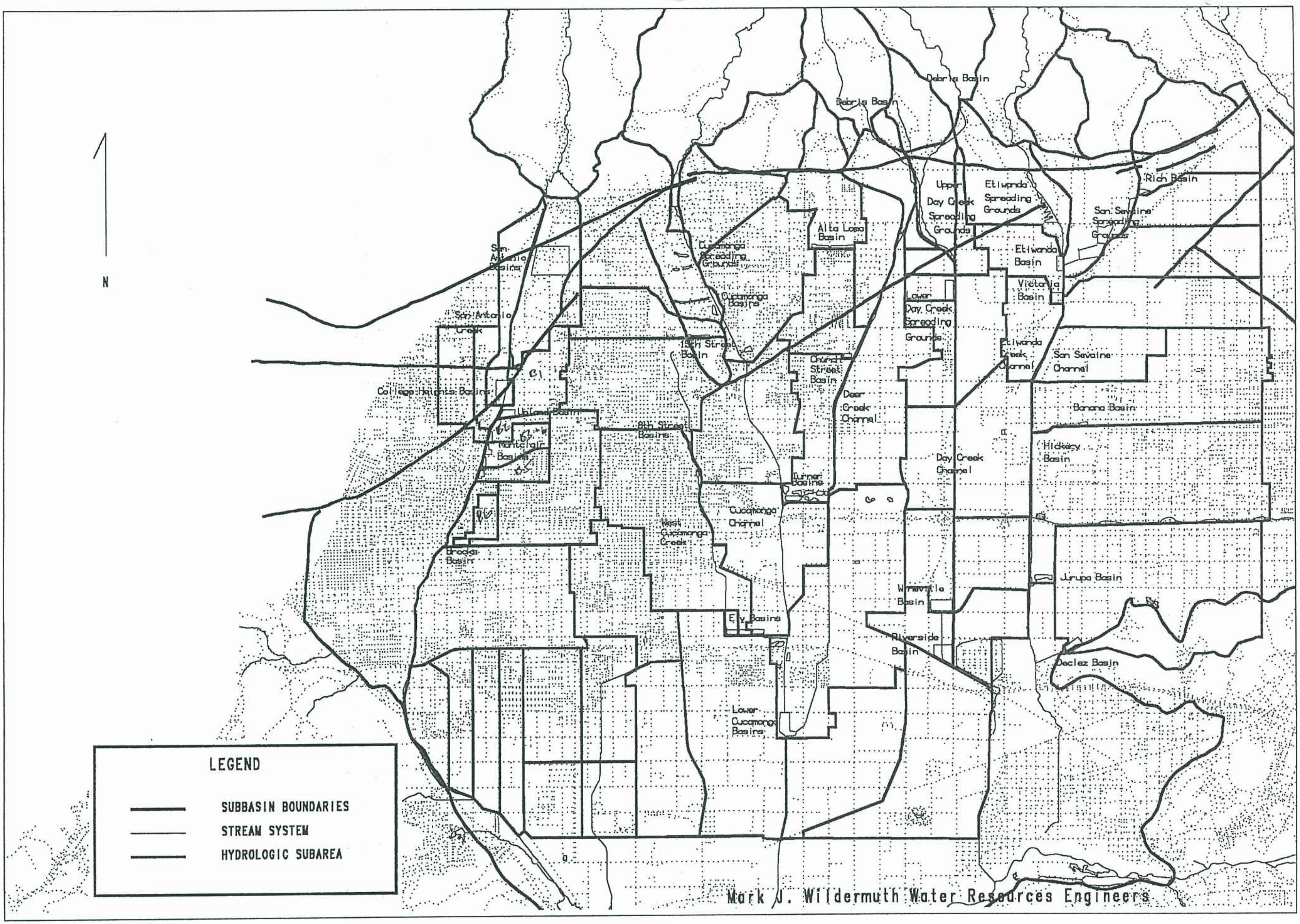
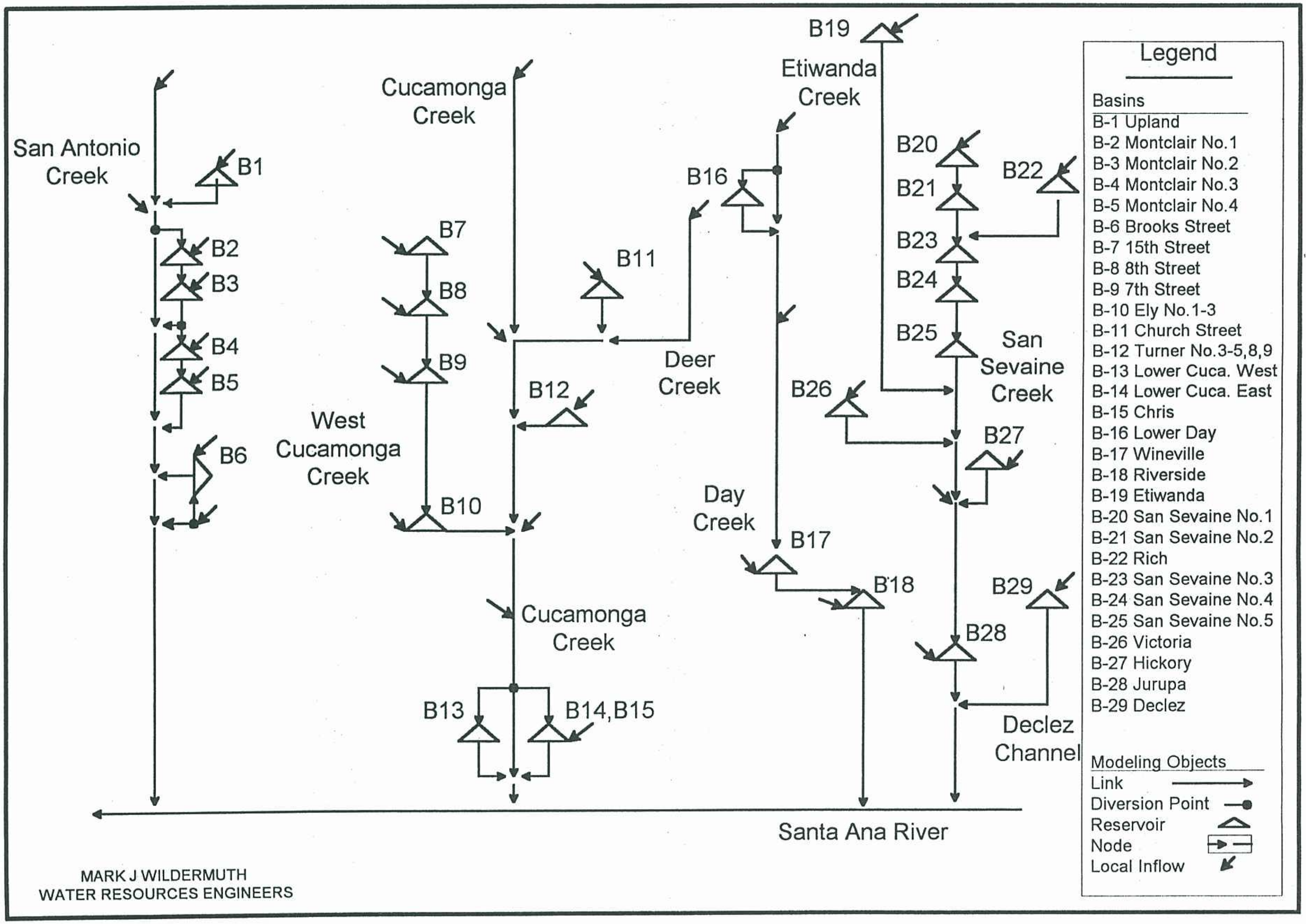


FIGURE 3-3 CHINO BASIN AREA HYDROLOGIC SUBAREAS TRIBUTARY TO EXISTING BASINS \\JGATE_C\ARCDATA\..\..\mp_dmain.sml

FIGURE 3-4
CHINO BASIN MODELING NODAL SCHEME



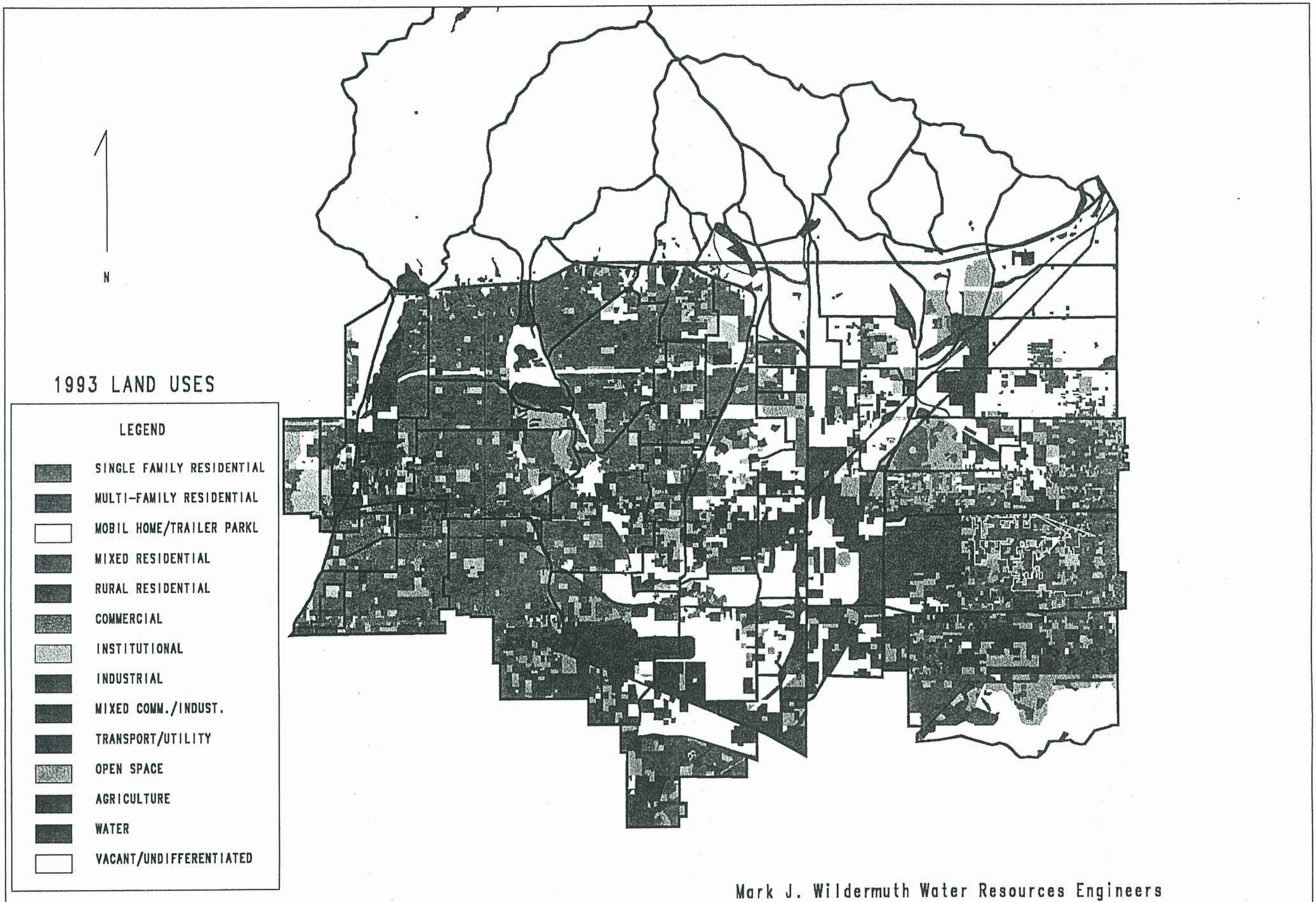


FIGURE 3-5 CHINO BASIN AREA 1993 LAND-USE

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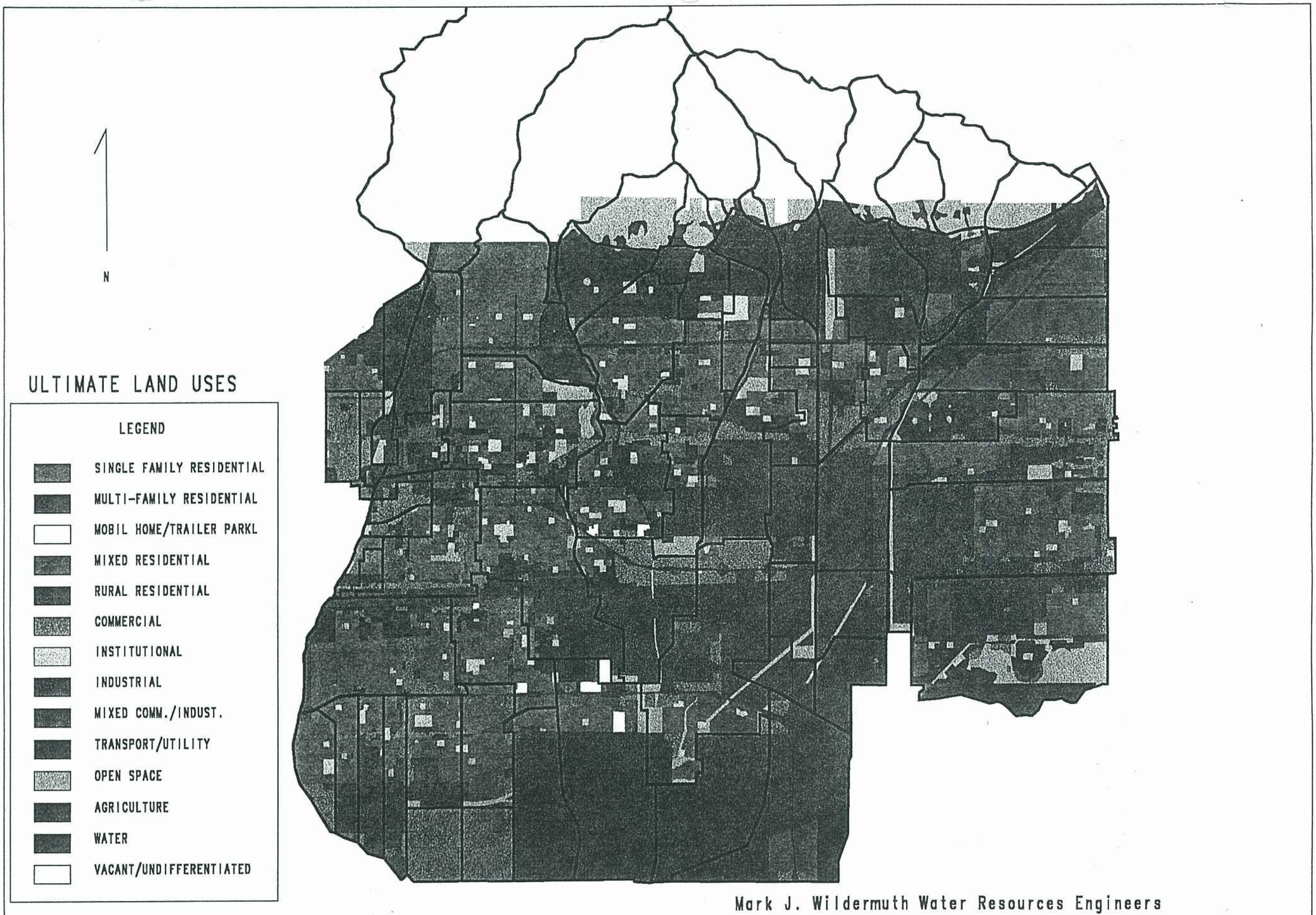

FIGURE 3-6 CHINO BASIN AREA ULTIMATE LAND-USE

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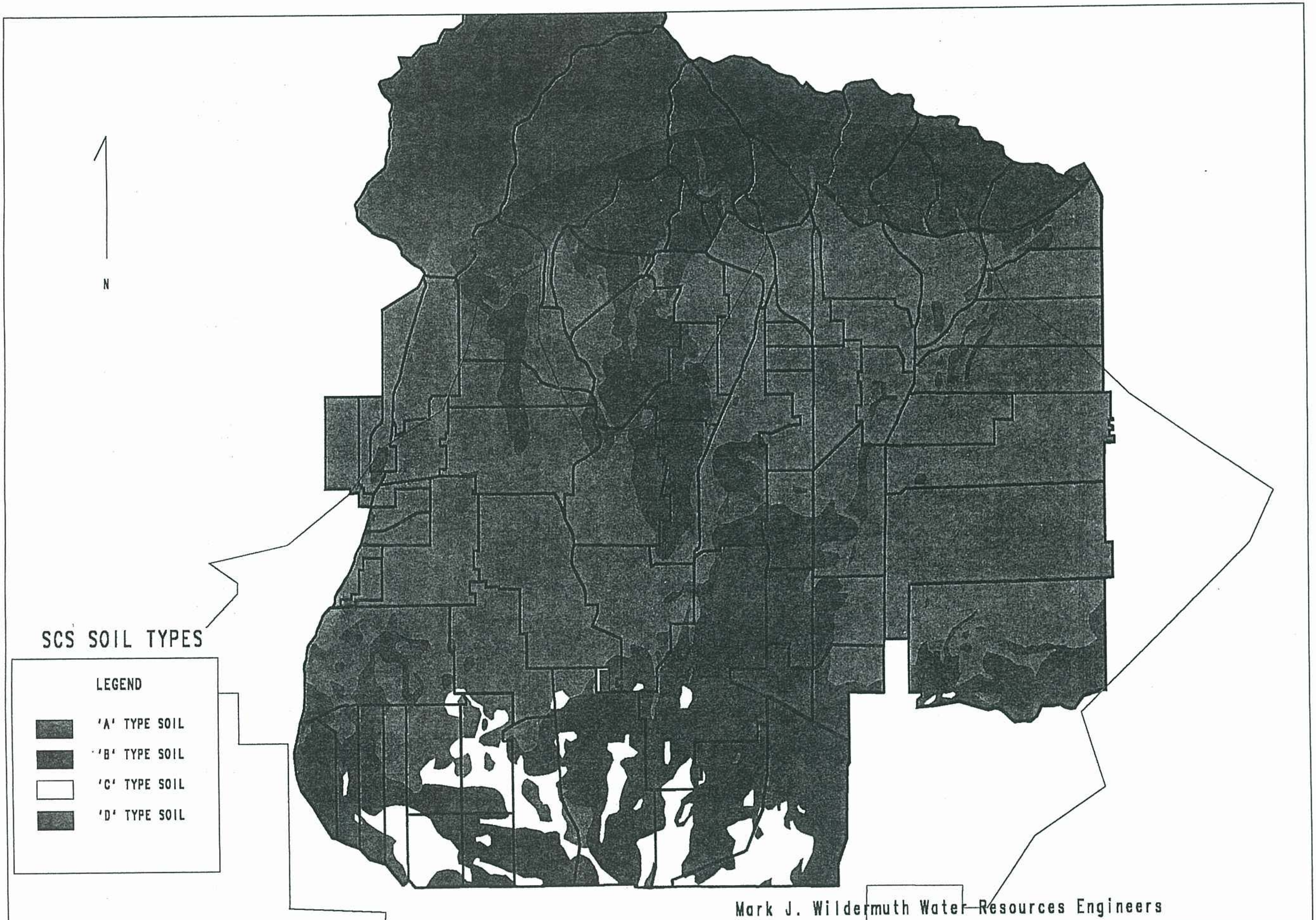

FIGURE ‑7 CHINO BASIN AREA SCS SOIL TYPES

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FIGURE 3-8 INCREASE IN RECHARGE AND COST OF NEW RECHARGE BROOKS STREET BASIN

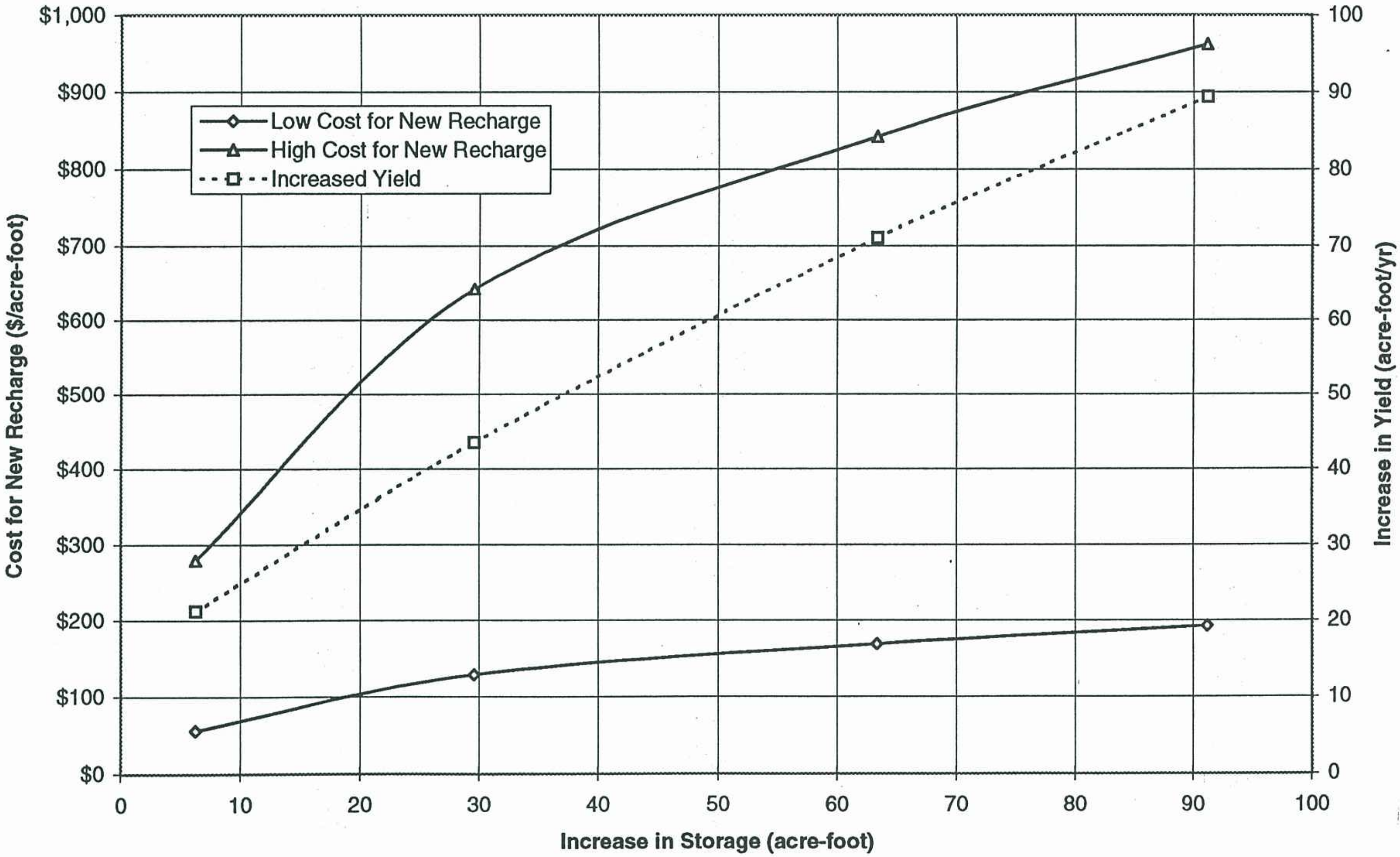


FIGURE 3-9 INCREASE IN RECHARGE AND COST OF NEW RECHARGE WEST CUCAMONGA CREEK

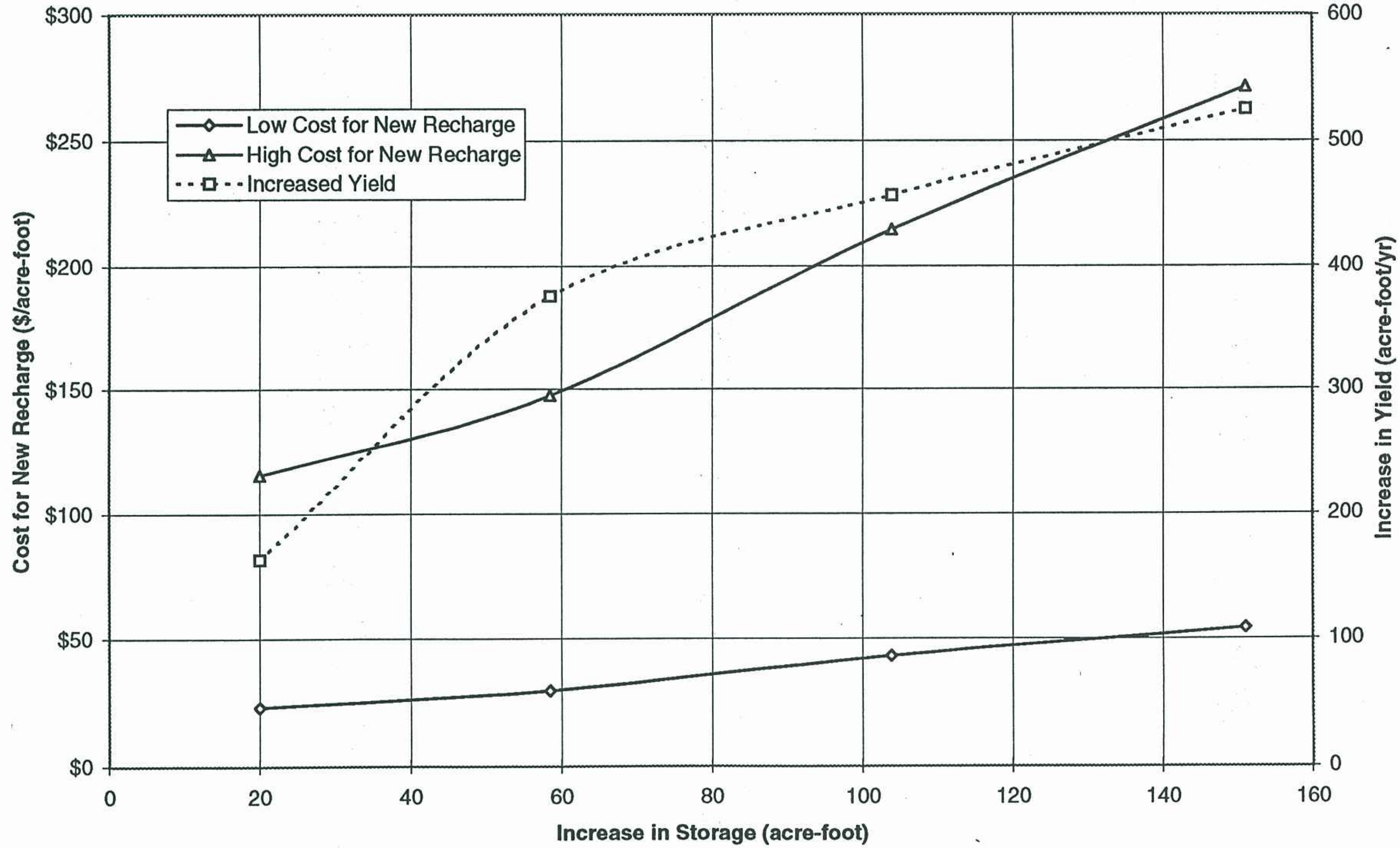


FIGURE 3-10 INCREASE IN RECHARGE AND COST OF NEW RECHARGE CUCAMONGA CREEK SYSTEM

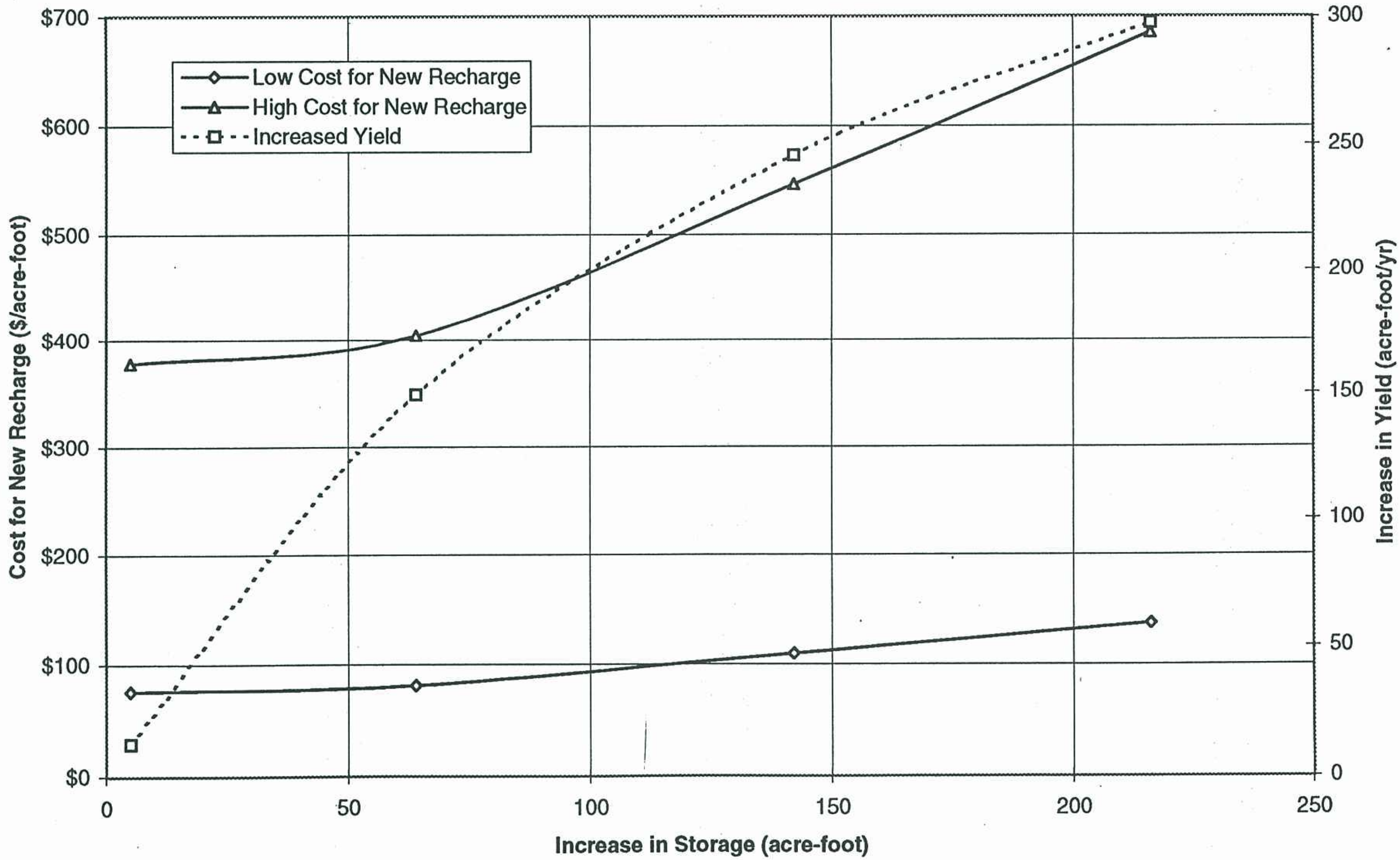


FIGURE 3-11 INCREASE IN RECHARGE AND COST OF NEW RECHARGE
CHURCH STREET BASIN

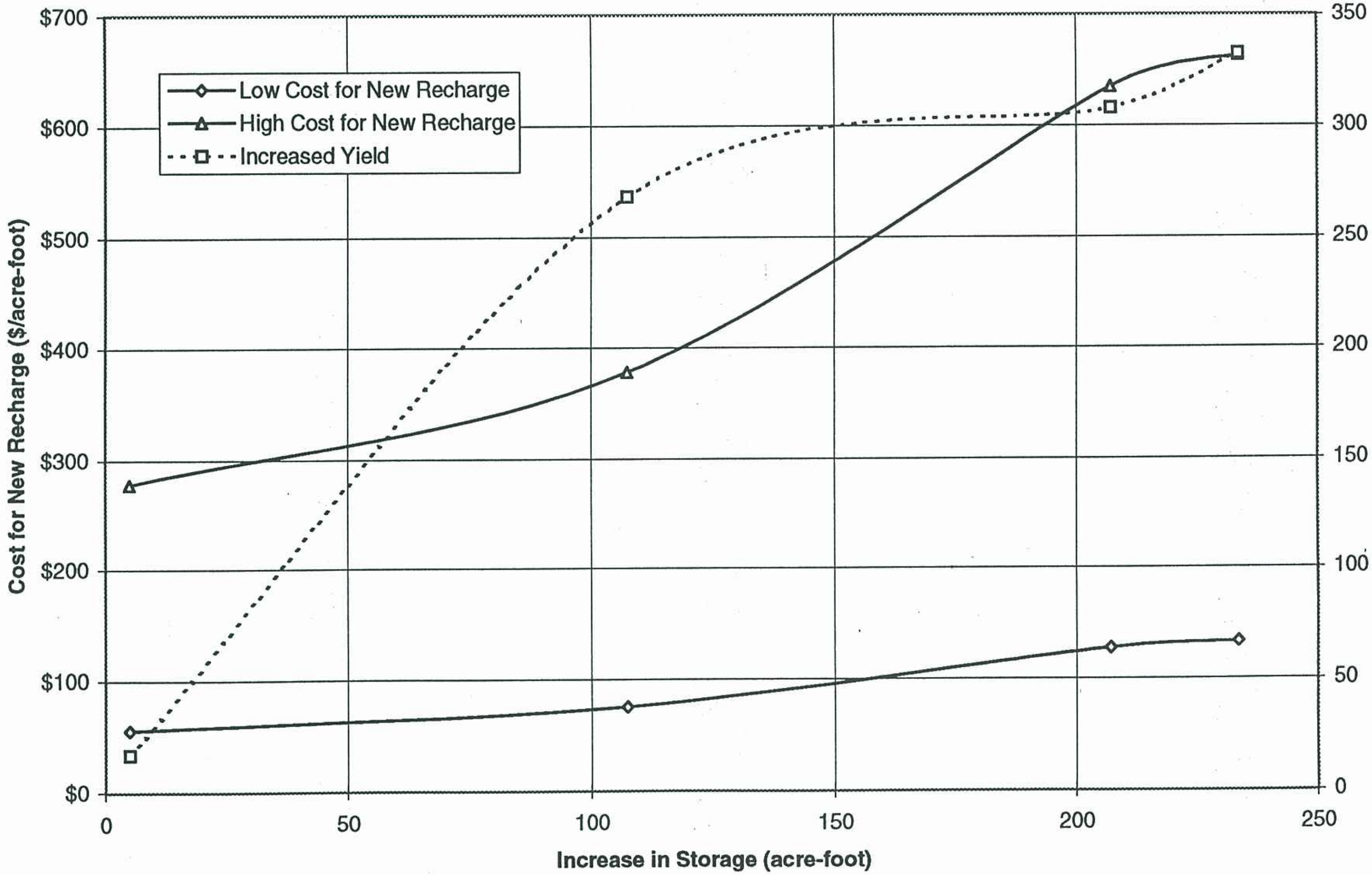


FIGURE 3-12 INCREASE IN RECHARGE AND COST OF NEW RECHARGE LOWER DAY BASIN

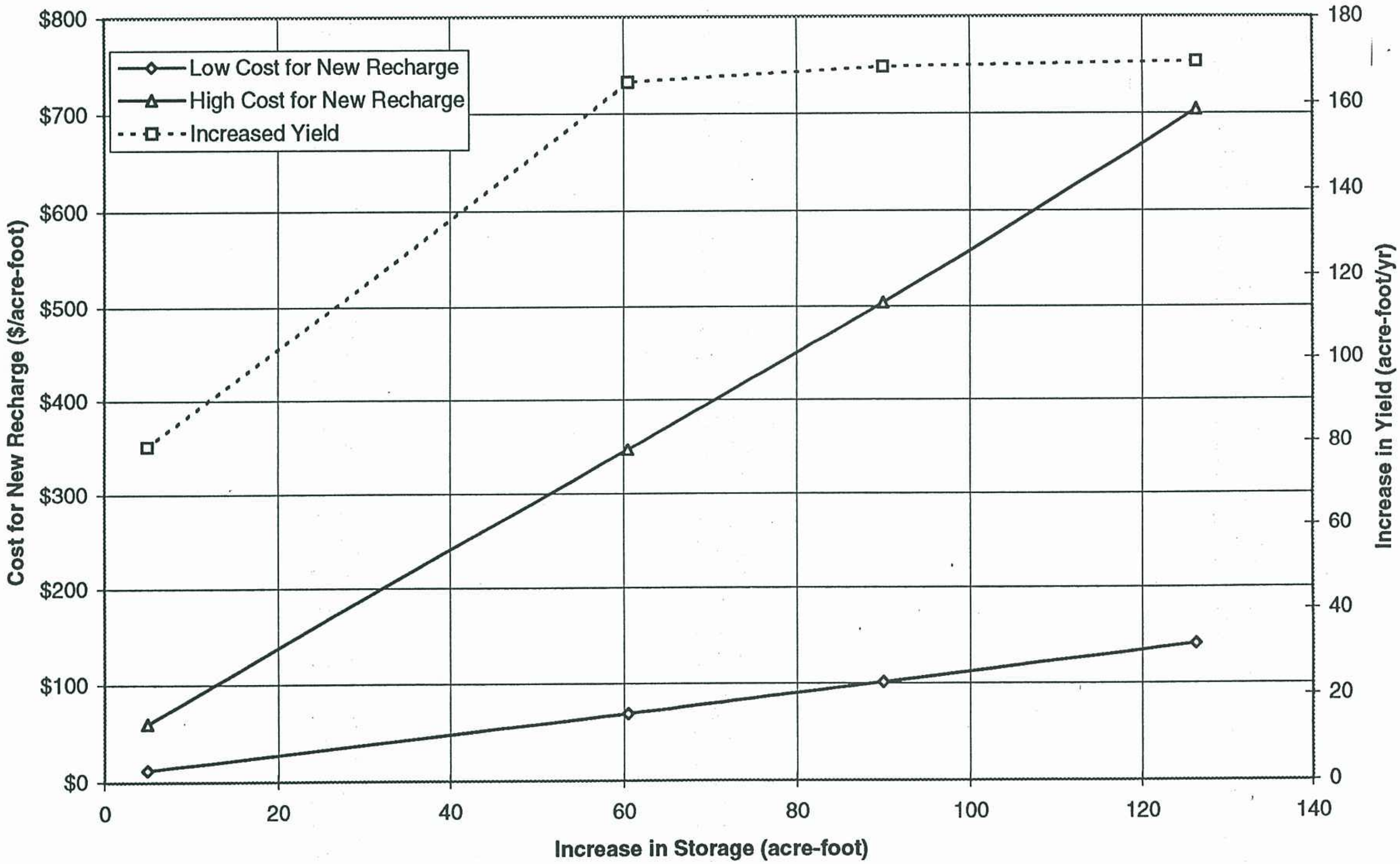


FIGURE 3-13 INCREASE IN RECHARGE AND COST OF NEW RECHARGE SAN SEVAINE CREEK SYSTEM

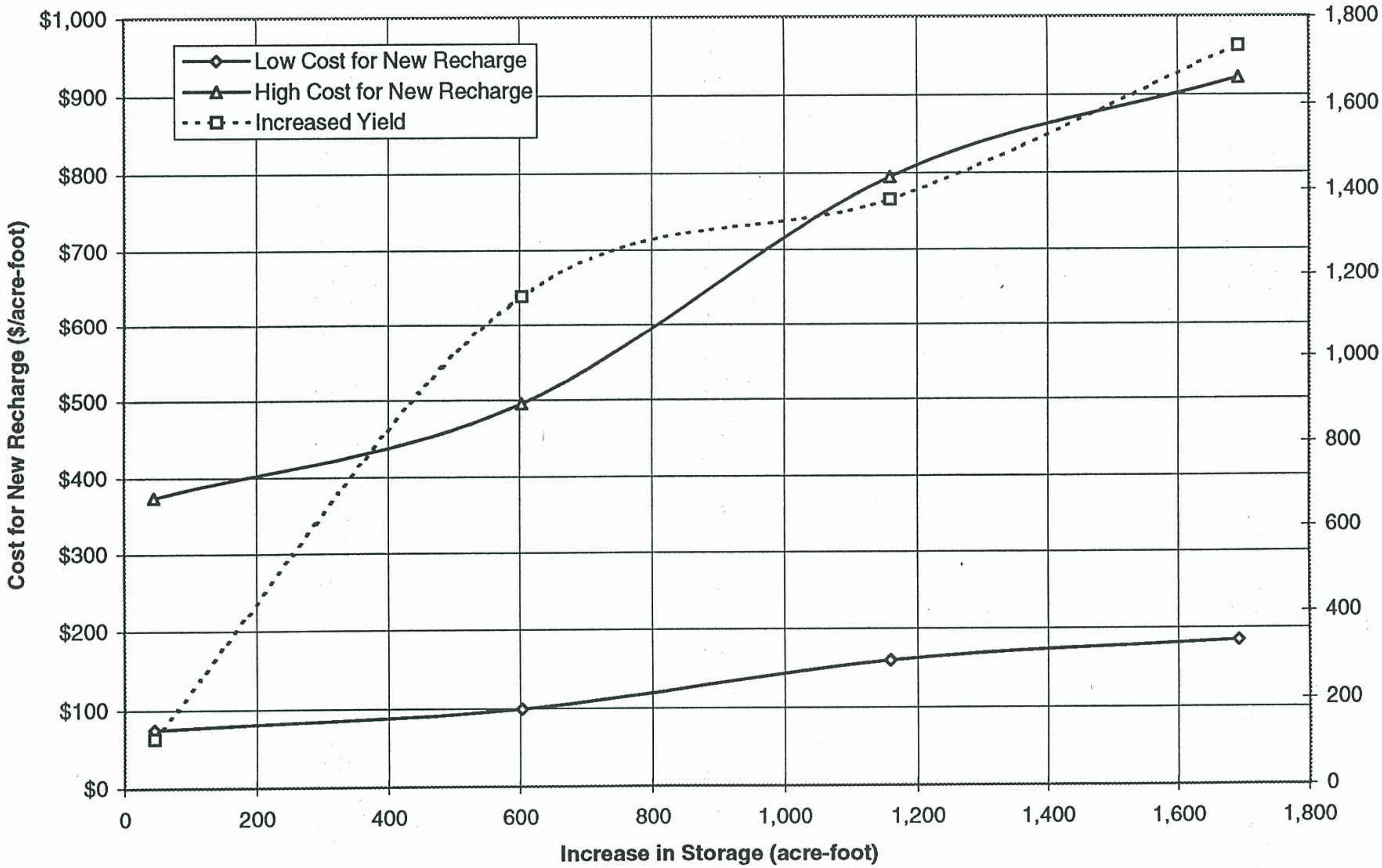
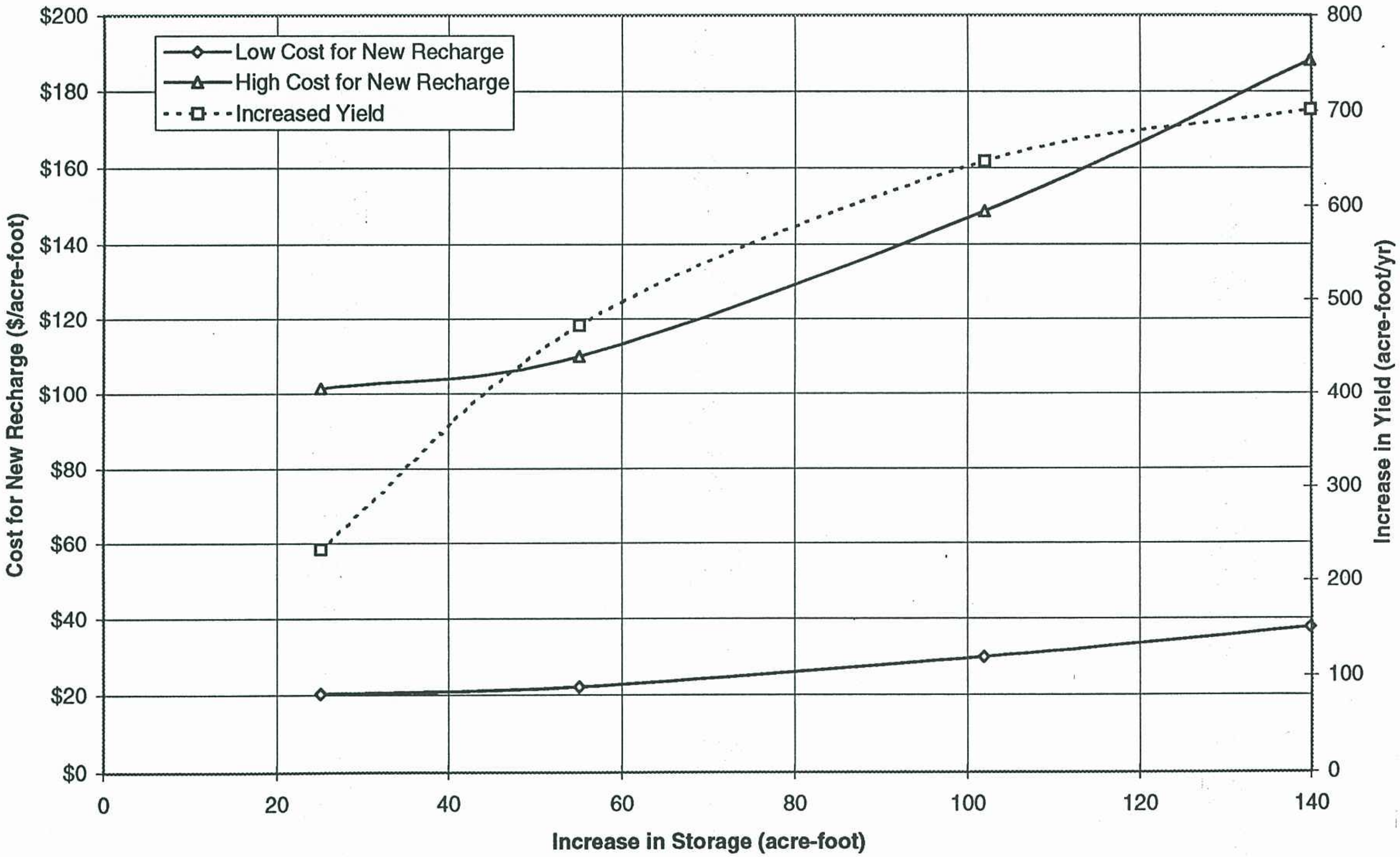


FIGURE 3-14 INCREASE IN RECHARGE AND COST OF NEW RECHARGE DECLEZ SYSTEM



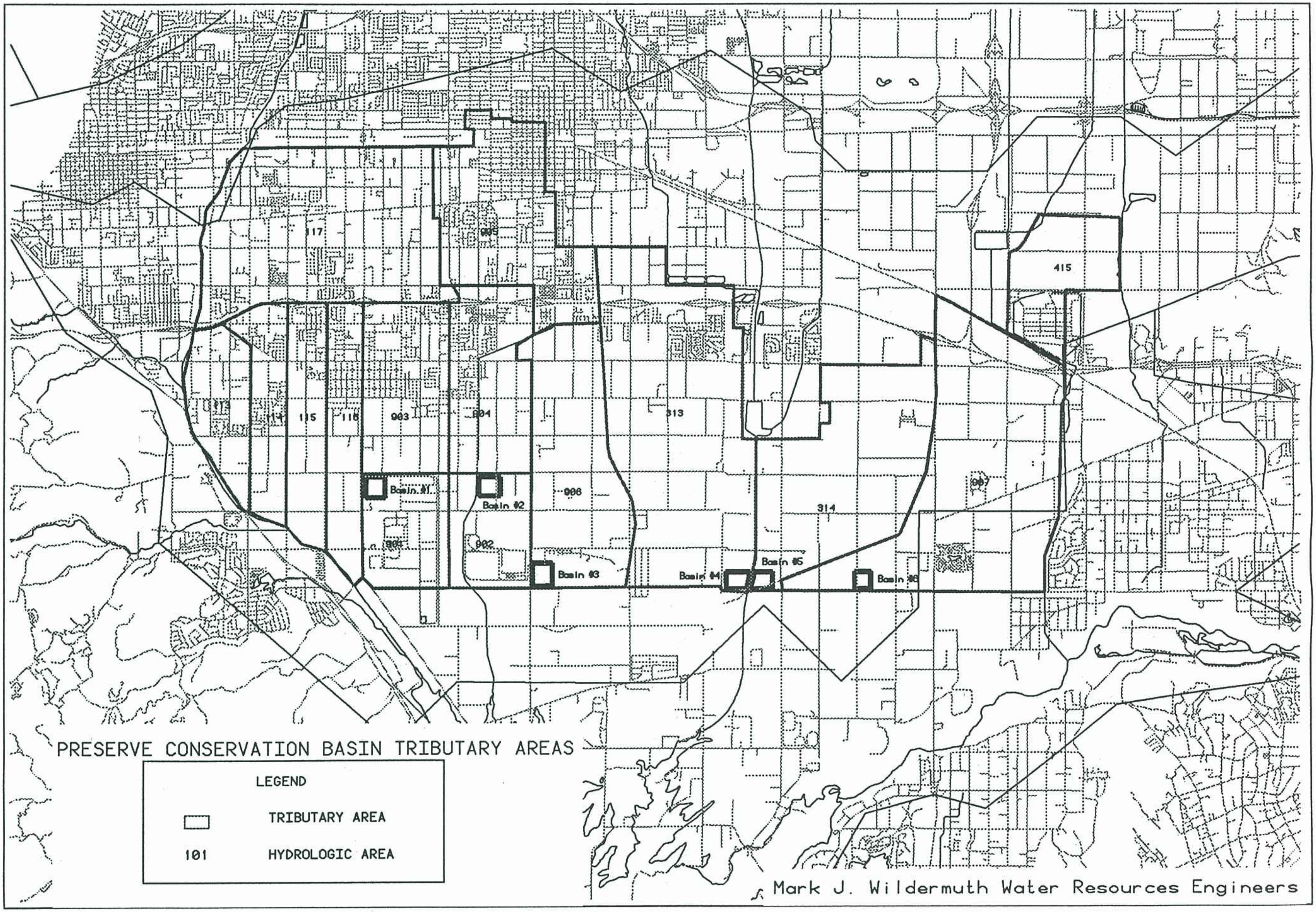


FIGURE 3-15 CONSERVATION PRESERVE TRIBUTARY AREAS

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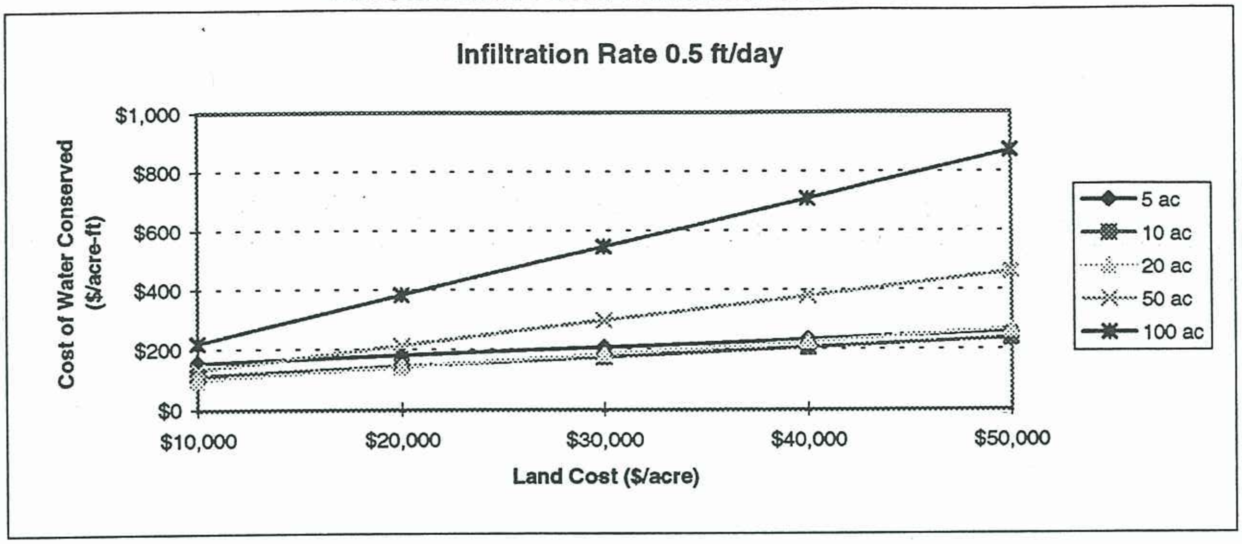
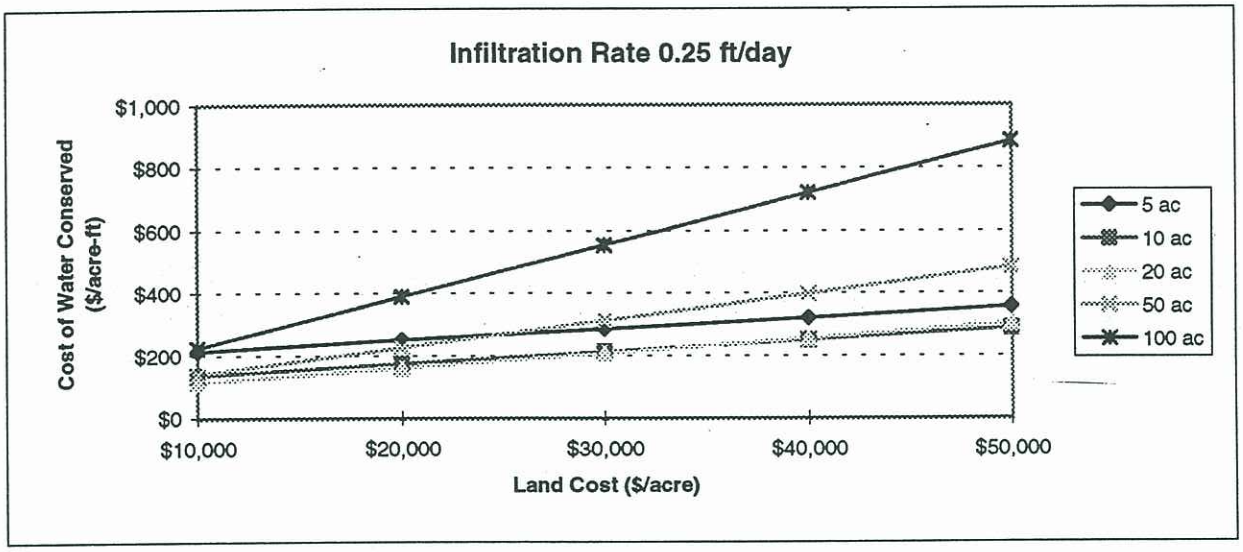
FIGURE NO.3-16
COST OF WATER CONSERVED -- CONSERVATION ONLY
LOWER CHINO CONSERVATION BASIN NO.1





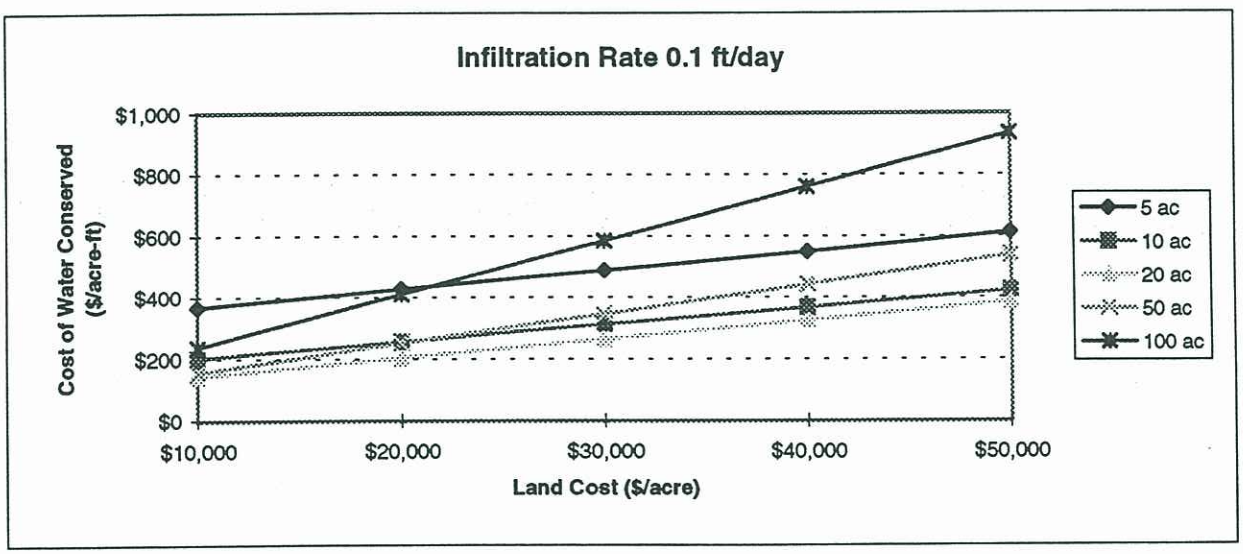
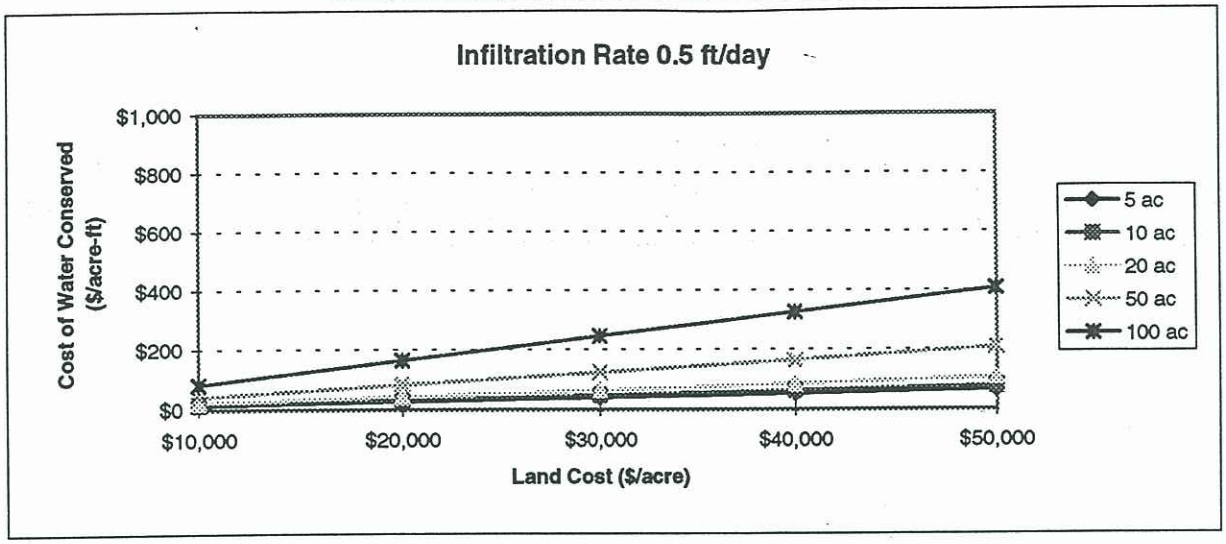
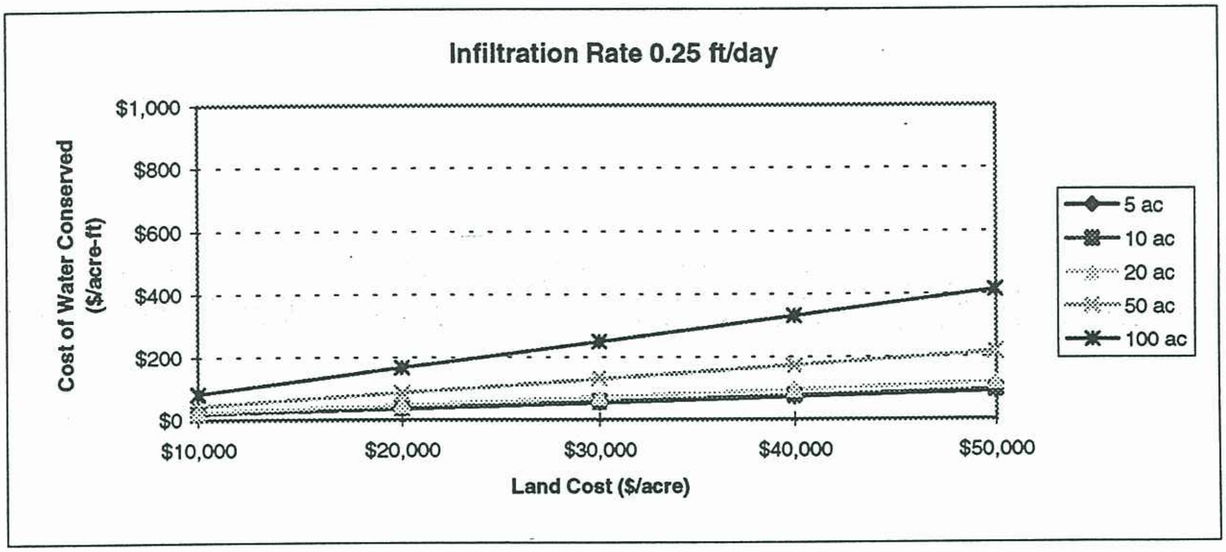


FIGURE NO.3-17
COST OF WATER CONSERVED -- CONSERVATION AND FLOOD CONTROL
LOWER CHINO CONSERVATION BASIN NO.1





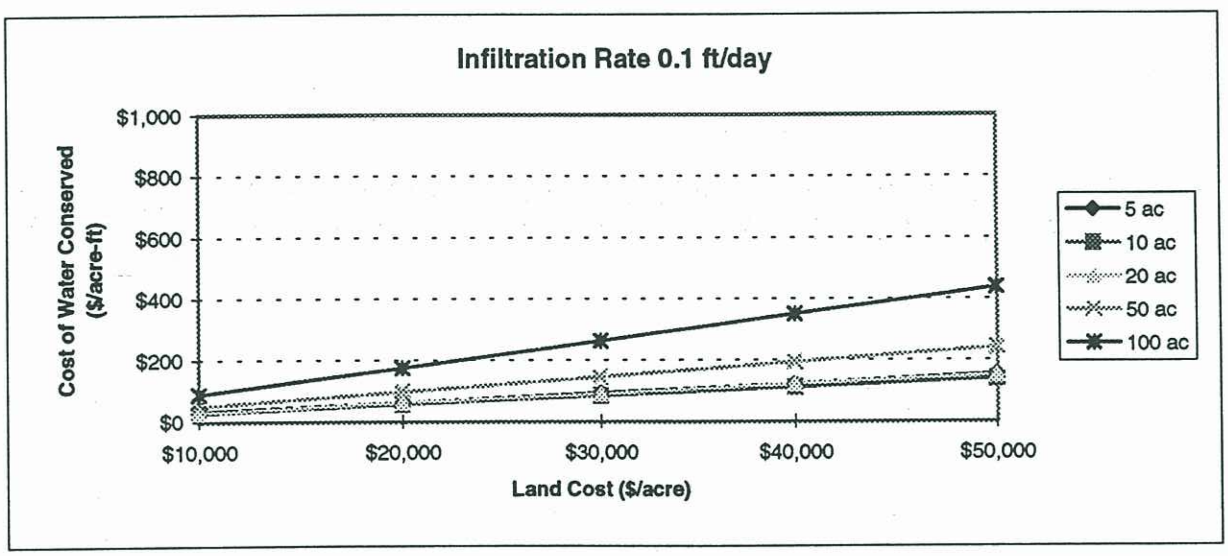
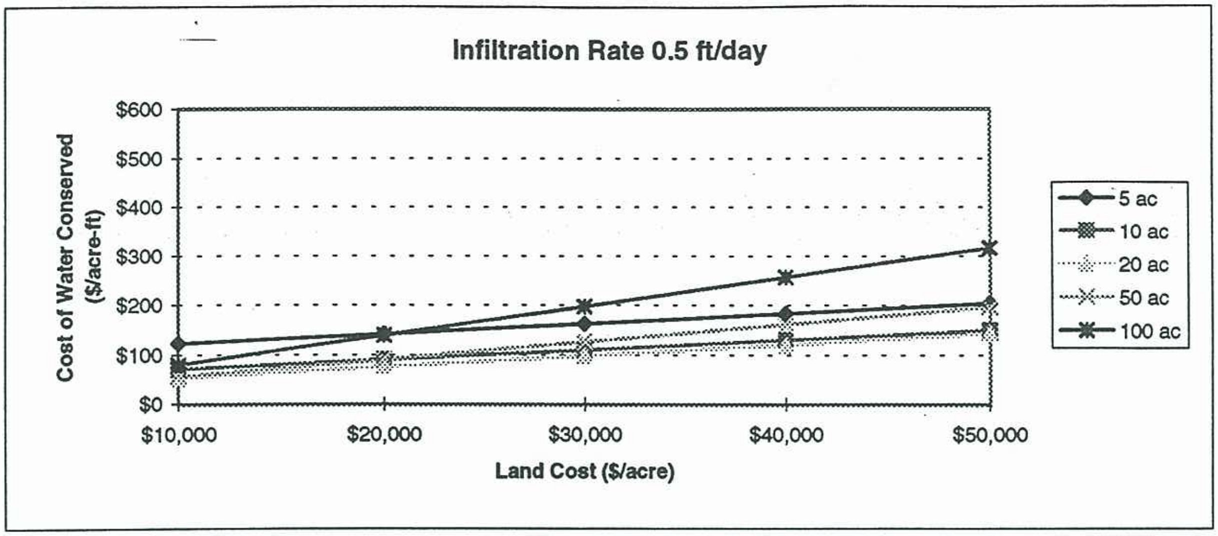
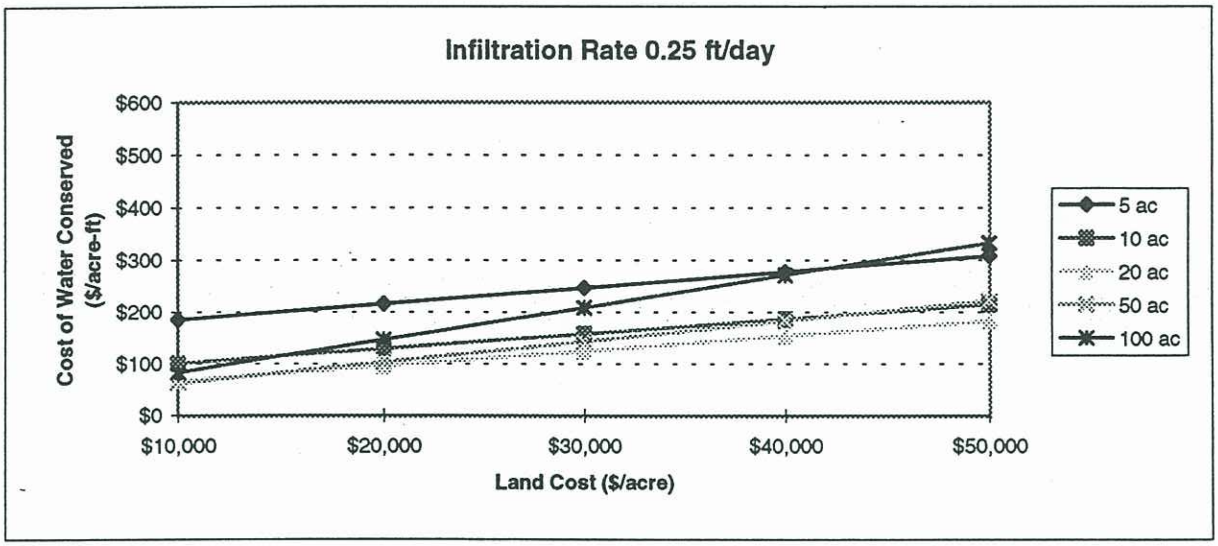


FIGURE NO.3-18
COST OF WATER CONSERVED -- CONSERVATION ONLY
LOWER CHINO CONSERVATION BASIN NO.2





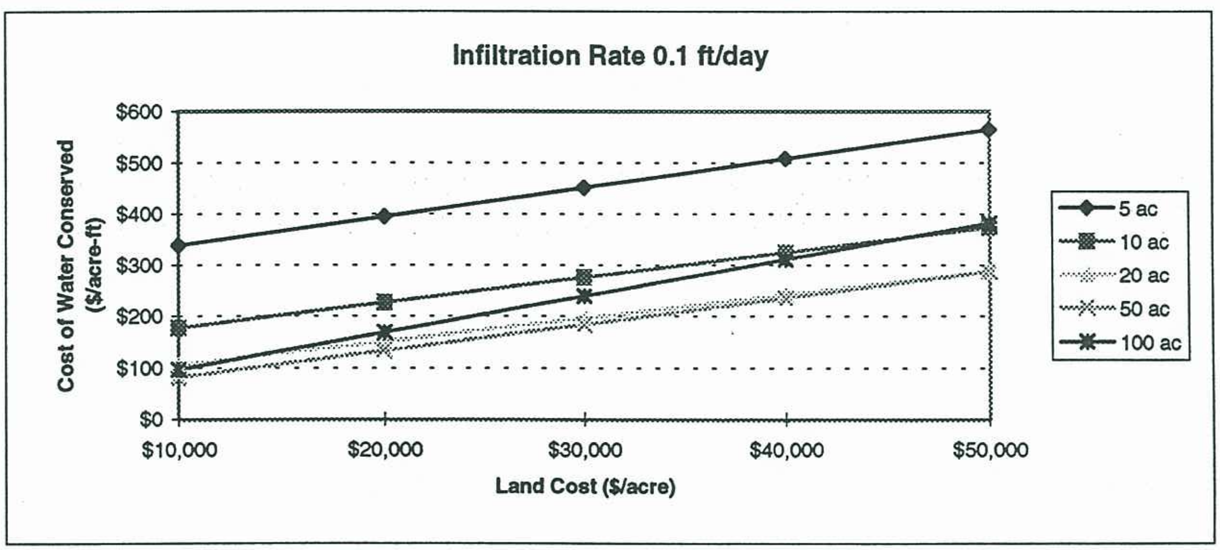
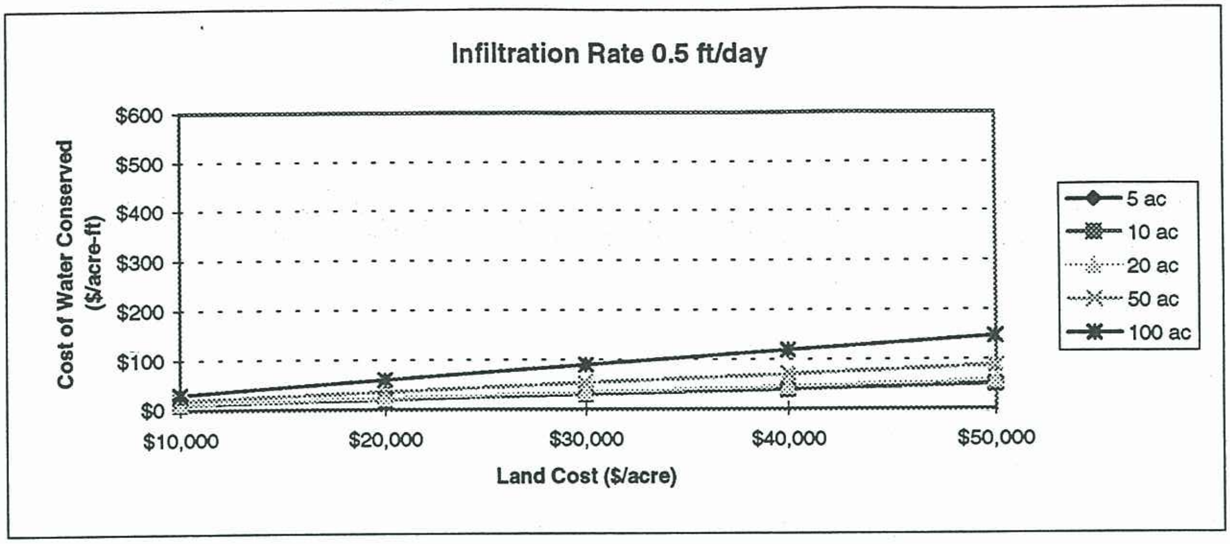
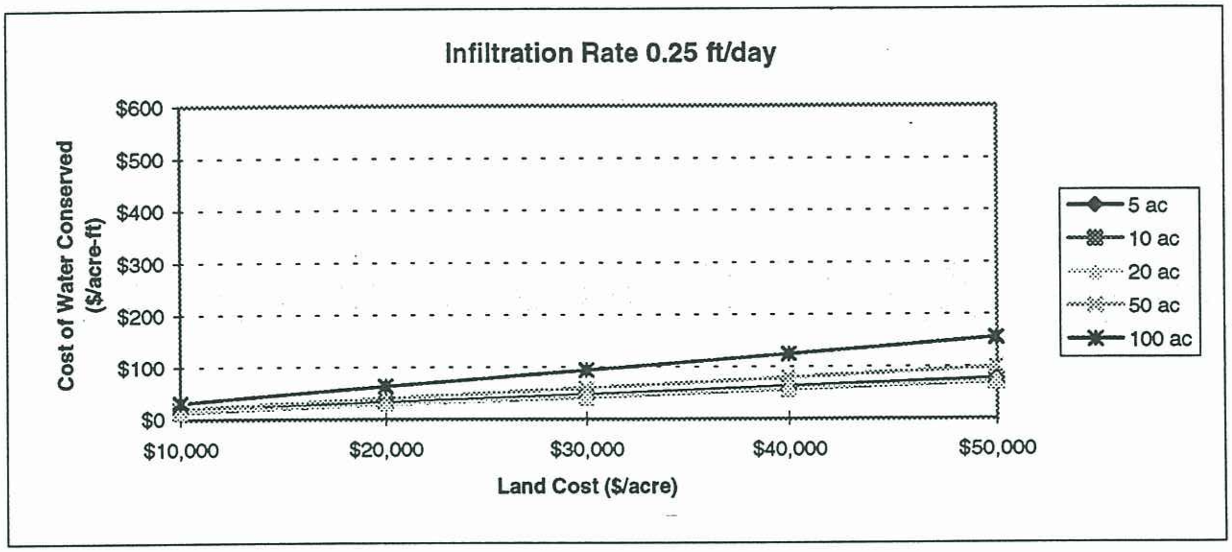


FIGURE NO.3-19
COST OF WATER CONSERVED -- CONSERVATION AND FLOOD CONTROL
LOWER CHINO CONSERVATION BASIN NO.2





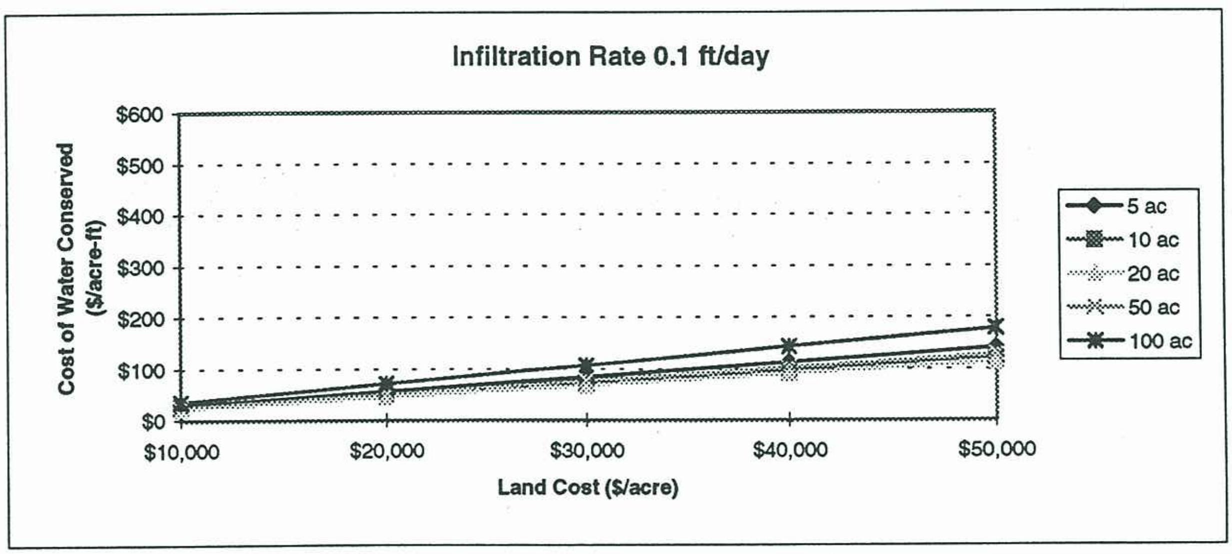
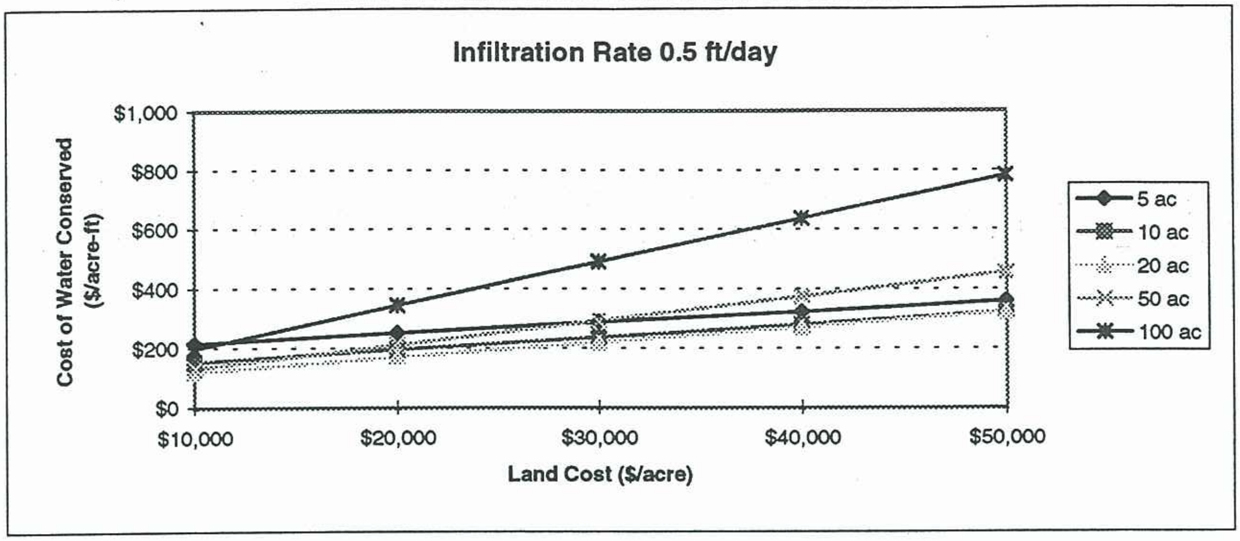
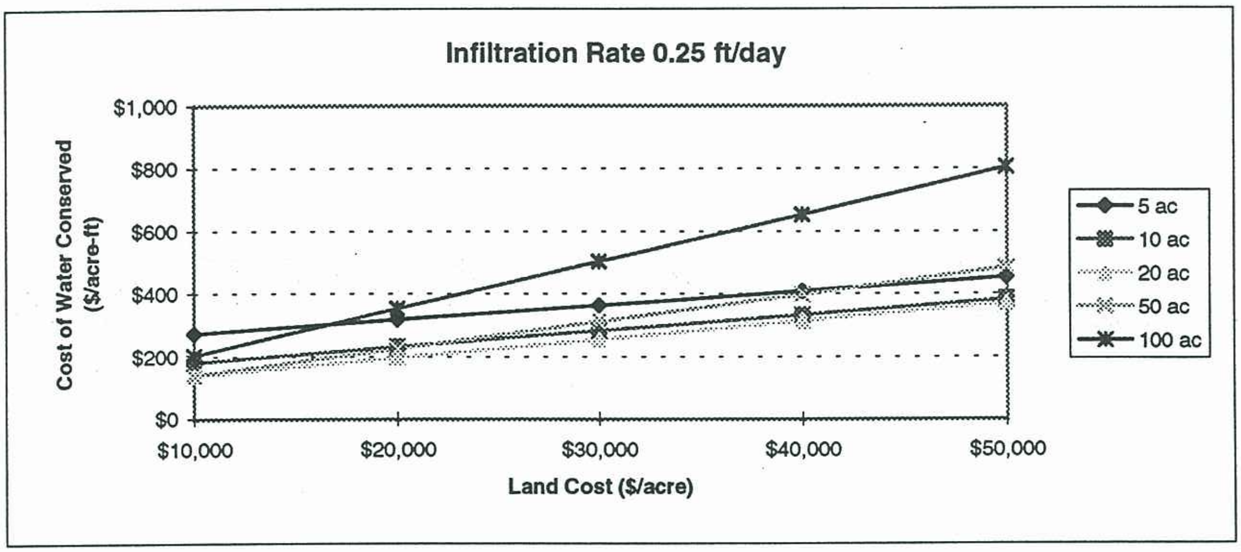


FIGURE NO.3-20
COST OF WATER CONSERVED -- CONSERVATION ONLY
LOWER CHINO CONSERVATION BASIN NO.3





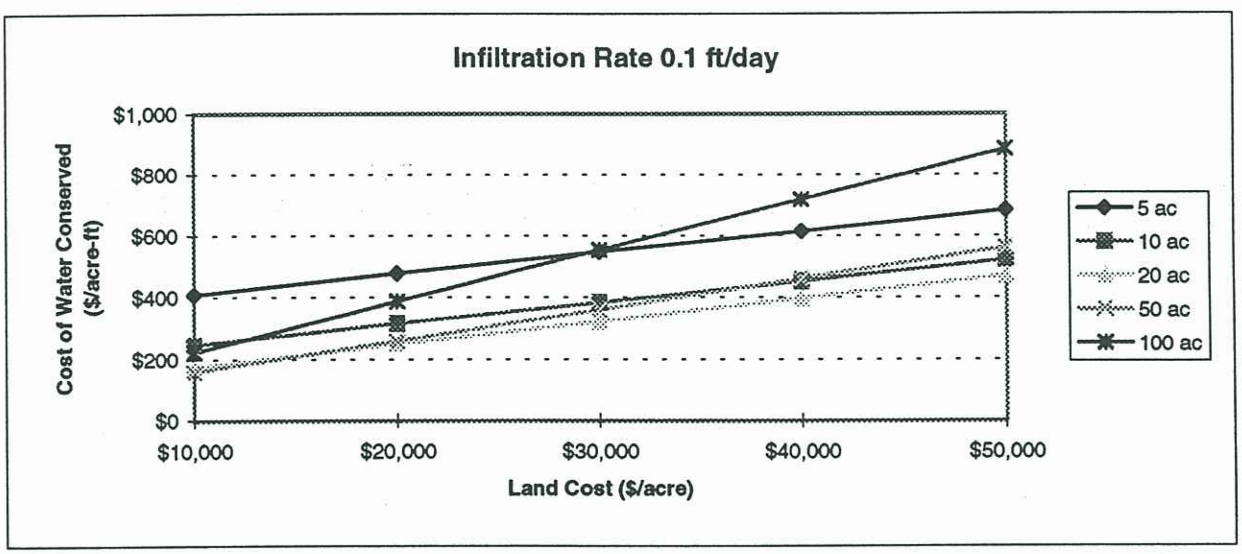
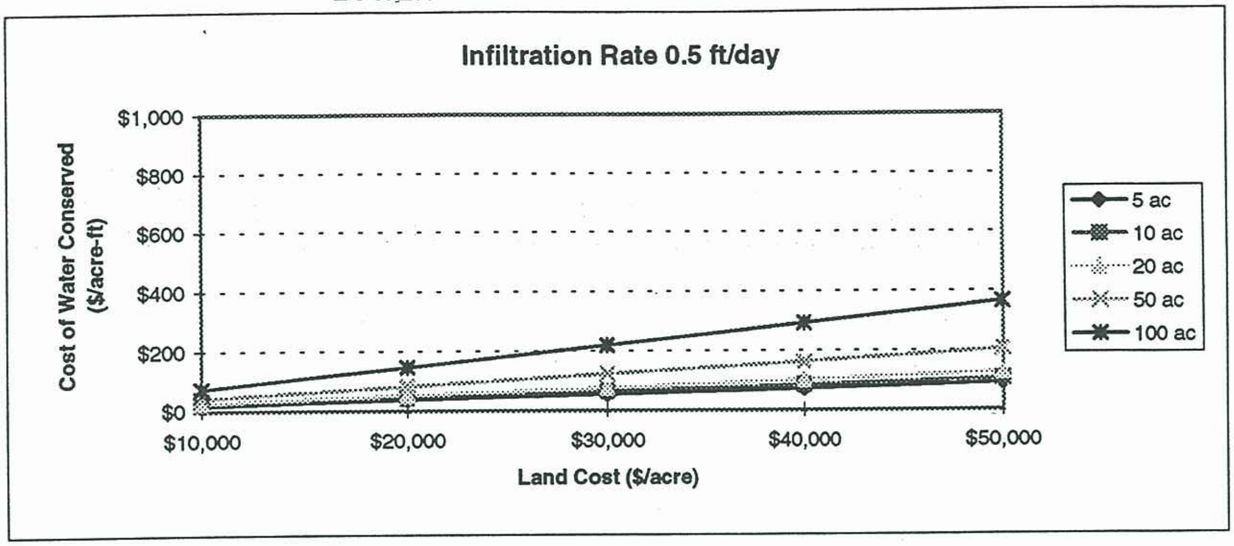
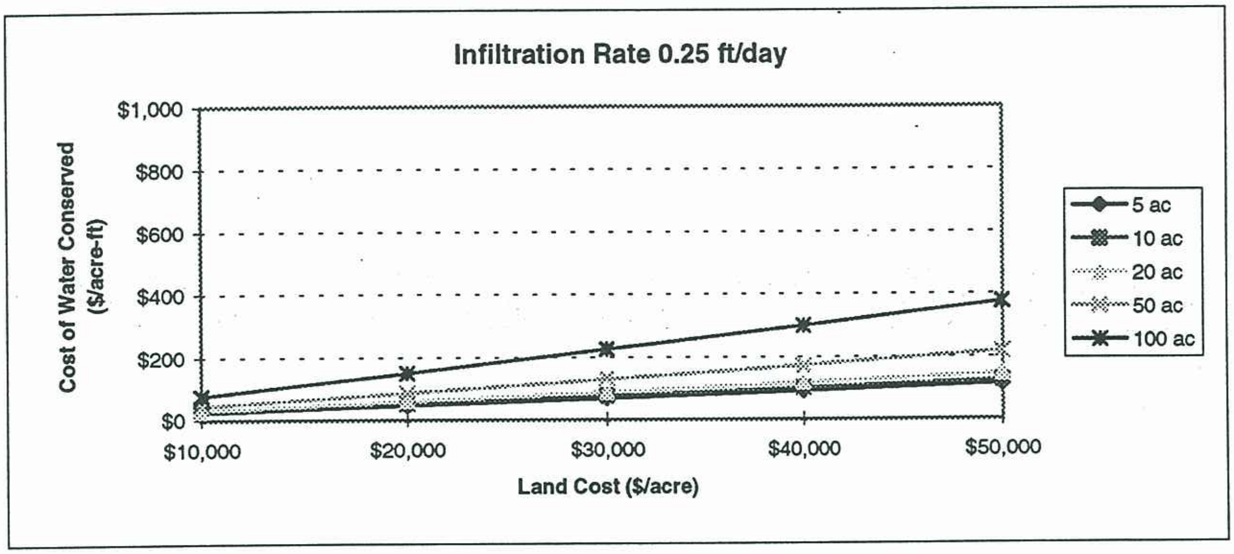


FIGURE NO.3-21
COST OF WATER CONSERVED -- CONSERVATION AND FLOOD CONTROL
LOWER CHINO CONSERVATION BASIN NO.3





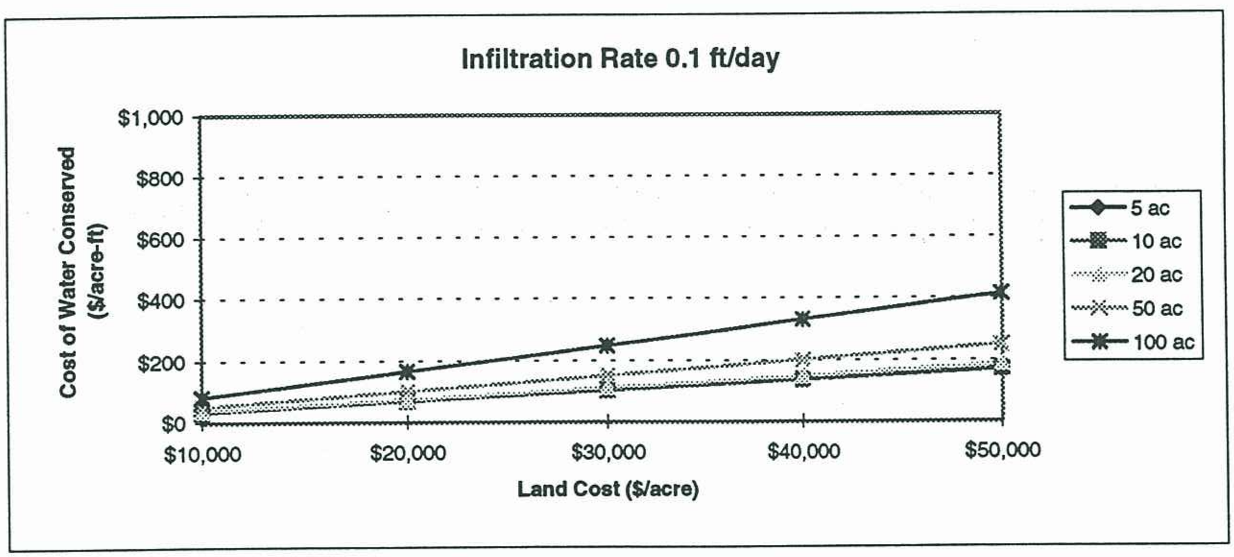
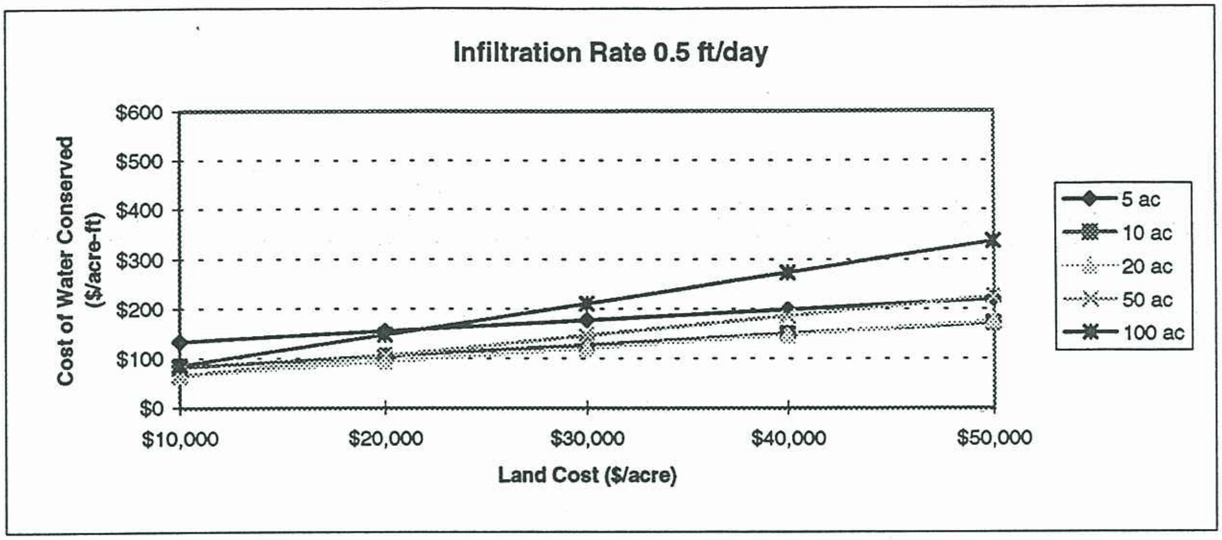
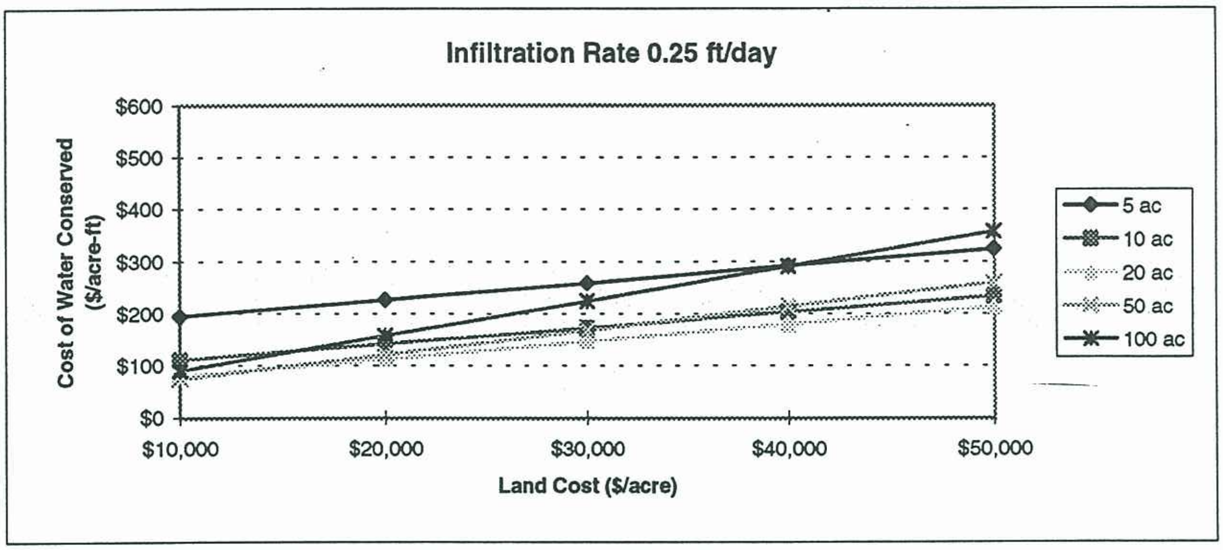


FIGURE NO.3-22
COST OF WATER CONSERVED -- CONSERVATION ONLY
LOWER CHINO CONSERVATION BASIN NO.4





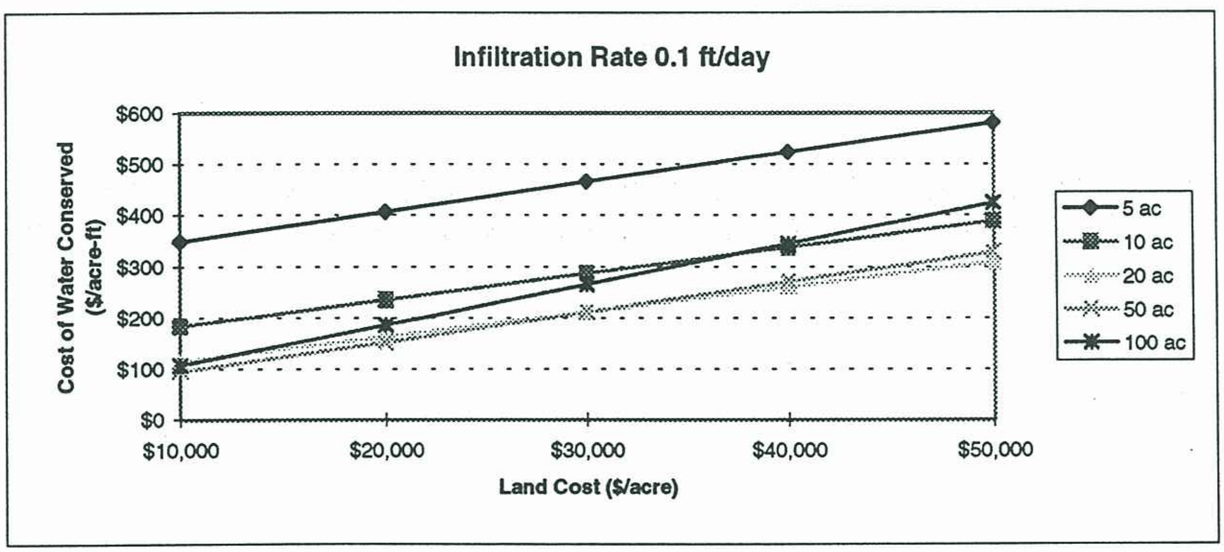
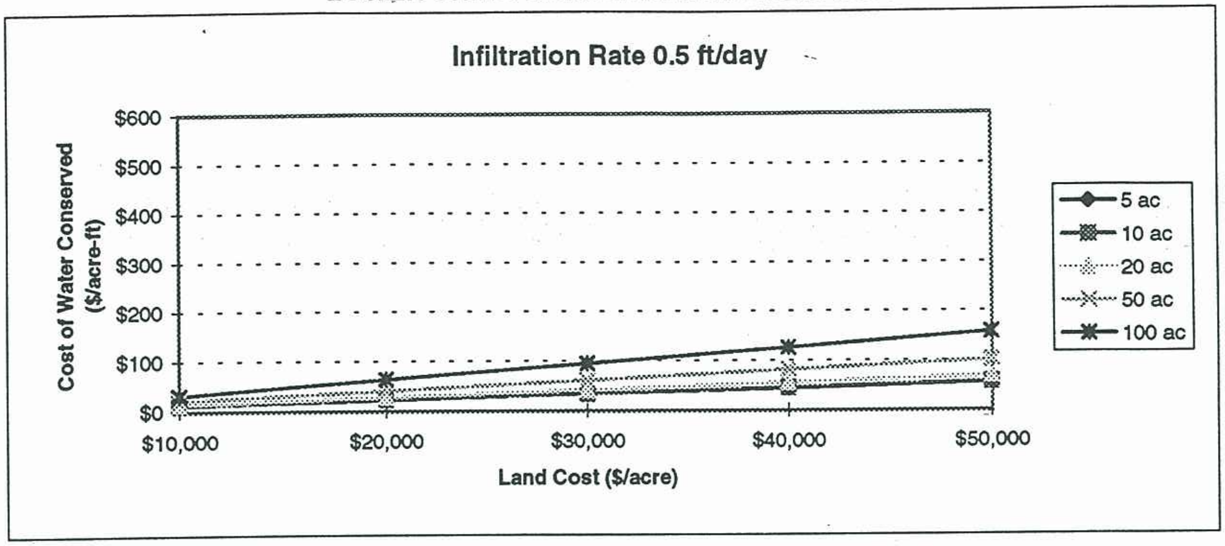
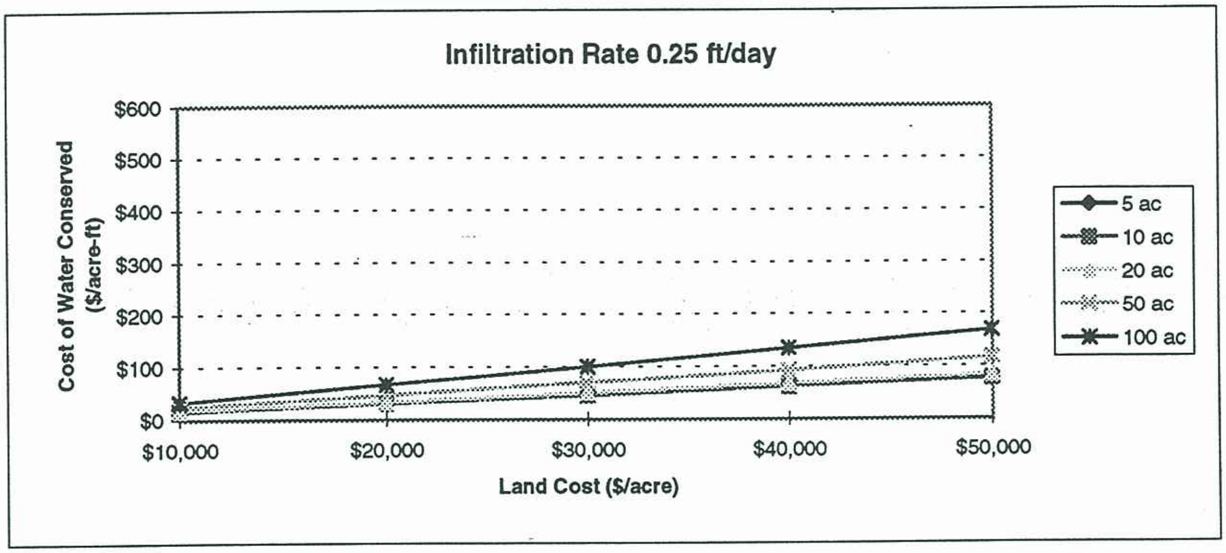


FIGURE NO.3-23
COST OF WATER CONSERVED -- CONSERVATION AND FLOOD CONTROL
LOWER CHINO CONSERVATION BASIN NO.4





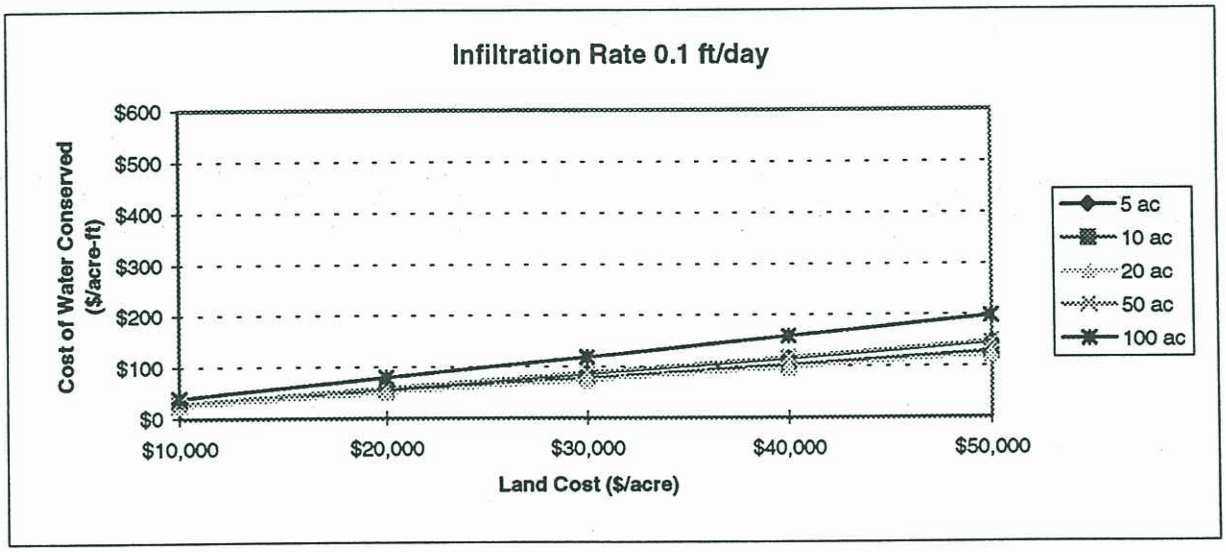
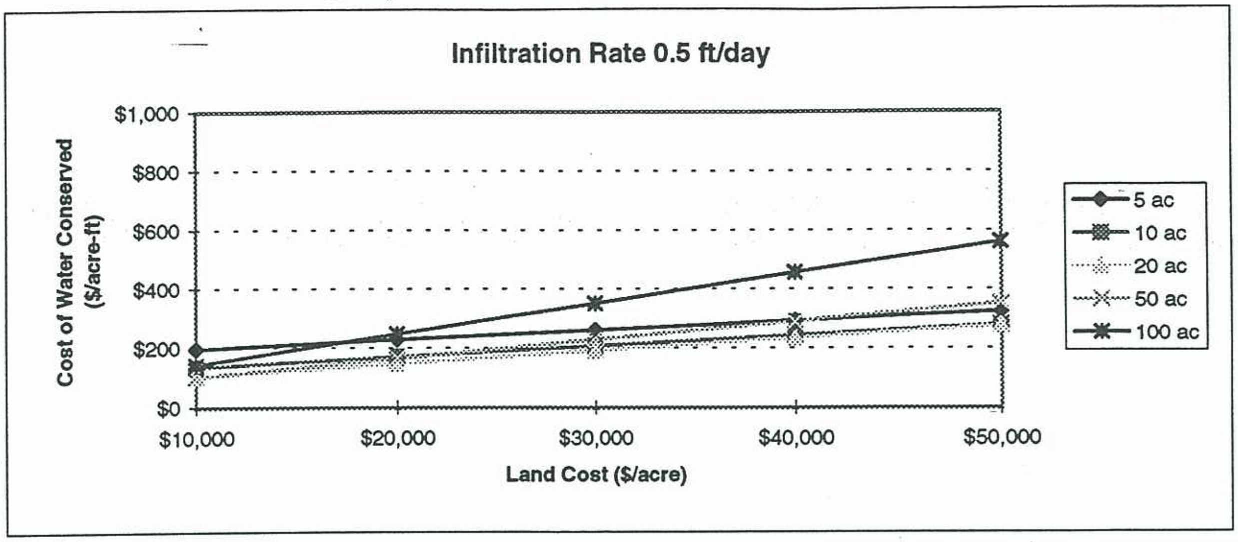
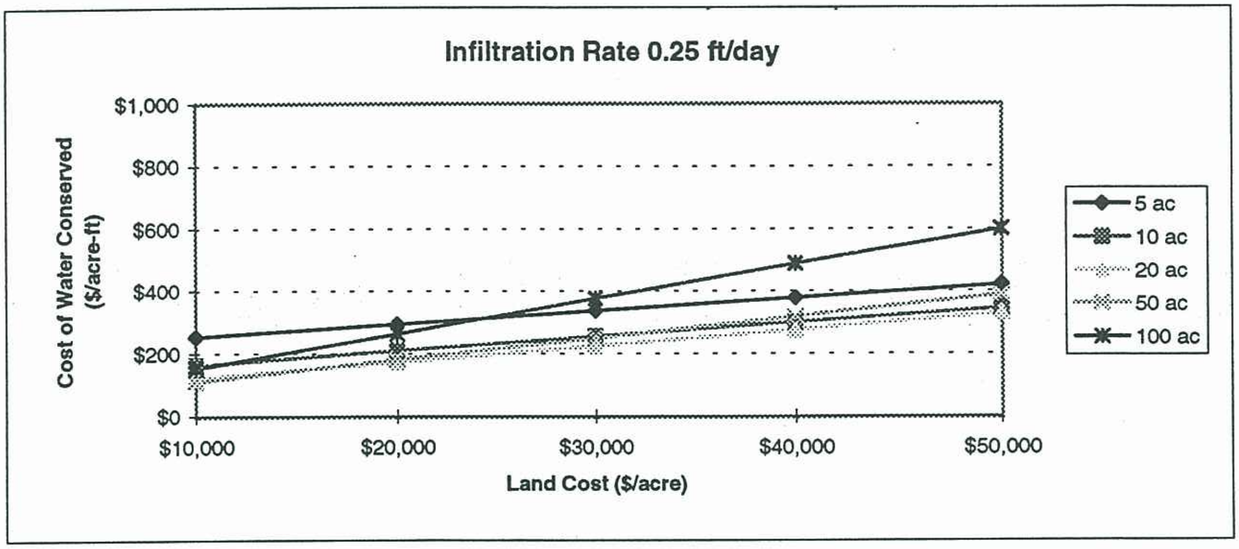


FIGURE NO.3-24
COST OF WATER CONSERVED – CONSERVATION ONLY
LOWER CHINO CONSERVATION BASIN NO.5





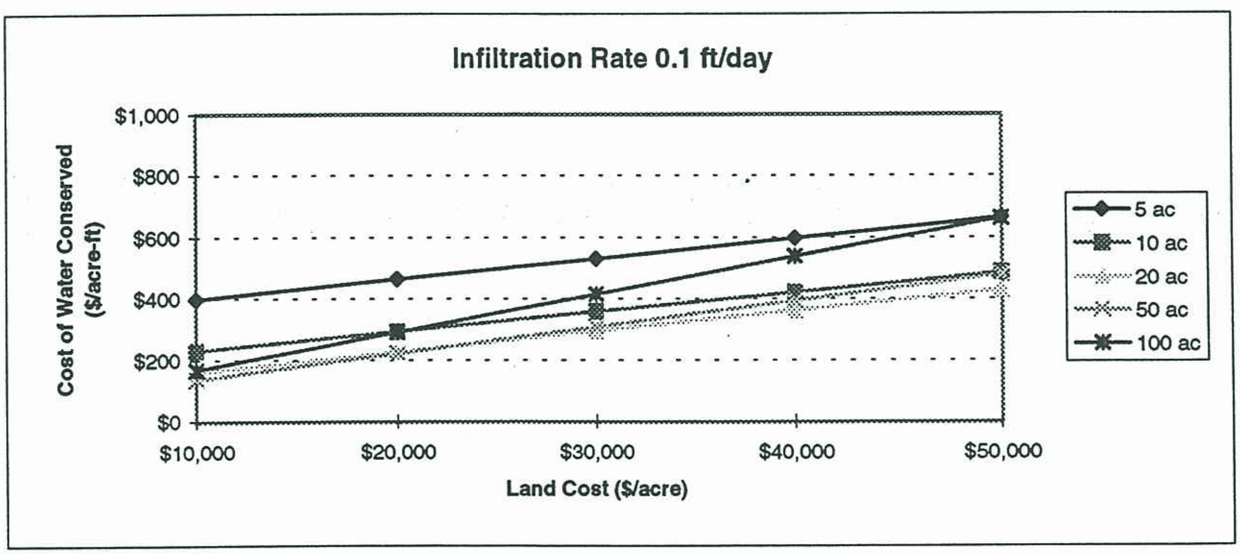
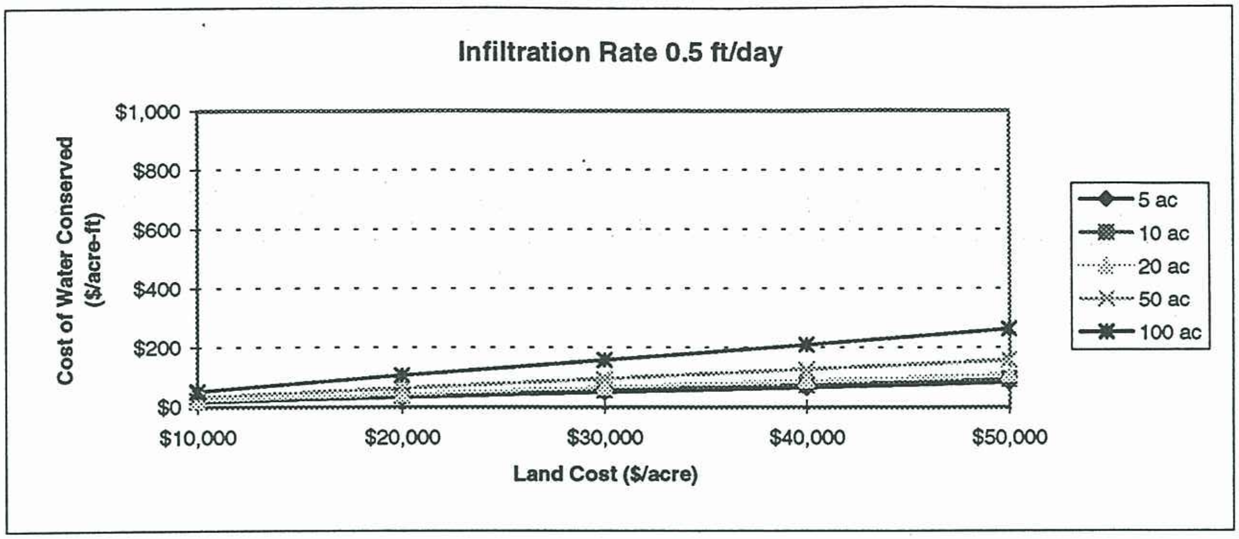
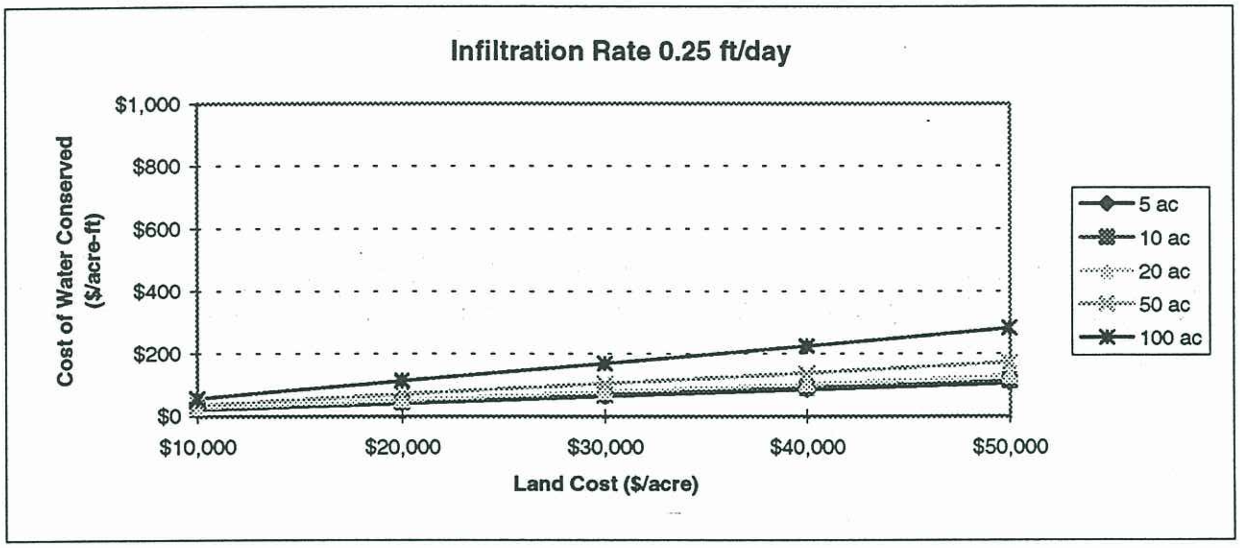


FIGURE NO.3-25
COST OF WATER CONSERVED -- CONSERVATION AND FLOOD CONTROL
LOWER CHINO CONSERVATION BASIN NO.5





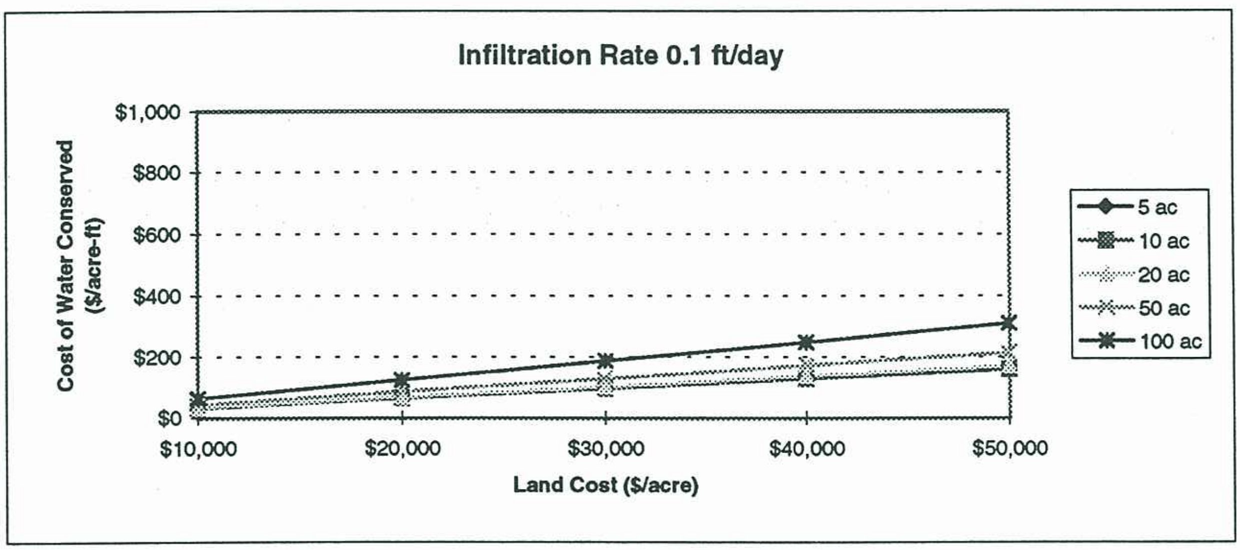
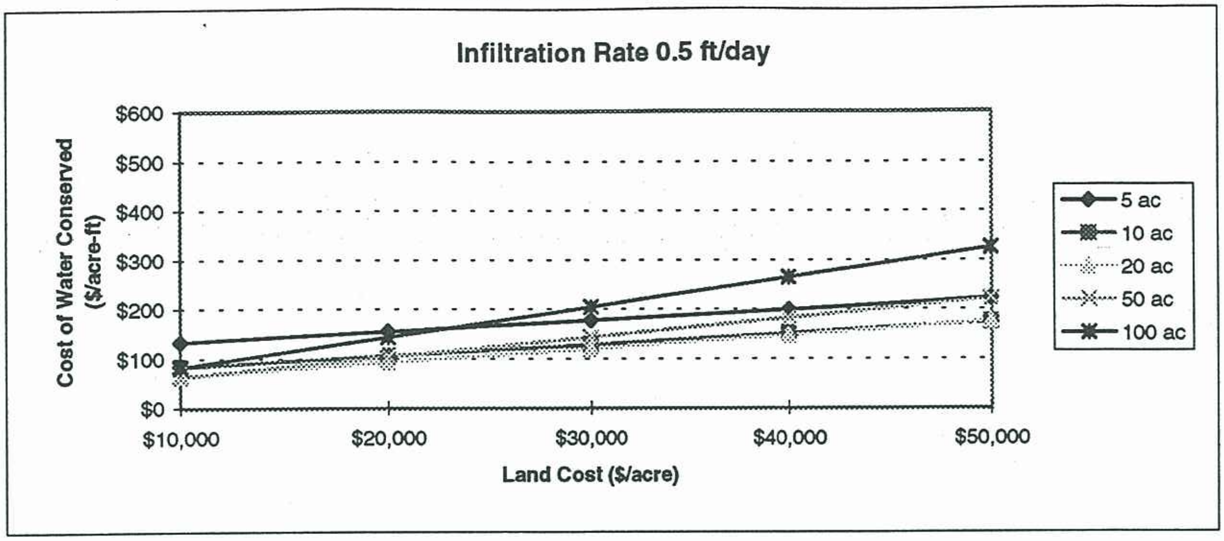
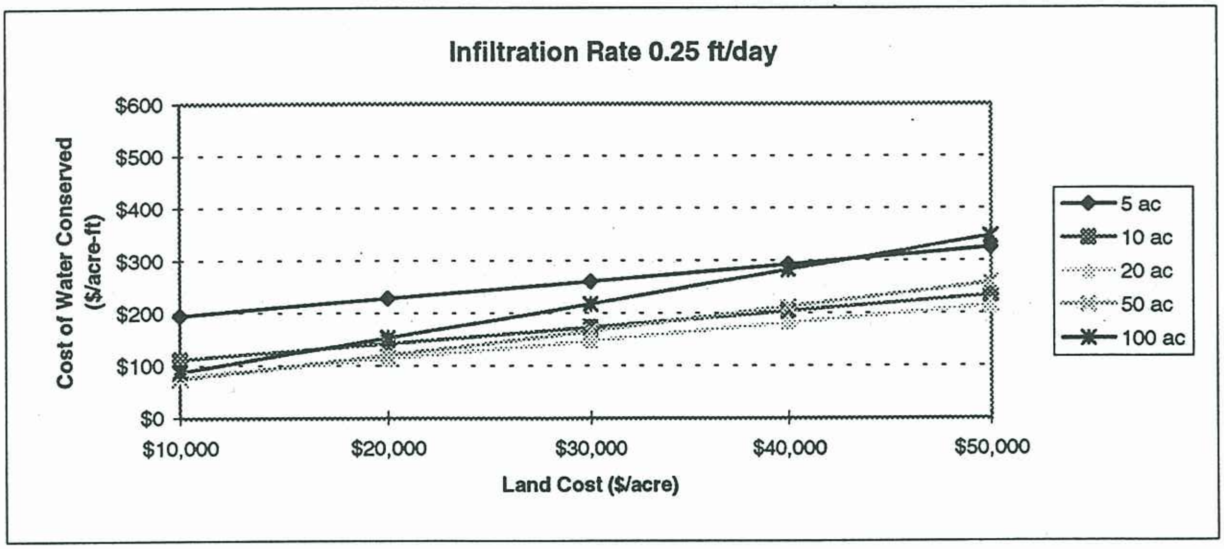


FIGURE NO.3-26
COST OF WATER CONSERVED -- CONSERVATION ONLY
LOWER CHINO CONSERVATION BASIN NO.6





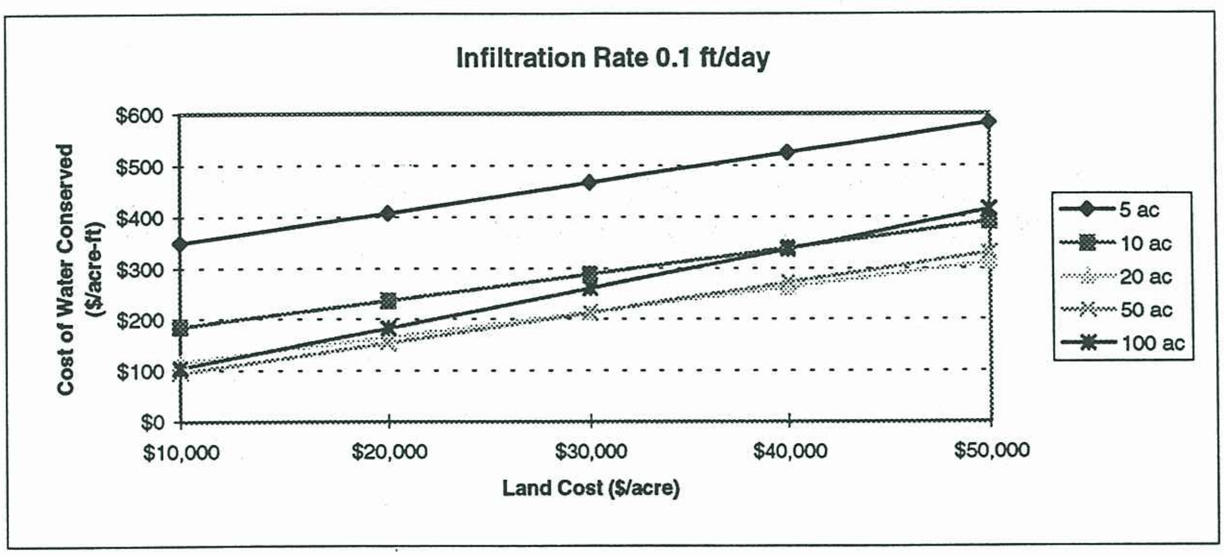
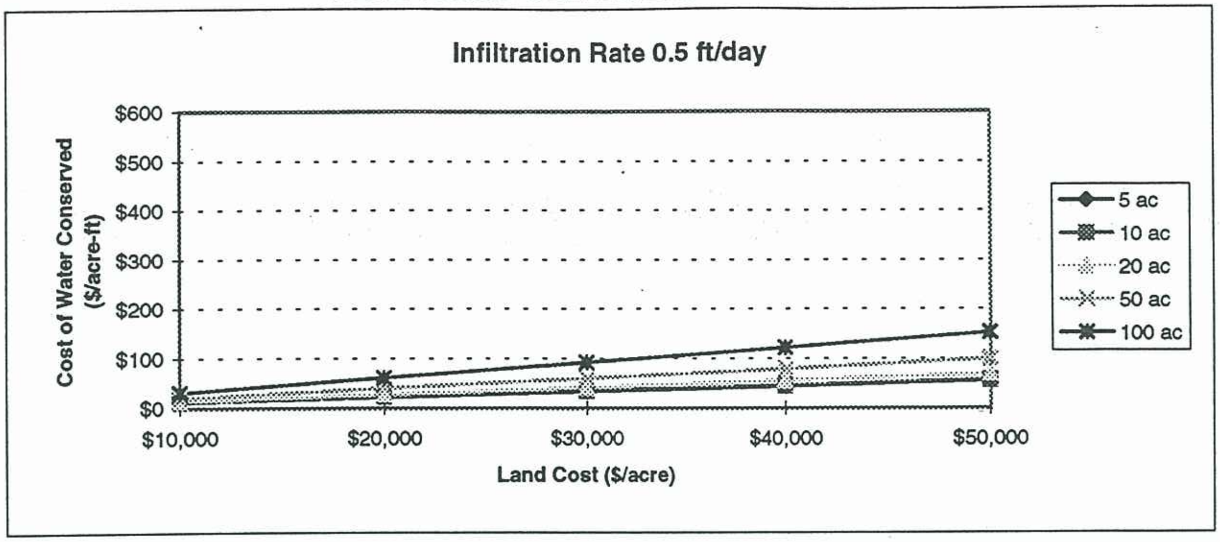
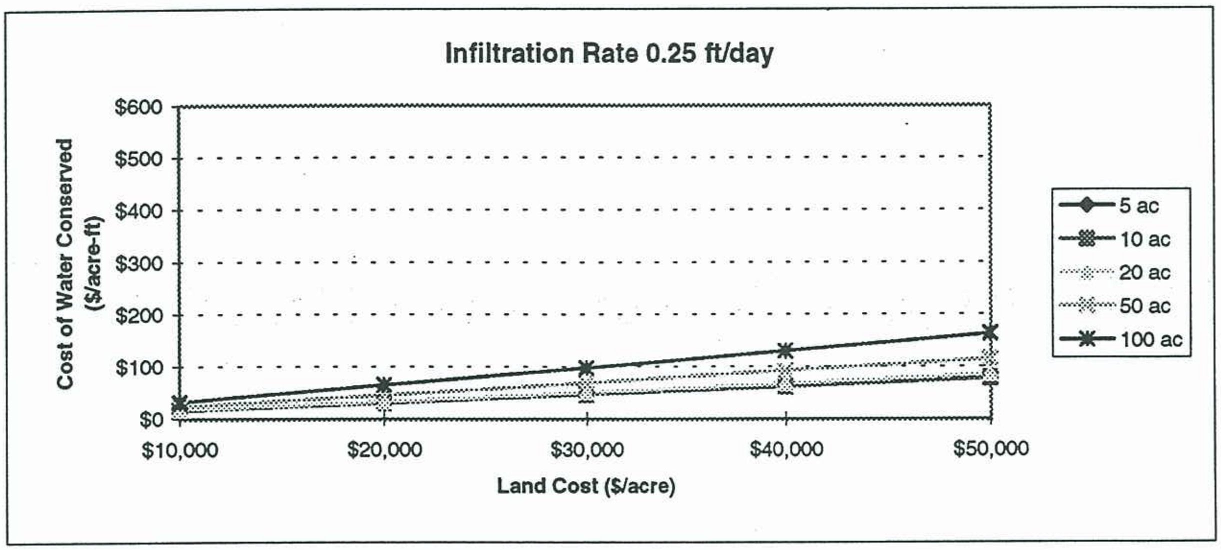
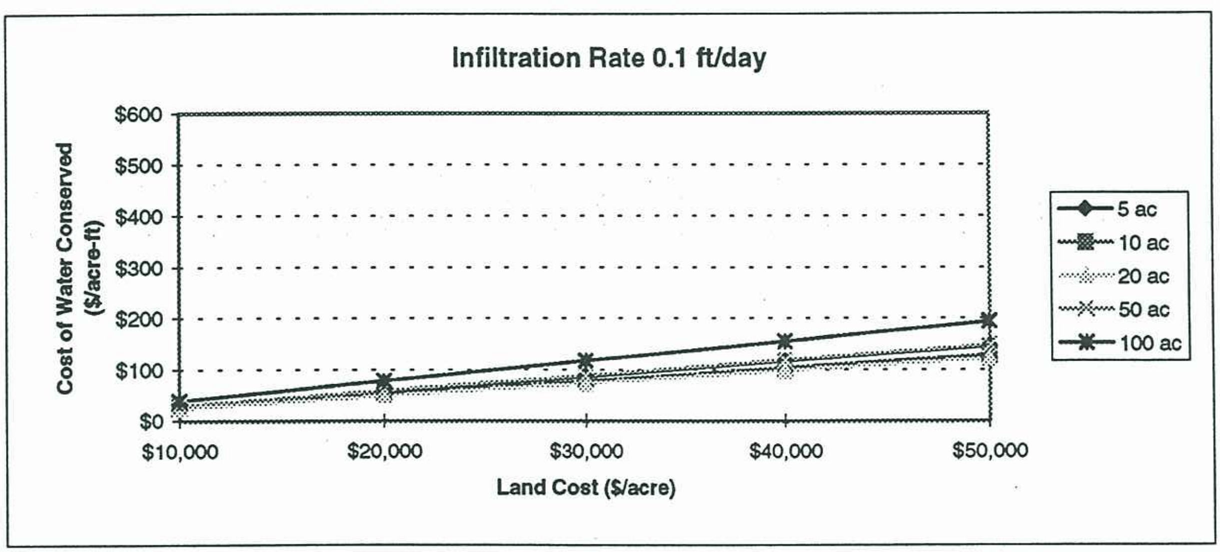


FIGURE NO.3-27
COST OF WATER CONSERVED -- CONSERVATION AND FLOOD CONTROL
LOWER CHINO CONSERVATION BASIN NO.6







Section 4

SECTION 4
ARTIFICIAL RECHARGE OF IMPORTED AND RECLAIMED WATER

AVAILABILITY OF IMPORTED WATER FOR ARTIFICIAL RECHARGE

Imported water for artificial recharge is currently available to the region from Metropolitan through CBMWD. Metropolitan provides water to southern California from the Colorado River Aqueduct (CRA) and the State Water Project (SWP). SWP water is conveyed into the Chino Basin from the Foothill Feeder flowing from east to west across the northern half of the Chino Basin. The location of the Foothill feeder is shown in Figure 4-1. CRA water comes north in the Upper Feeder from Lake Matthews in Riverside County and enters the Chino Basin in the Jurupa area eventually turns due west and flows west across the middle of the Chino Basin. The Etiwanda Cross Feeder connects the Foothill Feeder to the Upper Feeder in the Etiwanda area. The location of the Upper Feeder and the Etiwanda Cross Feeder are shown in Figure 4-1. The Upper Feeder west of the Etiwanda Cross Feeder conveys a mix of CRA and SWP water. In the future, other sources of imported water may become available from sources such as groundwater from the Bunker Hill Basin, Santa Ana River water and northern California water.

Colorado River Aqueduct (CRA)

CRA water is no longer used in the Chino Basin due to high TDS concentrations. The high TDS water conveyed through the CRA makes it difficult for wastewater treatment operators to comply with waste discharge requirements in their NPDES permits.

State Water Project (SWP)

SWP water is used with treatment as municipal supply and without treatment for groundwater replenishment. Several Metropolitan connections on the Foothill Feeder allow SWP water deliveries in the Chino Basin. Table 4-1 lists these connections and pertinent information about the connection including location, connection capacity, and connection status. The capacity of these connections range from a low of 15 cfs for CB-07 to 75 cfs for CB-59T. Artificial recharge from the designated *replenishment* connections for the Chino Basin has occurred through the Watermaster since the Basin was adjudicated. Several connections have been severed or dismantled. New connections have been added over time as supply needs to the area have changed. Recent replenishment deliveries to Watermaster are listed in Table 4-2. Replenishment deliveries have been reduced in the past few years due to increases in costs of import water, sale of unproduced groundwater between under-producers and over-producers, and the Watermaster's ability to promote in-lieu surface exchanges for groundwater replenishment. Over the last six years, Watermaster replenishment with imported water has ranged from no replenishment in fiscal 1995/96 to a high of about 16,000 acre-ft in fiscal 1993/94.

AVAILABILITY OF BASINS FOR IMPORTED WATER RECHARGE

Existing Imported Water Recharge Capacity

Artificial recharge of imported water occurs at San Sevaine No.1, 2 and 3, Etiwanda Spreading Grounds, and Montclair No.1, 2 and 3. Recharge is arranged by the Watermaster to satisfy replenishment obligations. Metropolitan schedules replenishment deliveries from October through April and they occur only when SWP water is abundant and available. Metropolitan restricts replenishment deliveries during periods of drought and scheduled outages. Recharge capabilities for imported water are dependent on the amount of conservation storage within each basin, percolation rates in each basin, and the ability to introduce imported water into them. The recharge capacity of these basins is about 29,000 acre-ft/yr based on 7 months of recharge and the reported operating characteristics of the basins. Table 4-3 summarizes the size, percolation rate, and source for these basins. Watermaster's operational experience in using these basins is summarized below.

Etiwanda Spreading Grounds. Recharge operations at these spreading grounds includes the delivery of Metropolitan water into Basin No. 1 from the CB-14T connection. Water deliveries from the connection vary depending on the pressure in the Foothill Feeder, but average about 15 cfs. The resulting recharge rate is about 30 acre-ft/day with a maximum annual capacity of about 6,250 acre-ft/yr. The percolation rate from historical data has been as high as 7 feet per day. The recharge in these basins is limited by the capacity of CB-14T.

San Sevaine Spreading Grounds. Imported water is discharged to Basins No. 1 and No. 2, but can include No. 3 and No. 4 depending on the existing water levels at the start of the spreading period. Spreading operations include water deliveries that can range from 20 to 25 cfs depending on the pressure in the Foothill Feeder at CB-13T. Deliveries from CB-13T are discharged into Basin 1 and spill from one basin to the next. The resulting recharge rate is about 40 to 50 acre-ft/day with a maximum annual capacity of about 9,150 acre-ft/yr.

Montclair Basins. Imported water recharge is limited to Basins No. 1 and No. 2. Recharge operation includes delivery of imported water from CB-59T via the San Antonio Creek into Basin No. 1. Overflow from Basin No. 1 enters No. 2 through a gated culvert. Historically, Basin No. 2 has been filled up to five feet below the outlet to Basin 3, but on occasion Basin No.3 has been used for recharge. To accomplish this, water deliveries from Metropolitan initially are at 60 to 65 cfs until Basin No. 2 is near the five foot mark, then the deliveries are throttled down to 30 cfs. At 30 cfs, the water level remains until recharge is terminated. The recharge rate is about 60 acre-ft/day and a maximum annual capacity of 13,325 acre-ft/yr.

Potential Imported Water Recharge Capacity

Capacity to recharge imported water at the existing basins is limited by percolation rates and Metropolitan connection capacities. Imported water recharged in the Montclair Basins is restricted by percolation rates in Basins No. 1 and No.2. The connection capacity is well above the basins' ability to recharge water shown in Table 4-3. Recharge in the Etiwanda and San Sevaine Spreading areas are limited to the capacity of the connections that serve them water.

There is an inherent conflict in trying to recharge imported water in basins that are used to recharge storm water. Most of the storm water inflow occurs in December through March with recharge occurring in December through April. This is the same period that Metropolitan delivers replenishment water. Therefore, there is some risk that water will be lost if the combination of imported water and storm flows exceed the conservation storage capacity of a basin.

There are 17 other basins along Metropolitan's Upper Feeder or other facilities that can receive SWP from the Foothill Feeder. Table 4-4 summarizes these potential recharge sites and the potential for recharge. Operating rules need to be developed to program the amount of SWP deliveries to all basins that can be used to recharge both imported water and stormflows. The operating rules define how the basins are to operate on a monthly basis through the year. Three operating rules were used to estimate the imported water recharge potential in the Chino Basin at existing basins. These rules are:

> <u>Theoretical maximum recharge capacity minus the average storm water recharge.</u> This is computed by estimating the recharge rate at the maximum conservation storage level minus the seasonal average storm water recharge rate (from Table 3-6). In this method, excess (unused) recharge capacity will exist in about 5 of 7 years and some losses could occur in about 2 of 7 years. These losses could be minimized and possibly avoided if weather forecasting is used to schedule replenishment deliveries.
>
> <u>Theoretical maximum recharge capacity minus the average storm water recharge minus one standard deviation of storm water recharge.</u> This is

computed by estimating the recharge rate at the maximum conservation storage level, minus the seasonal average storm water recharge, minus the standard deviation of the seasonal storm water recharge (from Table 3-6). In this method, excess (unused) recharge capacity will exist in about 3 of 4 years and some losses could occur in about 1 of 4 years. As with the prior rule, these losses could be minimized and possibly avoided if weather forecasting is used to schedule replenishment deliveries.

Reduced theoretical recharge capacity based on weather forecasting. This is computed by estimating the reduced theoretical recharge rate as the minimum of either the recharge rate at maximum conservation storage level or the recharge rate with 5 days of recharge water in conservation storage, minus the seasonal average storm water recharge rate (from Table 3-6). The recharge rate with 5 days of recharge in storage will, by definition, completely recharge all water in conservation storage within 5 days if the replenishment deliveries are terminated. A period of 5 days was selected to represent a reasonable period of time to forecast significant precipitation. Imported water deliveries would be terminated if an interpretation of a weather forecast suggests that water could be lost.

Estimates of the maximum amount of annual recharge for each operating rule are summarized in Tables 4-4 and 4-5 for existing basins and for basins with expanded conservation storage for storm water recharge, respectively. Assuming replenishment water could be made available to all the basins listed in Tables 4-4 and 4-5, and that recharge operations are as described above, the potential recharge capacity for imported water is about 118,000 acre-ft/yr to 121,000 acre-ft/yr. This increases to about 155,000 acre-ft/yr to 171,000 acre-ft/yr when the conservation storage is expanded as describe in Section 3.

FACILITIES AND COST ESTIMATES TO INCREASE IMPORTED WATER RECHARGE CAPACITY

Tables 4-6 and 4-7 summarize the facilities requirements and the cost to maximize the recharge at these basins. The facilities and costs to deliver imported water to existing basins are summarized below by drainage system. This is done to compare the facilities and costs for individual basins and the economies of scale if more than one basin is used in a system. The major capital cost items are the costs to connect to the Foothill Feeder, new inlet and outlet structures, piping and land. The costs for these improvements are based on similar projects in the Chino Basin area or from other studies. Mobilization, demobilization, earthwork, and general construction requirements were estimated in aggregate at fifteen percent of the sum of the major capital cost items. Construction cost is the sum of major capital cost items plus the cost of mobilization, demobilization, earthwork, and general construction. Design and construction management costs were estimated at fifteen percent of the construction cost and contingencies were estimated at 25 percent of the construction cost. Total capital cost is the sum of construction cost plus design and construction management plus contingency cost. The capital cost was amortized at 6.5 percent for 20 years.

Operations and maintenance was estimated at one percent of the project capital cost. Vector control cost was estimated at about $8,000 per basin per year from information supplied by Watermaster. The unit facility cost for recharge of imported water at each basin was estimated as the sum of amortized facility cost plus operations and maintenance cost divided by the imported water recharge capacity of each basin. The total unit cost of imported water recharge at a basin is equal to the facility unit cost plus the cost of imported water -- $582/acre-ft. The recharge rates in all basins are limited to rates that allow the imported water to be fully recharged prior to significant storm events.

San Antonio Creek System

Upland Basin. SWP water would be discharged from a new connection on the Foothill Feeder to San Antonio Creek. An inlet structure from the San Antonio Creek would be constructed to divert SWP water from San Antonio Creek into the Upland Basin. An outlet would be constructed to convey overflows to Montclair No. 1. The cost of the new connection would be about $500,000 and the cost of the new inlet to the Upland Basin would be about $600,000 based on *Chino Basin Conjunctive-Use Demonstration Project, Reports on Phases 1 and 2* (CH2M-Hill, 1995), inflated to 1997 dollars. The cost of an outlet to Montclair No. 1 is about $735,000. The estimated capital cost for the facilities to recharge SWP water into the Upland Basin is about $2,850,000 or $259,000 per year. The increased imported water recharge capacity resulting from this project is about 25,000 acre-ft/yr. The facilities cost for recharge is about $10 per acre-ft. The total cost of new recharge at these basins is about $592 per acre-ft.

Montclair Basins (1-2). No new facilities or costs.

Montclair Basins (3-4). The Montclair Basins No. 3 and No. 4 would operate in series just as Montclair Basins No. 1 and No. 2. SWP water would be discharged from a new or expanded Chino Basin connection on the Foothill Feeder at San Antonio Creek. An inlet structure from the San Antonio Creek would be constructed to divert SWP water from San Antonio Creek into Basin No. 3 for operational flexibility. Water would be ponded in Basin No. 3 at an elevation that would allow discharge of SWP from Basin No. 3 to Basin No. 4 via the spillway that connects these basins. The costs of the new connection would be about $500,000 and the cost of the new inlet to Basin No. 3 would be about $600,000. The estimated capital cost for the facilities to recharge SWP water into Montclair No. 3 and No. 4 is about $1,670,000 or $151,000 per year. The increased imported water recharge capacity resulting from this project is 8,000 acre-ft/yr. The facilities cost for recharge is about $24 per acre-ft. The total cost of new recharge at these basins is about $606 per acre-ft.

Brooks Street Basin. The Brooks Street Basin will require identical facilities as Montclair Basins No. 3 and No. 4 and the same cost. The estimated capital cost for the facilities to recharge SWP water into Brooks Street Basin is about $1,670,000 or $151,000 per year. The increased imported water recharge capacity resulting from this project is about 4,100 acre-ft/yr. The facilities cost for recharge is about $43 per acre-ft. The total cost of new recharge at this basin is about $625 per acre-ft.

Combined Projects on the San Antonio System. About $1,000,000 in capital costs would be saved if one connection was built to serve the Upland, Montclair No. 3 and No. 4, and the Brooks Street Basin. The estimated capital cost for the facilities to recharge SWP water into all three basins is about $4,800,000 or $434,000 per year. The increased imported water recharge capacity resulting from this project is about 31,000 acre-ft/yr. The facilities cost for recharge is about $21 per acre-ft. The total cost of new recharge at these basins is about $603 per acre-ft.

West Cucamonga Channel System

The Fifteenth Street, Eighth Street, Seventh Street, and Ely Basins are aligned in series on the West Cucamonga Creek channel. SWP water can be discharged into a storm drain tributary to the Fifteenth Street Basin where it can recharge or be discharged downstream to the Eighth Street, Seventh Street, and Ely Basins for recharge. Discharges from the Fifteenth Street Basin will enter the West Cucamonga Creek and flow into the Eighth Street basin. The new facilities required for these basins would be a new connection to the Foothill Feeder and the piping to convey the SWP water to the Fifteenth Street Basin. The cost of the new Metropolitan connection would be about $500,000 and the cost of piping is about $1,700,000. The estimated capital cost for the facilities to recharge SWP water into these basins is about $3,460,000 or $314,000 per year. The increased imported water recharge capacity resulting from this project is about 4,600 acre-ft/yr. The facilities cost for recharge is about $81 per acre-ft. The total cost of new recharge at these basins is about $663 per acre-ft.

Deer Creek System

The Church Street and Turner No.3/4 Basins straddle Deer Creek. SWP water would be discharged into a storm drain tributary to the Church Street Basin. Controlled discharges from the Church Street basin will enter Deer Creek and be diverted into the Turner No.3/4 basin via existing inlets from Deer Creek. This project is conceptually similar to the West Cucamonga Creek Channel System but with lower costs. The estimated capital cost for the facilities to recharge SWP water into these basins is about $779,000 or $71,000 per year. The increased imported water recharge capacity resulting from this project is about 14,000 acre-ft/yr. The facilities cost for recharge is about $7 per acre-ft. The total cost of new recharge at these basins is about $589 per acre-ft.

Day Creek System

Lower Day Creek Basin. Lower Day Basin, as it is currently operated, has no conservation storage and therefore cannot be used for recharge of imported water. With expanded conservation storage as described in Section 3, the amount of SWP water that could be recharged is about 2,700 acre-ft/yr. The new facilities required for these basins would be a new connection to the Foothill Feeder, piping to convey the SWP water to the Lower Day Basin and a new inlet structure. The cost of the new connection would be about $500,000, cost of piping is about $645,000 and the cost of a new inlet structure would be about $15,000. The estimated capital cost for the facilities to recharge SWP water into these basins is about $1,760,000 or $160,000 per year. The facilities cost for recharge is about $68 per acre-ft. The total cost of new recharge at these basins is about $650 per acre-ft.

Riverside and Wineville Basins. SWP water would be discharged to the Day Creek channel where the channel crosses the Foothill Feeder. SWP water would be conveyed in the channel and discharged into Wineville Basin where some of the water will recharge and some will be discharged to Riverside Basin for recharge. The new facilities required for these basins would be a new connection to the Foothill Feeder and a new outlet control structure for the Wineville Basin. The cost of the new connection would be about $500,000, and the cost of an outlet control structure for the Wineville Basin would be about $150,000. The estimated capital cost for the facilities to recharge SWP water into these basins is about $942,000 or $85,000 per year. The increased imported water recharge capacity resulting from this project is about 17,000 acre-ft/yr. The facilities cost for recharge is about $7 per acre-ft. The total cost of new recharge at these basins is about $589 per acre-ft.

Combined Projects on the Day Creek System. About $500,000 in capital costs would be saved if one connection was built to serve the Lower Day, Wineville and Riverside Basins. The estimated capital cost for the facilities to recharge SWP water into all three basins is about $2,000,000 or $182,000 per year. The increased imported water recharge capacity resulting from this project is about 23,000 acre-ft/yr. The facilities cost for recharge is about $11 per acre-ft. The total cost of new recharge at these basins is about $593 per acre-ft.

Etiwanda Creek System

Etiwanda Basin. Watermaster currently uses the Etiwanda Basin for replenishment. This basin will be replaced by the SBCFCD with a new larger basin in the next few years. The basin used by Watermaster will be filled in and used for debris storage by SBCFCD. The new Etiwanda Debris/Conservation Basin is located just north Summit Avenue within the existing spreading grounds. A new connection from the Foothill Feeder will need to be constructed to utilize the potential recharge capacity of the new basin and the spreading grounds. The new facilities required for the Etiwanda Basin would be a new connection to the Foothill Feeder, piping to convey the SWP water to the basin and a new inlet structure. The cost of the new connection would be about $500,000, cost of piping is about $290,000 and the cost of a new inlet structure would be about $55,000. The estimated capital cost for the facilities to recharge SWP water into the basin is about $1,260,000 or $114,000 per year. The imported water recharge capacity resulting from this project is about 22,000 acre-ft/yr -- an increase of about 16,000 acre-ft/yr. The facilities cost for recharge is about $6 per acre-ft. The total cost of new recharge at the basin is about $588 per acre-ft.

Victoria Basin. Victoria Basin, as it is currently operated, has no conservation storage and therefore cannot be used for recharge of imported water. With expanded conservation storage as described in Section 3, the amount of SWP water that could be recharged is about 3,900 acre-ft/yr. SWP would be conveyed to the Victoria Basin by discharging SWP water from the Foothill Feeder into Etiwanda Creek. The water would be conveyed to the Victoria Basin in the Etiwanda Creek channel. The new facilities required for the basin would be a new connection to the Foothill Feeder and discharge piping to convey the SWP water to Etiwanda Creek. The cost of the new connection and discharge piping would be about $500,000. The estimated capital cost for the facilities to recharge SWP water into the basin is about $700,000 or $64,000 per year. The increase in imported water recharge capacity resulting from this project is about 3,900 acre-ft/yr. The facilities cost for recharge is about $20 per acre-ft. The total cost of new recharge at the basin is about $602 per acre-ft.

Jurupa Basin. Etiwanda Creek discharges into San Sevaine Creek upstream of the Jurupa Basin and therefore the Jurupa Basin is really in the San Sevaine system. From a hydraulic perspective it is easier and less costly to get SWP water to the Jurupa Basin from the Etiwanda System and hence this basin is included in the discussion of the Etiwanda System. SWP would be conveyed to the Jurupa Basin by discharging SWP water from the Foothill Feeder into Etiwanda Creek. The water would be conveyed to the Jurupa Basin in the Etiwanda and San Sevaine channels. A new connection to the Foothill Feeder would be required. The cost of the new connection would be about $500,000. The increase in imported water recharge capacity resulting from this project is about 10,000 acre-ft/yr. The estimated capital cost for the facilities to recharge SWP water into the basin is about $700,000 or $64,000 per year. The facilities cost for recharge is about $8 per acre-ft. The total cost of new recharge at the basin is about $590 per acre-ft.

Combined Projects on the Etiwanda Creek System. About $1,000,000 in capital costs would be saved if one connection was built to serve the Etiwanda, Victoria and Jurupa Basins. The estimated capital cost for the facilities to recharge SWP water into all three basins is about $1,260,000 or $114,000 per year. The increased imported water recharge capacity resulting from this project is about 36,000 acre-ft/yr. The facilities cost for recharge is about $4 per acre-ft. The total cost of new recharge at these basins is about $586 per acre-ft.

The San Sevaine Creek System

Rich Basin. SWP water would be conveyed from a new connection in the Foothill Feeder through a pipeline directly into the Rich Basin. The new facilities required for the basin would be a new connection to the Foothill Feeder, piping to convey the SWP water to the Rich Basin and a new inlet structure. The cost of the new connection would be about $500,000, the cost of piping is about $255,000 and the cost of a new inlet structure would be about $15,000. The estimated capital cost for the facilities to recharge SWP water into the basin is about $1,130,000 or $103,000 per year. The increase in imported water recharge capacity resulting from this project is about 1,200 acre-ft/yr. The facilities cost for recharge is about $102 per acre-ft. The total cost of new recharge at the basin is about $684 per acre-ft.

San Sevaine Spreading Grounds. The San Sevaine Spreading Grounds consists of four debris/conservation basins and one flood control/conservation basin aligned in series on San Sevaine Creek. Watermaster currently uses the San Sevaine Spreading Grounds for replenishment. The current imported water recharge capacity is about 9,200 acre-ft/yr. SBCFCD is expanding the storage capacity of these basins. The project described herein is an expansion of recharge capacity by constructing a new larger connection to the Foothill Feeder and discharge piping to allow all five debris basins to be used for recharge. The facilities concept for these basins was adapted from *Chino Basin Conjunctive-Use Demonstration Project, Reports on Phases 1 and 2* (CH2M-Hill, 1995). The estimated capital cost for the facilities to recharge SWP water into these basins is about $975,000 or $89,000 per year. The recharge capacity resulting from this project is 10,600 acre-ft/yr. The facilities cost for recharge is about $13 per acre-ft. The total cost of new recharge at these basins is about $695 per acre-ft. If the conservation storage is expanded as described in Section 3, than the imported water recharge capacity would be about 30,000 acre-ft/yr and the associated unit cost of facilities and new recharge would be about $5/acre-ft and $587/acre-ft, respectively.

New Basin

Metropolitan completed a feasibility study for a conjunctive-use demonstration project for the Chino Basin in 1995. In that study, a new basin (New Basin) was proposed in the Fontana area just east of the Etiwanda Cross Feeder. This basin is included herein to show approximate cost of constructing new surface recharge facilities for imported water recharge. The New Basin concept and costs were adapted from *Chino Basin Conjunctive-Use Demonstration Project, Reports on Phases 1 and 2* (CH2M-Hill, 1995). The new facilities required for these basins would be a new connection to the Etiwanda Feeder and the piping to convey the SWP water to the New Basin, and an inlet structure. Other major costs include land purchase and grading. The cost of the new Metropolitan connection would be about $500,000, the cost of piping is about $3,600,000, the cost of an inlet structure is about $97,000, excavation cost is about $550,000 and cost of land is about $2,400,000. The estimated capital cost for the facilities to recharge SWP water into the basin is about $9,900,000 or $900,000 per year. The increased imported water recharge capacity resulting from this project is about 38,000 acre-ft/yr. The facilities cost for recharge is about $26 per acre-ft. The total cost of new recharge at the basin is about $608 per acre-ft.

Comparison of Imported Water Alternatives

The cost estimates presented herein are appraisal-level estimates. The cost differences between most of these basins are not that significant. Basins with unit facility costs less than $25 per acre-ft are roughly equivalent and the cost of basins with large annual recharge rates may be under estimated if these rates are not attained either through unanticipated physical limitations or variations in need for replenishment. Objectives other than minimizing cost of recharge may be important in developing new recharge capacity for imported water. With the exception of the New Basin, all the improvements are physically straightforward and have no significant environmental impacts.

AVAILABILITY OF RECLAIMED WATER

CBMWD collects and treats most of the municipal wastewater produced in the Chino Basin. Municipal wastewater produced in the Los Angeles County and Riverside County portions of the basin is exported from the basin. CBMWD's treatment facilities include Regional Plants No.1 (RP-1), No.2 (RP-2), No.4 (RP-4 scheduled for summer 1997), and Carbon Canyon Water Reclamation Facility (CCWRF) producing approximately 33 mgd, 5 mgd, 7 mgd (currently part of RP-1's flow) and 11 mgd, respectively. Figure 4-2 shows the location of these facilities. In the past, CBMWD recharged the southern half of the Chino Basin with secondary effluent as an effluent disposal method. These activities ceased in the mid-1970's to mid-1980's due to concerns over the water quality impacts on groundwater. Since the 1970's, tertiary effluent has been available for use from CBMWD facilities. The first 17,000 acre-feet, approximately, have traditionally been considered CBMWD's obligation to Orange County as part of the Orange County Judgment (OCWD vs. City of Chino, et al). Currently about 39,000 acre-feet of reclaimed water and future increases in reclaimed water could be reused in the Chino Basin.

Reclaimed water has been delivered to the El Prado Park and Whispering Lake Golf Course with the remainder discharged into Chino Creek and Cucamonga Creek since the mid 1970's. Additional direct use of reclaimed water is planned for the Carbon Canyon Reclaimed Water Distribution System and the RP-4/RP-1 Reclaimed Water Distribution System. Within the next 10 years, up to approximately 10,000 acre-feet could be delivered directly to users throughout the CBMWD service area for direct use.

The *CBMWD Reclaimed Water Master Plan* (Montgomery Watson, 1993), identified a potential reclaimed water recharge program that could utilize a large portion of the remaining reclaimed water over the 17,000 acre-feet Orange County obligation. A similar program has been identified as part of this study. Several existing recharge basins were studied. The basins listed on Table 4-8 were selected for the recharge of reclaimed water in the Chino Basin based on their proximity to the wastewater treatment, conveyance and flood control facilities and their potential conflicts with other planned recharge activities discussed in this report. The Ely, Lower Cucamonga, Riverside, Wineville and Jurupa Basins were assumed to be available for recharge from May through October. This allows seasonal recharge of imported water in the winter and minimizes conflicts with recharge of storm flows and the Basins' primary flood control mission. In addition to recharge in existing basins, recharge in the Whispering Lakes Golf Course ponds was studied in conjunction with the Ely Basins. The recharge of reclaimed water north of RP-4 was investigated for the Etiwanda, Victoria and Hickory Basins. The benefit of recharging further north in the Chino Basin is to ensure that the reclaimed water can be used (not become rising water in the Santa Ana River) and to maximize the use of the water (obtain more than one use).

Reclaimed water deliveries from the proposed system shown in Figure 4-3 could range from 17,000 acre-feet in fiscal year 2000/1 to 18,200 acre-feet in FY 2020/21 as shown in Tables 4-9 and 4-10, respectively. These tables show the total amounts of reclaimed water available, direct uses, amount available per basin, amount discharged to Orange County on a monthly basis, and cumulative amounts of recharge for the fiscal year. These projections were adapted from CBMWD's *Ten Year Capital Improvement Program,* and from seasonal variations of CBMWD wastewater flow from 1991 to 1996. TDS and nitrogen and other related reclamation issues may increase or decrease these amounts depending on the outcome of future studies. These quantities were considered solely from a water supply perspective as part of this study.

Regulatory Issues

There are two fundamental regulatory issues for reclaimed water recharge – consistency with *the 1995 Water Quality Control Plan for the Santa Ana Region (Basin Plan)* and consistency with the proposed Title 22 regulations for *Planned Recharge Projects Using Reclaimed Water*. Recharge of reclaimed water will require a permit from the Santa Ana Regional Water Quality Control Board (Regional Board). By law, the conditions of the permit must implement the Basin Plan. The Basin Plan contains numerical water quality objectives for the Chino Basin. These objectives are listed in Table 4-11. TDS and total inorganic nitrogen (TIN) are the only constituents where compliance to ambient concentration in groundwater have been estimated. The Basin Plan declares that there is no assimilative capacity in the Chino II and Chino III subbasins for TDS and TIN. This means that reclaimed water recharged in Chino II and Chino III must have TDS and TIN concentrations less than or equal to their respective objectives. The reclamation projects discussed herein all recharge effluent in the Chino II subbasin. The TDS concentration of RP1 effluent has averaged about 440 mg/L over the last five years or about 110 mg/L over the Chino II objective. The TIN concentration of RP1 effluent has averaged about 12 mg/L as nitrogen, or about 6 mg/L over the Chino II objective. RP4 effluent will be comparable to RP1. Total nitrogen in RP1 and RP4 reclaimed water delivered for recharge was assumed to always be less than or equal to 10 mg/L. The Basin Plan assumes that only 350 acre-ft/yr of storm water recharge will occur in the Chino II subbasin and that this recharge will be eliminated after the year 2000. The TDS and TIN concentrations associated with the storm water recharge in the Basin Plan are 200 mg/L and 1.0 mg/L, respectively. In Section 3, the estimated storm runoff recharge in existing basins is estimated to range from about 24,000 acre-ft/yr to 30,000 acre-ft/yr. TDS and nitrogen associated with storm runoff measured in the Chino Basin are about 110 mg/L and 1.0 mg/L, respectively. If we assume that half of the recharge associated with the low end of the range (12,000 acre-ft/yr) recharges the Chino Basin at the TDS and TIN levels recently measured in spreading basins in the Chino Basin, then the newly determined recharge may be able to offset the TDS and TIN loads to the basin from recharge of reclaimed water. Figure 4-4 shows the TDS and TIN concentration of the storm water and reclaimed water blend. In this analysis, mixing was assumed to occur in the Chino II subbasin. The TDS concentration in the composite storm water/reclaimed water blend is less than the TDS objective of 330 mg/L for reclaimed water recharge volumes up to 20,000 acre-ft/yr. The TIN concentration in the composite storm water/reclaimed water blend is less than the objective of 6 mg/L for reclaimed water recharge volumes up 18,000 acre-ft/yr. Reclaimed water recharge greater than 18,000 acre-ft/yr will require mitigation. Mitigation may include nitrogen removal at RP1 or RP4, increased SWP water recharge, increased storm water recharge or nitrogen removal from groundwater.

The proposed Title 22 regulations for planned reclaimed water recharge projects are de facto regulations. The proposed regulations have been circulated throughout the reclamation community for about 8 years. Discussions with the Department of Health Services (telephone discussion with Robert Hultquist, 5/15/97) revealed that the proposed regulations should be adopted in late 1997 or early 1998. In the interim, the DHS and the Regional Board are requiring agencies interested in recharging reclaimed water to follow the proposed regulations.

The proposed regulations define four categories of recharge projects:

Project Category I - Surface spreading projects that use reclaimed water that has been oxidized (secondary treatment), filtered (tertiary treatment), disinfected and subjected to organics removal.

Project Category II - Surface spreading projects that use reclaimed water that has been oxidized (secondary treatment), filtered (tertiary treatment) and disinfected.

Project Category III - Surface spreading projects that use reclaimed water that has been oxidized (secondary treatment) and disinfected.

Project Category IV - Direct injection projects that use reclaimed water that has been oxidized (secondary treatment), filtered (tertiary treatment), disinfected and subjected to organics removal.

The identified projects discussed in this report are considered Category II projects. For project Categories I and IV, the maximum amount of reclaimed water that can be captured by any well is a function of the total organic carbon (TOC) in the reclaimed water. Table 4-12 shows the maximum allowable contributions of reclaimed water in a well as a function of the TOC after organics removal. The maximum contribution of reclaimed water for a down-gradient well's supply for Categories I and IV is 50 percent. For Categories II and III, the maximum allowable reclaimed water contributions to any well is only 20 percent. This and other important operational criteria contained in the proposed recharge guidelines are summarized in Table 4-13. With the exception of nitrogen compounds, reclaimed water quality used for planned recharge projects must meet Title 22 standards for drinking water quality (Title 22, Division 4, Chapter 15, Sections 64435, 64443, 64444.5 and 64473). The total nitrogen concentration of reclaimed water used in recharge projects shall not exceed 10 mg/L as nitrogen, unless the project sponsor can demonstrate that the standard can be consistently met prior to reaching the groundwater table. The minimum retention time in the groundwater prior to production shall be six months for Categories I and II, and twelve months for Categories III and IV. Also, the minimum horizontal separation between the recharge facility and a producing domestic well is 500 feet for Categories I and II, 1,000 feet for Category III, and 2,000 feet for Category IV. The project sponsor must have the authority to prevent the use of groundwater for drinking water within the area required to achieve the minimum retention time and minimum horizontal separation. The project sponsor must prepare a comprehensive engineering report that demonstrates that the recharge project can meet all the criterion in the proposed regulations. Finally, the proposed regulations require rigorous groundwater and reclaimed water monitoring to ensure the project is in compliance with these regulations.

IMPROVEMENTS TO INCREASE RECHARGE OF RECLAIMED WATER

The recharge of reclaimed water is dependent on available supply, regulatory constraints, and the recharge capacity of basins with facilities to recharge reclaimed water. The following discussion summarizes the facilities and costs needed to recharge reclaimed water in the Chino Basin. These costs are based in part on cost information in *CBMWD Reclaimed Water Master Plan* (Montgomery Watson, 1993), updated to 1997, and recent construction cost for similar projects. The construction cost items associated with each project typically include pumps, site work, pipes, valves and appurtenances, creek crossings and monitoring wells. Engineering and construction management was estimated at fifteen percent of the construction costs. Contingency cost was estimated at 25 percent of construction cost. Total capital cost is the sum of construction cost plus engineering and construction management cost and contingency cost. Capital costs were amortized at 6.5 percent for 20 years.

Annual costs include the amortized capital cost, power ($0.07 per kwh), fixed operation and maintenance cost (2 percent of pump cost), vector control ($8,000 per basin per year), and regulatory compliance ($52,000 per year per recharge project). CBMWD will assess a charge for the reclaimed water equal to about $70 per acre-ft, hereafter referred to as *tertiary recovery* cost. The total annual cost is the sum of the above annual costs, and a unit cost of recharge is computed from the annual amount of reclaimed water recharge divided by the total annual cost. The capital and annual costs for recharge projects in listed in Table 4-8 are summarized in Tables 4-14 and 4-15.

Ely Basins and Whispering Lakes

Table 4-14 and 4-15 show five different recharge projects for these basins with recharge ranging from 1,400 acre-ft/yr to 4,500 acre-ft/yr. About 200 acre-ft/yr of reclaimed water recharge in each project occurs at the Whispering Lakes Golf Course adjacent to RP-1 and the remaining recharge occurs in the Ely Basins. The first alternative shown in Table 4-14 makes use of the existing RP-1 utility water pump station to deliver reclaimed water to both facilities. The improvements necessary for this project include modifications to the utility water pump station and the reactivation of the abandoned Ely Basin discharge line. New monitoring wells would need to be constructed to comply with the proposed Title 22 regulations. The remaining alternatives assume that reclaimed water deliveries to the Ely Basins will be from a modified Westwind Park pump station. The Westwind Park pump station is located at the south end of RP-1 and was originally constructed to deliver water to the Westwind Park. Capital costs for this project ranges from $475,000 at 1,400 acre-ft/yr of recharge to about $1,130,000 for 4,500 acre-ft/yr of recharge. The unit cost of recharge ranges from $165 per acre-ft at 1,400 acre-ft/yr of recharge to about $122 per acre-ft for 4,500 acre-ft/yr of recharge. These costs are well below the minimum equivalent cost of imported water recharge of $582 per acre-ft.

Riverside and Wineville Basins

Reclaimed water recharge in the Riverside and Wineville Basins is initially limited by the reclaimed water distribution system and ultimately limited by the recharge capacity of the basins between May through October each year. The project described herein will recharge up to 4,300 acre-ft/yr of reclaimed water in these two basins from May through October. Recharge will be initially limited to 2,500 acre-ft/yr until the proposed *Reclaimed Water Distribution Pump Station* is completed at the Regional Plant No.1. Reclaimed water deliveries will occur from the *Regional Plant No.1/4 Outfall Line* at the Day Creek crossing and travel down to the Wineville Basin. Controlled discharges from Wineville will enter into the Riverside Basin. The costs shown in Table 4-14 consider the use of the existing outfall after the outfall is pressurized. The improvements necessary for this project include new outlet gates at the two basins, a new discharge point from the outfall into Day Creek, and new monitoring wells. The capital cost of this project is about $728,000. The unit cost of recharge ranges from $143 per acre-ft at 2,500 acre-ft/yr of recharge to about $181 per acre-ft for 4,300 acre-ft/yr of recharge. These costs are well below the minimum equivalent cost of imported water recharge of $582 per acre-ft.

Jurupa Basin

Reclaimed water recharge in the Jurupa Basin is limited by the recharge capacity of the basin between May through October each year. About 4,300 acre-ft/yr of reclaimed water can be recharged from May through October. This will be possible only after the *Reclaimed Water Distribution Pump Station* is completed at the Regional Plant No.1. Reclaimed water deliveries will occur from a new lateral from the *Regional Plant No.1/4 Outfall Line* at the San Sevaine/Etiwanda Creek crossing and travel down to the Jurupa Basin and enter the low flow inlets from the channel. The capital cost of this project is about $1,450,000 and the unit cost of recharge is about $196 per acre-ft. This cost is well below the minimum equivalent cost of imported water recharge of $582 per acre-ft.

Etiwanda, Hickory, and Victoria Basins

The volume of water available for recharge at the Etiwanda, Hickory, and Victoria Basins is limited to that which is available after the other projects have taken their deliveries. About 3,300 acre-ft/yr of reclaimed water can be delivered to these basins from May through October. This will be possible only after the *Reclaimed Water Distribution Pump Station* and a new pump station and delivery system is constructed north of RP-4 to deliver to the three basins. Water deliveries will occur from this new delivery system, supplied by the *Regional Plant No.1/4 Outfall Line* at RP-4, directly into the basins. The costs shown in Table 4-14 consider the use of the existing outfall after the outfall is pressurized. The capital cost of this project is about $6,450,000 and the unit cost of recharge is about $517.

Comparison of Reclaimed Water Recharge Projects

Reclaimed water recharge is far less costly than imported water on a volumetric basis. Significant water quality impacts, if any, may be able to be mitigated in the Chino Basin by improving the recharge of storm water and through groundwater treatment. The cost estimates presented herein are appraisal-level estimates. With the exception of the recharge project north of RP-4, the reclaimed water recharge projects described above should be considered comparable from a cost perspective with tertiary treatment costs of approximately $70 per acre-ft.

The cost of reclaimed water recharge in the Etiwanda, Victoria and Hickory basins is relatively high compared to the other reclaimed water projects, however the cost is still lower than the cost of imported water recharge and should be considered a viable recharge alternative to imported water recharge. The increased cost of reclamation this high in the

Chino basin can be justified if it can be shown that the reclaimed water recharge in the lower basins cannot be recaptured and used within the Chino Basin.

TABLE 4-1
METROPOLITAN CONNECTIONS WITHIN CHINO BASIN

Connection Name	Source	Connection Status	Maximum Capacity (cfs)	End User	Use	Location
CB-01	Upper Feeder	Active	50	SCE	Power Generation	Etiwanda Ave. N/O San Bernardino Ave., R.C.
CB-02	Upper Feeder	Active Emergency	20	City of Ontario	Municipal	5th and Berlyn, Ontario
CB-03	Upper Feeder	Severed	N/A			Monte Vista and Margarita, Montclair
CB-04	Upper Feeder	Severed	N/A			5th and Benson, Montclair
CB-05	Upper Feeder	Inactive	20			Archibald and Acacia, R.C.
CB-06	Upper Feeder	Active Emergency	20	FWC	Municipal	Live oak and San Bernardino, Fontana
CB-07	Upper Feeder	Active	15	CCWD	Municipal	24th St. and Hanley Ave., R.C.
CB-08	Upper Feeder	Dismantled	N/A			Etiwanda and San Sevaine Channel, R.C.
CB-09	Upper Feeder	Severed	N/A			Palo Verde and Ramona, Montclair
CB-10	Upper Feeder	Dismantled	N/A			San Antonio Wash, Upland
CB-11	Upper Feeder	Dismantled	N/A			Archibald and 4th, R.C.
CB-11T	Upper Feeder	Dismantled	N/A			Hermosa and 7th, R.C.
CB-11TB	Foothill Feeder	Dismantled	N/A			Haven Ave. and Banyan, R.C.
CB-12	Foothill Feeder	Active	120	WFA	Municipal	Benson and 18th St., Upland
CB-13T	Foothill Feeder	Active	30	Watermaster	Replenishment	San Sevaine S.G., R.C.
CB-14T	Foothill Feeder	Active	30	Watermaster	Replenishment	Etiwanda S.G., R.C.
CB-15T	Foothill Feeder	Dismantled	N/A			Day Creek S.G., R.C.
CB-16	Foothill Feeder	Active	150	CCWD	Municipal	Etiwanda Ave. and 24th St.
CB-16T	Foothill Feeder	Dismantled	N/A			N/O Summit and W/O Cherry, R.C.
CB-17	Foothill Feeder	Dismantled	N/A			N/O Summit and W/O Cherry, R.C.
CB-59T(a)	Foothill Feeder	Active	75	Watermaster	Replenishment	San Antonio Creek
Total			530			

(a)CB-59T is a connection off OC-59. OC-59 is 300 cfs.

TABLE 4-2
METROPOLITAN SPREADING DELIVERIES TO CHINO BASIN WATER MASTER

Fiscal Year	Connection Name	Spreading Activity(a) (acre-feet)	Spreading Basin
FY 90/91	CB-14T	828.0	Etiwanda S.G., R.C.
	CB-15T	604.3	Day Creek
	CB-59T	1,987.6	Montclair Basins
Subtotal		3,419.9	
FY 91/92	CB-14T	1,195.9	Etiwanda S.G., R.C.
	CB-15T	501.4	Day Creek
	CB-59T	2,422.7	Montclair Basins
Subtotal		4,120.0	
FY 92/93	CB-13T	3,181.6	San Sevaine S.G., R.C.
	CB-14T	3,641.1	Etiwanda S.G., R.C.
	CB-59T	7,389.0	Montclair Basins
Subtotal		14,211.7	
FY 93/94	CB-13T	3,204.6	San Sevaine S.G., R.C.
	CB-14T	2,786.5	Etiwanda S.G., R.C.
	CB-59T	10,351.4	Montclair Basins
Subtotal		16,342.5	
FY 94/95	CB-13T	6,942.7	San Sevaine S.G., R.C.
	CB-14T	2,641.2	Etiwanda S.G., R.C.
	CB-59T	716.1	Montclair Basins
Subtotal		10,300.0	
FY 95/96	CB-13T	0.0	San Sevaine S.G., R.C.
	CB-14T	0.0	Etiwanda S.G., R.C.
	CB-59T	0.0	Montclair Basins
Subtotal		0.0	

(a) Includes Metropolitan Cyclic Deliveries and Replenishment Deliveries from the connections. Cyclic storage can be purchased to off-set a replenishment obligation.

TABLE 4-3
SPREADING FACILITIES FOR MWD REPLENISHMENT DELIVERIES TO CHINO BASIN WATER MASTER

Spreading Facility	Basin Size (acres)	Percolation Rate(a) (ft/day)	MWD Connection	Limiting Operating Conditions	Max Daily Recharge Capacity(b) (acre-ft/Day)	Max Annual Recharge Capacity(c) (acre-ft/Day)
Etiwanda Spreading Grounds	59	3	CB-14T	Fully open MWD Connection delivers up to 15 cfs and fills 1, 3 and a portion of 4 depending on wash-outs	29.75	6,250
San Sevaine Spreading Grounds	2,950	3	CB-13T	Fully open MWD connection delivers between 22-25 cfs and for the five basins only fills 1 thru 3.	43.63	9,150
Montclair Basins No.1 and 2	22	4	CB-59T	SBCFCD allows basin No.2 to fill 5 feet below the outlet to basin No.3. Under these conditions, CB-59T is opened to nearly full until basin No.2 nears the five foot mark and then CB-59T is turned back to approximately 32 cfs for recharge.	63.45	13,325
Total						28,725

(a) Reported percolations rates should be field verified. Recharge capcity can be increased with increased percolation rates.
(b) Calculations based on Watermaster Staff operations during scheduled replenishment period delivers from MWD.
(c) Calculated annual recharge based on 7 months of recharge during the months of October thru April.

TABLE 4-4
POTENTIAL RECHARGE SPREADING CAPACITIES FOR EXPANDED METROPOLITAN REPLENISHMENT DELIVERIES UNDER EXISTING CONSERVATION STORAGE CONDITIONS

Spreading Facility	Basin Size	Percolation Rate	Water Depth	Wetted Area for Recharge(f)	Conservation Storage	Theoretical				Theoretical Minus One Standard Deviation		Capacity @ 5-Day Storage	
						Max Daily Recharge Capacity(a)	Max Seasonal Recharge Capacity(b)	Seasonal Stormwater Recharge(c)	Imported Water Recharge Potential	Seasonal Stormwater Recharge(d)	Imported Water Recharge Potential	Recharge Capacity Rate(e)	Imported Water Recharge Potential
	(acres)	(ft/day)	(ft)	(acres)	(acre-ft)	(acre-ft/day)	(acre-ft)	(acre-ft)	(acre-ft)	(acre-ft)	(acre-ft)	(acre-ft/day)	(acre-ft)
Brooks Street Basin	15	3	10	8.5	77	25.5	5,355	1,136	4,219	1,282	4,073	25.5	4,073
Church Street Basin	11.2	2	20	10.5	77	21	4,410	1,261	3,149	1,397	3,013	21.0	3,013
Day Creek Basin (Lower)	17.7	2	0	0	0	0	-	-	-	-	-	-	-
Eighth/Seventh Street Basins	27	2	0-4	4	9	8	1,680	348	1,332	387	1,293	8.0	1,293
Ely Basins (1-3)	42.2	1	11	36.3	360	36.3	7,623	3,071	4,552	3,480	4,143	32.4	3,324
Etiwanda Basin	40	3	9.1	39	621	117	24,570	2,049	22,521	2,478	22,092	117.0	22,092
Jurupa Basin	50.2	2	7	30.6	217	61.2	12,852	2,468	10,384	2,776	10,076	61.2	10,076
Montclair Basins (1-2)	22	4	25-27	15.9	273	63.5	13,325	1,125	12,200	1,246	12,079	63.5	12,079
Montclair Basins (3-4)	13.4	4	11-45	10.6	224	42.4	8,904	865	8,039	941	7,963	41.0	7,669
Rich Basin	7.6	2	1	5	34	10	2,100	818	1,282	898	1,202	10.0	1,202
Riverside Basin	58.1	1	22	51.3	835	51.3	10,773	1,212	9,561	1,526	9,247	43.8	7,672
San Sevaine Spreading Grounds (Basins 1-4)	17	3	2.5-3.5	21	103.5	63	13,230	2,491	10,739	2,647	10,583	63.0	10,583
San Sevaine Spreading Grounds (Basin 5)	69	3	0.5	0.0	1.0	0.0	6	4	2	5	0	0.2	37
Turner Basin No. 3/4	19	2	10	18.9	160	37.8	7,938	112	7,826	179	7,759	37.8	7,759
Upland Basin	31.6	4	65	31	1675	124	26,040	868	25,172	1,050	24,990	95.7	19,047
Victoria Basin	15	2	1	0.7	1.0	1.31	275	235	40	275	0	1.3	0
Wineville Basin	69.1	1	3	54.4	90	54.4	11,424	1,849	9,575	2,091	9,333	54.4	9,333
Totals							139,081		121,018		118,512		119,251
New Basin	40	5	10	36.5	550	182.5	38,325	-	38,325	-	38,325	-	38,325
Totals							177,406		159,343		156,837		157,576

(a) Calculations based on reported percolation, wetted area for recharge at depth.
(b) Calculated annual recharge based on 7 months of recharge during the months of October through April based on basin recharge rates.
(c) Average recharge based on the 7 month period October through April shown in Table 3-7.
(d) Based on the 7 month period October through April shown in Table 3-6 plus one standard deviation for the seasonal period.
(e) Calculation is the lesser of the conservation storage recharge rate or storage rate that will percolate over a five day period if rain is forcasted, currently used recharge facilities in Table 4-3 are exempt from this calculation.
(f) Area at maximum conservation pool.

TABLE 4-5

POTENTIAL RECHARGE SPREADING CAPACITIES FOR EXPANDED METROPOLITAN REPLENISHMENT DELIVERIES UNDER EXPANDED CONSERVATION STORAGE CONDITIONS

Spreading Facility	Basin Size	Percolation Rate	Water Depth	Wetted Area for Recharge(f)	Conservation Storage	Theoretical				Theoretical Minus One Standard Deviation		Capacity @ 5-Day Storage	
						Max Daily Recharge Capacity(a)	Max Seasonal Recharge Capacity(b)	Seasonal Stormwater Recharge(c)	Imported Water Recharge Potential	Seasonal Stormwater Recharge(d)	Imported Water Recharge Potential	Recharge Capacity Rate(e)	Imported Water Recharge Potential
	(acres)	(ft/day)	(ft)	(acres)	(acre-ft)	(acre-ft/day)	(acre-ft)	(acre-ft)	(acre-ft)	(acre-ft)	(acre-ft)	(acre-ft/day)	(acre-ft)
Brooks Street Basin	15	3	52	12	387	36	7,560	1,136	6,424	1,282	6,278	17.0	4,073
Church Street Basin	11.2	2	23	10.5	185	21	4,410	1,261	3,149	1,397	3,013	37.0	6,373
Day Creek Basin (Lower)	17.7	2	16	10.2	126.3	20.4	4,284	-	4,284	-	4,284	13	2,730
Eighth/Seventh Street Basins	27	2	2-4	17.7	40.9	35.4	7,434	348	7,086	387	7,047	35.4	7,047
Ely Basins (1-3)	42.2	1	12	36.3	365	36.3	7,623	3,071	4,552	3,480	4,143	32.4	3,324
Etiwanda Basin	40	3	9.1	39	621	117	24,570	2,049	22,521	2,478	22,092	117.0	22,092
Jurupa Basin	50.2	2	33.6	39.8	1140	79.6	16,716	2,468	14,248	2,776	13,940	63.2	10,496
Montclair Basins (1-2)	22	4	25-27	15.9	273	63.5	13,325	1,125	12,200	1,246	12,079	63.5	12,079
Montclair Basins (3-4)	13.4	4	11-45	10.6	224	42.4	8,904	865	8,039	941	7,963	41.0	7,669
Rich Basin	7.6	2	22	5.29	87	10.58	2,222	818	1,403	898	1,323	7.6	1,202
Riverside Basin	58.1	1	23	51.3	840	51.3	10,773	1,212	9,561	1,526	9,247	43.8	7,672
San Sevaine Spreading Grounds (Basins 1-4)	17	3	2.5-3.5	21	103.5	63	13,230	2,491	10,739	2,647	10,583	63.0	10,583
San Sevaine Spreading Grounds (Basin 5)	69	3	20	31.8	499.5	95.4	20,028	4	20,024	5	20,022	92.2	19,357
Turner Basin No. 3/4	19	2	10	18.9	160	37.8	7,938	112	7,826	179	7,759	37.8	7,759
Upland Basin	31.6	4	65	31	1675	124	26,040	868	25,172	1,050	24,990	95.7	19,047
Victoria Basin	15	2	12	10.0	104.0	19.94	4,187	235	3,953	275	3,912	19.6	3,841
Wineville Basin	69.1	1	4	54.4	95	54.4	11,424	1,849	9,575	2,091	9,333	54.4	9,333
Totals							190,668		170,756		168,009		154,676
New Basin	40	5	10	36.5	550	182.5	38,325	-	38,325	-	38,325	-	38,325
Totals							228,993		209,081		206,334		193,001

(a) Calculations based on reported percolation, wetted area for recharge at depth.
(b) Calculated annual recharge based on 7 months of recharge during the months of October through April based on basin recharge rates.
(c) Average recharge based on the 7 month period October through April shown in Table 3-7.
(d) Based on the 7 month period October through April shown in Table 3-6 plus one standard deviation for the seasonal period.
(e) Calculation is the lesser of the conservation storage recharge rate or storage rate that will percolate over a five day period if rain is forcasted, currently used recharge facilities in Table 4-3 are exempt from this calculation.
(f) Area at maximum conservation pool.

TABLE 4-6
SPREADING FACILITIES RETENTION FACILITY REQUIREMENTS FOR EXPANDED METROPOLITAN REPLENISHMENT DELIVERIES UNDER EXISTING CONSERVATION STORAGE CAPACITIES

Spreading Facility	Imported Water Delivery System Needs	Capital Costs(a)										Annualized Capital Costs(b)	Supply Facilities O&M (1% Capital)	Vector Control	Annual Recharge with Avail Conservation Storage	Spreading Costs per acre-ft Recharged	Cost per acre-ft Recharged incl. MWD Commodity Charge(c)		
		Inlet Structure	Outlet Structure	Piping	Earthwork & General (15% Const)	Metropolitan Connection	Land	Capital Project Subtotal	Design & Construction Management (15% Const)	Contingency (25% Const)	Total								
		($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	($)	(acre-ft)	($/acre-ft)	($/acre-ft)		
San Antonio System																			
Upland Basin	Inlet and piping from MWD line and outlet piping to the Montclair Basins	$600,000	$150,000	$585,000	$200,250	$500,000		$2,035,250	$305,288	$508,813	$2,849,350	$258,597	$28,494	$8,000	19,047	$15	$597	295090.2	11380429
Montclair Basins (1-2)	None							$0	$0	$0	$0	$0	$0	$16,000	12,079	$1	$583		
Montclair Basins (3-4)	Inlet Structure from San Antonio Creek	$600,000			$90,000	$500,000		$1,190,000	$178,500	$297,500	$1,666,000	$151,200	$16,660	$16,000	7,669	$24	$606	183860.2	4647392
Brooks Street Basin	Inlet Structure from San Antonio Creek	$600,000			$90,000	$500,000		$1,190,000	$178,500	$297,500	$1,666,000	$151,200	$16,660	$8,000	4,073	$43	$625	175860.2	2546090
San Antonio Subtotal	Combined Capital and Shared MWD Connection Costs	$1,800,000	$150,000	$585,000	$380,250	$500,000	$0	$3,415,250	$512,288	$853,813	$4,781,350	$433,938	$47,814	$48,000	42,868	$12	$594	21.26779	603.2678
West Cucamonga Creek System																			
Eighth/Seventh Street & Ely Basins	Connection to MWD and piping to 15th Basin Deliveries will occur via West Cucamonga Creek	$15,000		$1,700,000	$257,250	$500,000		$2,472,250	$370,838	$618,063	$3,461,150	$314,121	$34,612	$24,000	4,616	$81	$663		
Cucamonga Creek System																			
Church Street and Turner No.3/4 Basins	Reestablish CB-11TB for delivery via storm drain Deliveries will occur via Deer Creek to Turner 3/4	$15,000		$34,000	$7,350	$500,000		$556,350	$83,453	$139,088	$778,890	$70,689	$7,789	$16,000	10,772	$9	$591		
Day Creek System																			
Riverside and Wineville Basins	Reestablish CB-15T to discharge to Day Creek, and outlet control structure in Wineville Basin		$150,000		$22,500	$500,000		$672,500	$100,875	$168,125	$941,500	$85,447	$9,415	$16,000	17,005	$7	$589		
Day Creek Subtotal	Combined Capital and Shared MWD Connection Costs	$0	$150,000	$0	$22,500	$500,000	$0	$672,500	$100,875	$168,125	$941,500	$85,447	$9,415	$16,000	17,005	$7	$589		
Etiwanda Creek System																			
Etiwanda Basin	Connection to MWD and piping to basin	$55,000		$292,400	$52,110	$500,000		$899,510	$134,927	$224,878	$1,259,314	$114,291	$12,593	$8,000	22,092	$6	$588		
Jurupa Basin	New MWD Connection and Piping to San Sevaine Channel	$0		$0	$0	$500,000		$500,000	$75,000	$125,000	$700,000	$63,529	$7,000	$8,000	10,076	$8	$590		
Etiwanda Subtotal	Combined Capital and Shared MWD Connection Costs	$55,000	$0	$292,400	$52,110	$500,000	$0	$899,510	$134,927	$224,878	$1,259,314	$114,291	$12,593	$16,000	32,168	$4	$586		
New Basin	Land Purchase, Basin design and construction, MWD connection and piping	$96,000		$3,567,650	$549,548	$500,000	$2,372,500	$7,085,698	$1,062,855	$1,771,424	$9,919,977	$900,301	$99,200	$8,000	38,325	$26	$608		
Rich Basin	Connection to MWD and piping to basin.	$15,000		$255,000	$40,500	$500,000		$810,500	$121,575	$202,625	$1,134,700	$102,981	$11,347	$8,000	1,202	$102	$684		
San Sevaine Spreading Grounds (Basins 1-5)	New MWD Connection and distribution piping to control recharge in the basins.	$81,000		$90,000	$25,650	$500,000		$696,650	$104,498	$174,163	$975,310	$88,516	$9,753	$40,000	10,620	$13	$595		
Totals											$23,252,191	$2,116,285	$232,522	$176,000	157,576	$16	$598		

(a) 1997 dollars based on Report on Phases 1 and 2 Facility Planning Study Chino Basin Conjunctive-Use Demonstration Project, June 30, 1995, CH2M Hill
(b) Annualized at 20 yr. using 6.5 % interest.
(c) The estimated Metropolitan present worth of recharge water is $582 per acre-ft, see Table 2-6.

TABLE 4-7
SPREADING FACILITIES RETENTION FACILITY REQUIREMENTS FOR EXPANDED METROPOLITAN REPLENISHMENT DELIVERIES EXPANDED UNDER 5-DAY STORAGE CAPACITIES

Spreading Facility	Imported Water Delivery System Needs	Capital Costs(a) Inlet Structure ($)	Outlet Structure ($)	Piping ($)	Earthwork & General (15% Const) ($)	Metropolitan Connection ($)	Land ($)	Capital Project Subtotal ($)	Design & Construction Management (15% Const) ($)	Contingency (25% Const) ($)	Total ($)	Annualized Capital Costs(b) ($)	Supply Facilities O&M (1% Capital) ($)	Vector Control ($)	Annual Recharge with Mod. Conservation Storage (acre-ft)	Spreading Costs per acre-ft Recharged ($/acre-ft)	Cost per acre-ft Recharged incl. MWD Commodity Charge(c) -($/acre-ft)
San Antonio System																	
Upland Basin	Inlet and piping from MWD line and outlet piping to the Montclair Basins	$600,000	$150,000	$585,000	$200,250	$500,000		$2,035,250	$305,288	$508,813	$2,849,350	$258,597	$28,494	$8,000	19,047	$15	$597
Montclair Basins (1-2)	None							$0	$0	$0	$0	$0	$0	$16,000	12,079	$1	$583
Montclair Basins (3-4)	Inlet Structure from San Antonio Creek	$600,000			$90,000	$500,000		$1,190,000	$178,500	$297,500	$1,666,000	$151,200	$16,660	$16,000	7,669	$24	$606
Brooks Street Basin	Inlet Structure from San Antonio Creek	$600,000			$90,000	$500,000		$1,190,000	$178,500	$297,500	$1,666,000	$151,200	$16,660	$8,000	4,073	$43	$625
San Antonio Subtotal	Combined Capital and Shared MWD Connection Costs	$1,800,000	$150,000	$585,000	$380,250	$500,000	$0	$3,415,250	$512,288	$853,813	$4,781,350	$433,938	$47,814	$48,000	42,868	$12	$594
West Cucamonga Creek System																	
Eighth/Seventh Street & Ely Basins	Connection to MWD and piping to 15th Basin Deliveries will occur via West Cucamonga Creek	$15,000		$1,700,000	$257,250	$500,000		$2,472,250	$370,838	$618,063	$3,461,150	$314,121	$34,612	$24,000	10,370	$36	$618
Cucamonga Creek System																	
Church Street and Turner No.3/4 Basins	Reestablish CB-11TB for delivery via storm drain Deliveries will occur via Deer Creek to Turner 3/4	$15,000		$34,000	$7,350	$500,000		$556,350	$83,453	$139,088	$778,890	$70,689	$7,789	$16,000	14,132	$7	$589
Day Creek System																	
Day Creek Basin (Lower)	Connection to MWD and piping to basin	$15,000		$645,000	$99,000	$500,000		$1,259,000	$188,850	$314,750	$1,762,600	$159,967	$17,626	$8,000	2,730	$68	$650
Riverside and Wineville Basins	Reestablish CB-15T to discharge to Day Creek, and outlet control structure in Wineville Basin		$150,000		$22,500	$500,000		$672,500	$100,875	$168,125	$941,500	$85,447	$9,415	$16,000	17,005	$7	$589
Day Creek Subtotal	Combined Capital and Shared MWD Connection Costs	$15,000	$150,000	$645,000	$121,500	$500,000	$0	$1,431,500	$214,725	$357,875	$2,004,100	$181,885	$20,041	$24,000	19,735	$11	$593
Etiwanda Creek System																	
Etiwanda Basin	Connection to MWD and piping to basin	$55,000		$292,400	$52,110	$500,000		$899,510	$134,927	$224,878	$1,259,314	$114,291	$12,593	$8,000	22,092	$6	$588
Victoria Basin	Connection to MWD				$0	$500,000		$500,000	$75,000	$125,000	$700,000	$63,529	$7,000	$8,000	3,841	$20	$602
Jurupa Basin	New MWD Connection and Piping to San Sevaine Channel	$0		$0	$0	$500,000		$500,000	$75,000	$125,000	$700,000	$63,529	$7,000	$8,000	10,496	$7	$589
Etiwanda Subtotal	Combined Capital and Shared MWD Connection Costs	$55,000	$0	$292,400	$52,110	$500,000	$0	$899,510	$134,927	$224,878	$1,259,314	$114,291	$12,593	$16,000	36,429	$4	$586
New Basin	Land Purchase, Basin design and construction, MWD connection and piping	$96,000		$3,567,650	$549,548	$500,000	$2,372,500	$7,085,698	$1,062,855	$1,771,424	$9,919,977	$900,301	$99,200	$8,000	38,325	$26	$608
Rich Basin	Connection to MWD and piping to basin.	$15,000		$255,000	$40,500	$500,000		$810,500	$121,575	$202,625	$1,134,700	$102,981	$11,347	$8,000	1,202	$102	$684
San Sevaine Spreading Grounds (Basins 1-5)	New MWD Connection and distribution piping to control recharge in the basins.	$81,000		$90,000	$25,650	$500,000		$696,650	$104,498	$174,163	$975,310	$88,516	$9,753	$40,000	29,940	$5	$587
Totals											$24,314,791	$2,206,723	$243,148	$184,000	193,001	$14	$596

(a) 1997 dollars based on Report on Phases 1 and 2 Facility Planning Study Chino Basin Conjunctive-Use Demonstration Project, June 30, 1995, CH2MHill
(b) Annualized at 20 yr. using 6.5 % interest.
(c) The estimated Metropolitan present worth of recharge water is $582 per acre-ft, see Table 2-6.

TABLE 4-8
POTENTIAL SPREADING FACILITIES FOR RECLAIMED WATER RECHARGE DELIVERIES

Spreading Facility	Basin Size (acres)	Percolation Rate (ft/day)	Delivery Method into Basin
Ely Basins (1-3)	42.2	1	Surplus Utility Water from CBMWD Regional Plant No.1
Jurupa Basin(a)	50.2	2	Effluent Line Connecting CBMWD Regional Plant 1 and 4 discharges to San Sevaine Creek
Lower Cucamonga/ Chris Basins	55	2	Connections to the Effluent Line from Regional Plant 1 in Chino Avenue
Riverside Basin	58.1	1	Effluent Line Connecting CBMWD Regional Plant 1 and 4 discharges to Day Creek
Wineville Basin	69.1	1	Effluent Line Connecting CBMWD Regional Plant 1 and 4 discharges to Day Creek
Etiwanda Basin(a)	36	5	New pipeline and Pump station from RP-4 North to Basin
Victoria Basin(a)	11	2	New pipeline and Pump station from RP-4 North to Basin
Hickory Basin(a)	11	2	New pipeline and Pump station from RP-4 North to Basin

(a) Assumes a pump station is installed at Regional Plant No.1 to pump reclaimed water north into the Delivery System

TABLE 4-9
POTENTIAL RECHARGE OF RECLAIMED WATER UNDER 2000 FLOW CONDITIONS
(acre-ft)

Reclaimed Water Distribution	January	February	March	April	May	June	July	August	September	October	November	December	Totals
CBMWD Northern Plants Effluent(a)	3,802	3,552	3,708	3,461	3,299	3,498	3,514	3,552	3,569	3,783	3,658	3,795	43,191
Direct Uses from CBMWD's Northern Service Area													
RP-1/4 Direct use of Reclaimed Water by users	364	373	443	472	532	558	622	612	520	468	381	369	5,715
Whispering Lakes Golf Course	12	15	23	28	35	40	48	46	35	26	15	12	336
El Prado Parks	105	139	204	251	315	359	426	414	311	235	138	111	3,007
Subtotal of available effluent	3,321	3,025	3,038	2,710	2,416	2,540	2,418	2,481	2,704	3,054	3,124	3,303	34,133
Potential Recharge per basin(b)													
Ely Basin	0	0	466	500	517	500	517	517	500	517	466	0	4,500
Outfall Turnouts													
L. Cucamonga	0	0	0	252	260	252	260	260	252	260	0	0	1,798
Jurupa	0	0	0	0	725	701	725	725	701	725	0	0	4,300
Riverside & Wineville	0	0	0	0	725	701	725	725	701	725	0	0	4,300
Etiwanda	0	0	0	0	55	256	57	119	408	421	0	0	1,316
Hickory	0	0	0	0	101	98	101	101	98	101	0	0	600
Victoria	0	0	0	0	34	33	34	34	33	34	0	0	200
Subtotal	0	0	466	752	2,416	2,540	2,418	2,481	2,692	2,782	466	0	17,014
Total Discharge to Orange County via CBMWD's Northern Service Area	3,321	3,025	2,572	1,958	0	0	0	0	12	271	2,658	3,303	17,119
Cumulative Groundwater Recharge	0	0	466	1,218	3,634	6,175	8,593	11,074	13,766	16,548	17,014	17,014	17,014
Cumulative Discharge to Orange County(c)	3,321	6,346	8,918	10,876	10,876	10,876	10,876	10,876	10,887	11,159	13,816	17,119	17,119

(a) Contributors include the Regional Plants 1 and 4, based on the CBMWD Ten Year Capital Improvements Program.
(b) Basin Planning issues may reduce these deliveries.
(c) Cumulative discharge from the Northern portion of CBMWD is 17,119 acre-feet. An additional 14,642 acre-feet will be discharged to Orange County from CBMWD's Southern treatment facilities.
This takes into consideration CBMWD's planned Carbon Canyon Reclaimed Water Deliver System.

TABLE 4-10
POTENTIAL RECHARGE OF RECLAIMED WATER UNDER 2020 (ULTIMATE) FLOW CONDITIONS
(acre-ft)

Reclaimed Water Distribution	January	February	March	April	May	June	July	August	September	October	November	December	Totals
CBMWD Northern Plants Effluent(a)	4,614	4,311	4,499	4,200	4,003	4,244	4,264	4,311	4,332	4,590	4,439	4,606	52,414
Direct Uses from CBMWD's Northern Service Area													
RP-1/4 Direct use of Reclaimed Water by users	431	441	525	559	630	661	736	724	616	554	451	437	6,765
Whispering Lakes Golf Course	12	15	23	28	35	40	48	46	35	26	15	12	336
El Prado Parks	105	139	204	251	315	359	426	414	311	235	138	111	3,007
Subtotal of available effluent	4,066	3,715	3,748	3,362	3,023	3,185	3,055	3,127	3,370	3,775	3,835	4,046	42,307
Potential Recharge per basin(b)													
Ely Basin	0	0	466	500	517	500	517	517	500	517	466	0	4,500
Outfall Turnouts													
L. Cucamonga	0	0	0	252	260	252	260	260	252	260	0	0	1,798
Jurupa	0	0	0	0	725	701	725	725	701	725	0	0	4,300
Riverside & Wineville	0	0	0	0	725	701	725	725	701	725	0	0	4,300
Etiwanda	0	0	0	0	421	408	421	421	408	421	0	0	2,500
Hickory	0	0	0	0	101	98	101	101	98	101	0	0	600
Victoria	0	0	0	0	34	33	34	34	33	34	0	0	200
Subtotal	0	0	466	752	2,782	2,692	2,782	2,782	2,692	2,782	466	0	18,198
Total Discharge to Orange County via CBMWD's Northern Service Area	4,066	3,715	3,282	2,610	241	492	272	344	678	993	3,369	4,046	24,109
Cumulative Groundwater Recharge	0	0	466	1,218	4,000	6,693	9,475	12,257	14,950	17,732	18,198	18,198	18,198
Cumulative Discharge to Orange County(c)	4,066	7,781	11,063	13,673	13,914	14,406	14,679	15,023	15,701	16,694	20,063	24,109	24,109

(a) Contributors include the Regional Plants 1 and 4, based on the CBMWD Ten Year Capital Improvements Program.
(b) Basin Planning issues may reduce these deliveries.
(c) Cumulative discharge from the Northern portion of CBMWD is 24,109 acre-feet. An additional 10,614 acre-feet will be discharged to Orange County from CBMWD's Southern treatment facilities.
This takes into consideration CBMWD's planned Carbon Canyon Reclaimed Water Deliver System.

TABLE 4-11
WATER QUALITY OBJECTIVES FOR THE CHINO BASIN

Constituent	Units	Chino I		Chino II		Chino III	
		Objective	Ambient Level	Objective	Ambient Level	Objective	Ambient Level
Total Dissolved Solids	(mg/L)	220	<220	330	>330	740	>740
Hardness	(mg/L)	170	unknown	185	unknown	425	unknown
Sodium	(mg/L)	15	unknown	18	unknown	100	unknown
Chloride	(mg/L)	15	unknown	18	unknown	50	unknown
Nitrate - Nitrogen	(mg/L)	5	<5	6	>6	11	>11
Sulfate	(mg/L)	20	unknown	20	unknown	110	unknown

TABLE 4-12
MAXIMUM ALLOWABLE TOC AFTER ORGANICS REMOVAL IN RECLAIMED WATER

	Maximum TOC Concentration (mg/L)	
Reclaimed water Contribution (%)	Surface Spreading Category I	Direct Injection Category IV
0 - 20	20	5
21 - 25	16	4
26 - 30	12	3
31 - 35	10	3
36 - 45	8	2
46 - 50	6	2

TABLE 4-13
KEY CRITERIA FOR RECLAIMED WATER RECHARGE PROJECT

Criterion	Category I	Category II	Category III	Category IV
Maximum Contribution of Reclaimed Water in Water at Domestic Wells (1)	50%	20%	20%	50%
Minimum Horizontal Separation Between Point of Recharge and Domestic Wells (feet)	500	500	1,000	2,000
Minimum Retention Time in Groundwater (months)	6	6	12	12

TABLE 4-14
CAPITAL COSTS FOR RECLAIMED WATER RECHARGE ALTERNATIVES

Alternative Monthly (acre-ft/mo)	Alternative Annual (acre-ft/yr)	Improvements Needed	Relocate Intake Point	Pumps	Site Work	Discharge/ Pressure Valve	Pipe	Valves/ Appert. (10% Pipe)	Creek Crossing	Monitoring Wells	Connection to Ely Line	Construction Subtotal	ENG/CM (15%)	Conting. (25%)	Total
		Ely and Whispering Lakes(a)													
100	1,400	Relocate Utility Water Suction Location, Reconnect 18 in. Line to Ely.	$82,480	$0	$0	$0	$0	$0	$0	$200,000	$57,000	$339,480	$50,922	$84,870	$475,272
200	2,600	Increase Westwind Park P.S. by 1,500 gpm, new 14" pipeline to Ely feed pipe.	$0	$37,500	$20,000	$0	$234,000	$23,400	$25,000	$200,000	$57,000	$596,900	$89,535	$149,225	$835,660
300	3,200	Increase Westwind Park P.S. by 2,250 gpm, new 16" pipeline to Ely feed pipe.	$0	$60,000	$20,000	$0	$270,000	$27,000	$25,000	$200,000	$57,000	$659,000	$98,850	$164,750	$922,600
400	3,900	Increase Westwind Park P.S. by 3,000 gpm, new 18" pipeline to Ely feed pipe. Deliver water to West Wind park through pressure release valve.	$0	$75,000	$20,000	$20,000	$295,200	$29,520	$25,000	$200,000	$57,000	$721,720	$108,258	$180,430	$1,010,408
500	4,500	Increase Westwind Park P.S. by 3,750 gpm, new 20" pipeline to Ely feed pipe. Deliver water to West Wind park through pressure release valve.	$0	$120,000	$20,000	$20,000	$331,200	$33,120	$25,000	$200,000	$57,000	$806,320	$120,948	$201,580	$1,128,848
		Riverside and Wineville													
May-Oct	4,300	Install slide gate structures to control water levels in each basin and a discharge point to Day Creek.	$0	$0	$300,000	$20,000	$0	$0	$0	$200,000	$0	$520,000	$78,000	$130,000	$728,000
		Jurupa													
May-Oct	4,300	Pipeline on San Bernardino Ave. from RP1/4 Outfall to San Sevaine Channel	$0	$0	$150,000	$20,000	$580,800	$58,080	$25,000	$200,000	$0	$1,033,880	$155,082	$258,470	$1,447,432
		Etiwanda, Victoria, and Hickory													
May-Oct	3,300	Pump station and Pipelines from RP-4 to the three basins	$0	$805,500	$150,000	$60,000	$3,059,200	$305,920	$25,000	$200,000	$0	$4,605,620	$690,843	$1,151,405	$6,447,868

(a) All alternatives include an additional 200 acre-feet annually for Whispering Lakes.

TABLE 4-15
ANNUALIZED AND UNIT COSTS FOR RECLAIMED WATER RECHARGE ALTERNATIVES

Recharge Capacity	(1) Capital Cost	(2) Amortized Costs (20 yrs @ 6.5%)	(3) O&M(b)	(4) Power(c)	(5) Total Annual Recharge(d)	(6)=[(2)+(3)+(4)]/(5) Capital and O & M costs ($/acre-ft)	(7) Vector Control ($/acre-ft)	(8) Tertiary Recover Cost(c) ($/acre-ft)	(9)=(6)+(7)+(8) Unit Cost of Recharge Fac ($/acre-ft)	(10) Unit Cost of Regulatory ($/acre-ft)	(11)=(8)+(9) Unit Cost of Recharge ($/acre-ft)
Ely and Whispering Lakes (a)											
1,400 acre-ft	$475,272	$43,134	$6,000	$7,180	1,400	$40	$17	$70	$127	$37	$165
2,600 acre-ft	$835,660	$75,841	$10,000	$14,360	2,600	$39	$9	$70	$118	$20	$138
3,200 acre-ft	$922,600	$83,732	$12,000	$21,540	3,200	$37	$8	$70	$114	$16	$131
3,900 acre-ft	$1,010,408	$91,701	$16,000	$28,721	3,900	$35	$6	$70	$111	$13	$125
4,500 acre-ft	$1,128,848	$102,450	$20,000	$35,901	4,500	$35	$5	$70	$111	$12	$122
Riverside and Wineville											
May-Oct before FY 2000/01(e)	$728,000	$66,071	$0	$35,901	2,520	$40	$10	$70	$120	$23	$143
May-Oct after FY 2000/01(e)	$728,000	$66,071	$200,000	$129,000	4,300	$92	$6	$70	$167	$14	$181
Jurupa											
May-Oct after FY 2000/01(e)	$1,447,432	$131,364	$200,000	$129,000	4,300	$107	$6	$70	$183	$14	$196
Etiwanda, Victoria, and Hickory											
May-Oct after FY 2000/01(e&f)	$6,447,868	$585,185	$16,100	$791,499	3,300	$422	$7	$70	$499	$18	$517

(a) All alternatives listed for Ely are in maximum acre-ft/mo and include 200 acre-ft/yr for Whispering Lakes.
(b) Estimated at 2% of the cost for a new pump station with an equivalent capacity.
(c) TDH approximately 58 ft @ $0.07 per kilowatt hour. Except for Riverside and Wineville after FY2001/2 O&M increases to $30 per acre-foot.
(d) Based on peak average monthly recharge of storm water flow and capacity constraints.
(e) Based on 4.5 MGD flow at RP-4 from the CBMWD Ten-Year Capital Improvements Program. After FY 2000/01 the RP-1/4 pump station will be completed and recharge will increase to 4,200 acre-feet annually.
(f) TDH approximately 592 ft @ $0.07 per kilowatt hour.

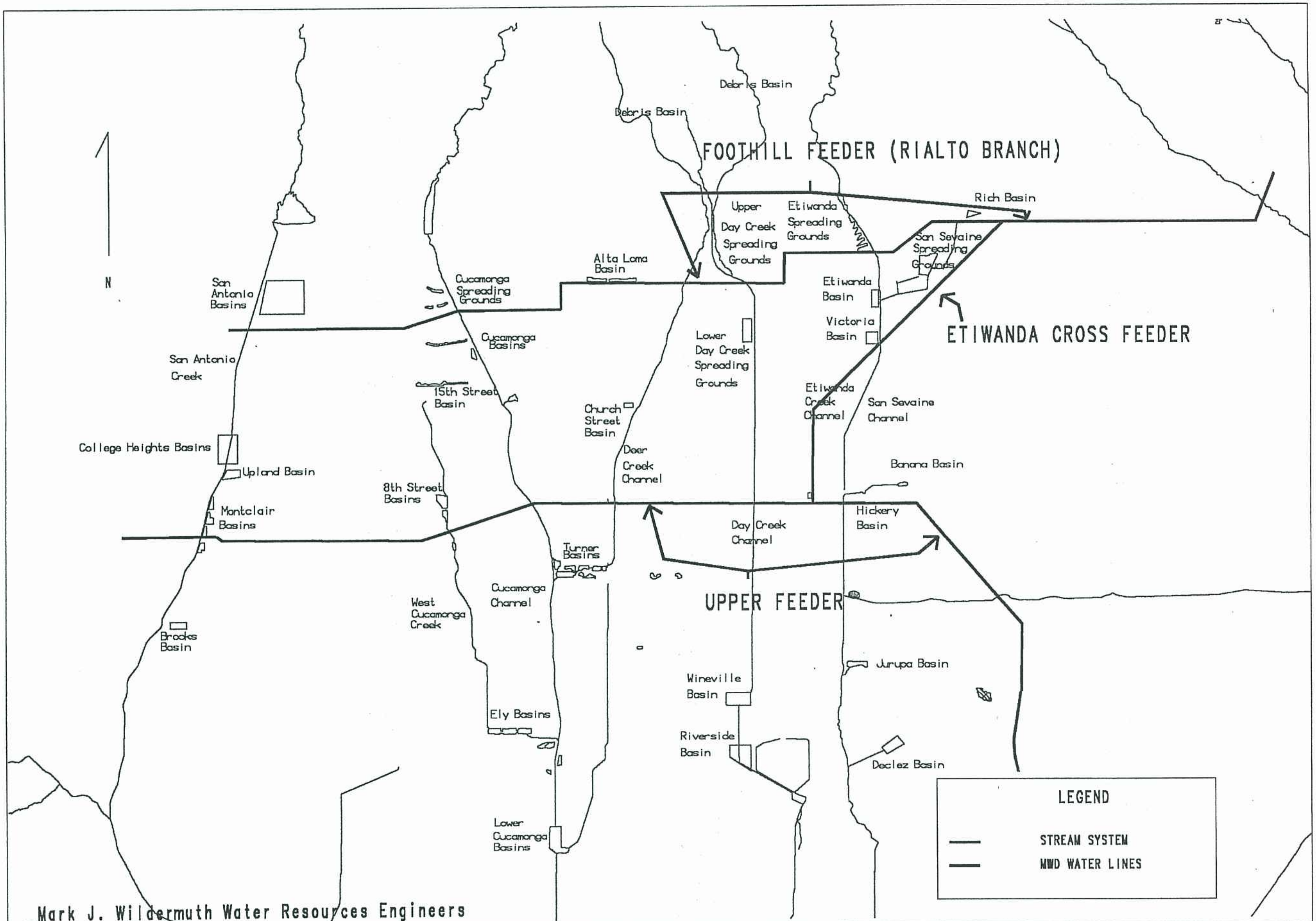


FIGURE 4-1 CHINO BASIN AREA MWD WATER FACILITIES

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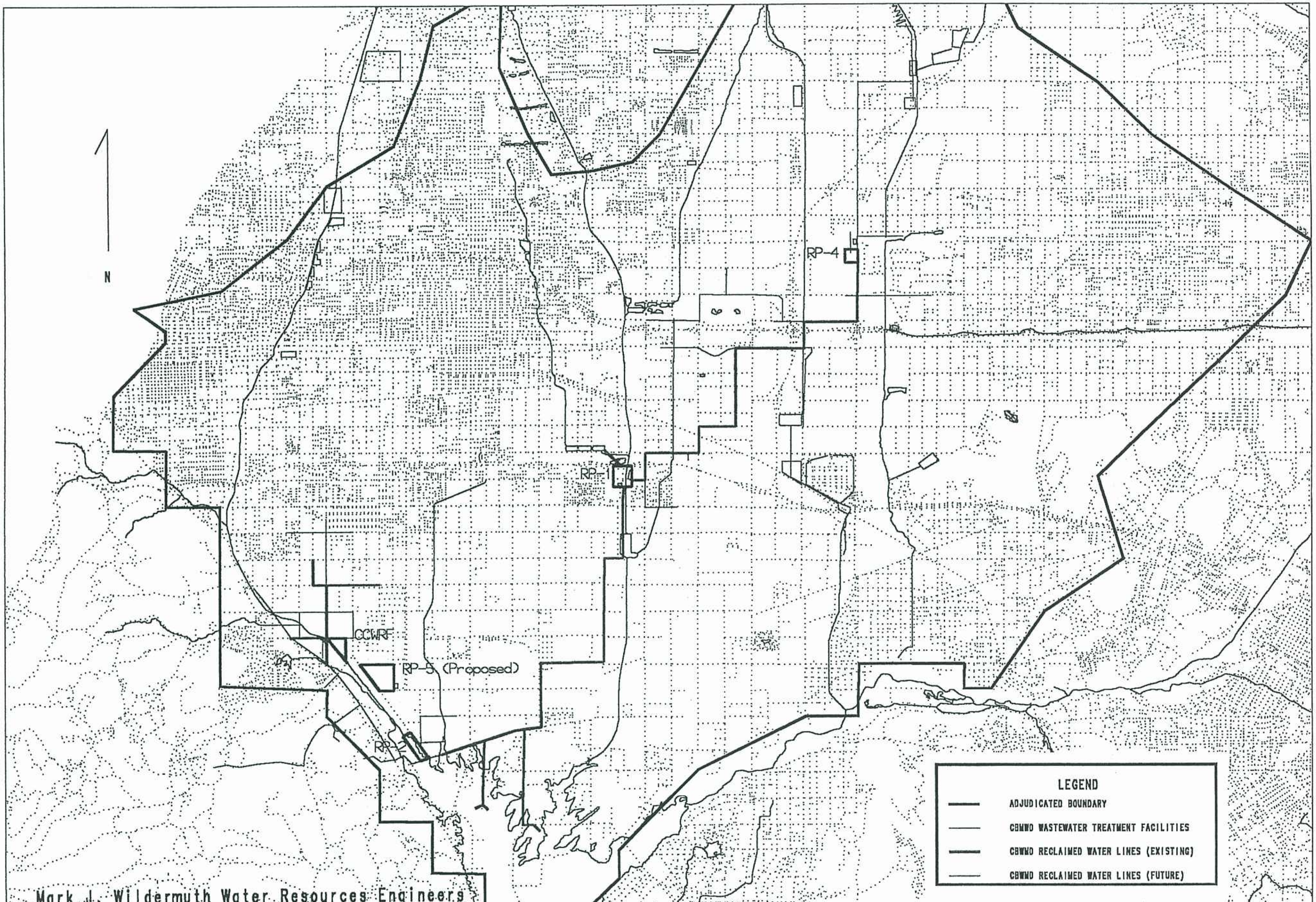

FIGURE 4-2 CHINO BASIN AREA RECLAMATION FACILITIES

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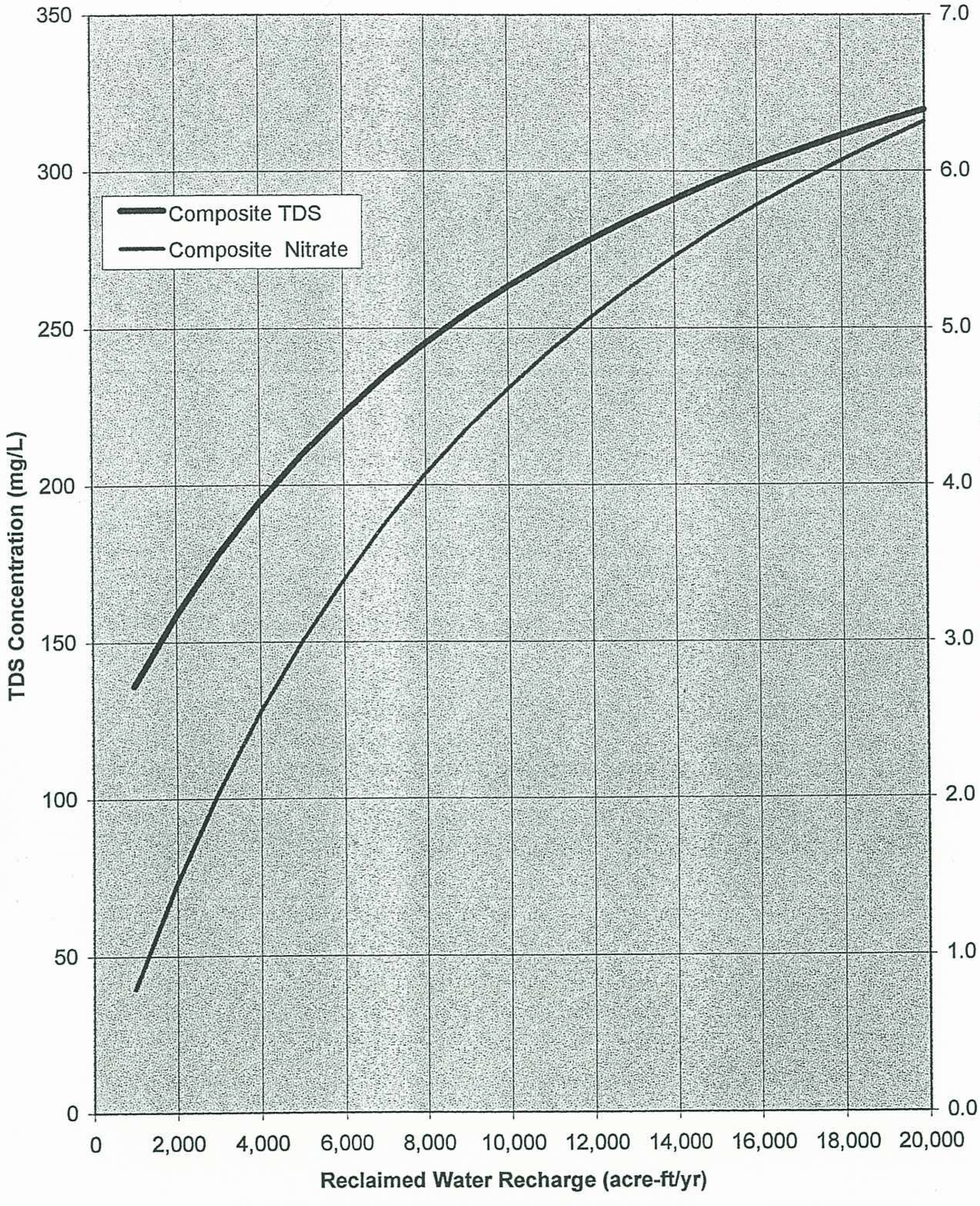
FIGURE 4-3
COMPOSITE RECHARGE QUALITY -- STORM WATER RECHARGE AND RECLAIMED WATER RECHARGE



Section 5

SECTION 5
RECOMMENDATIONS FOR PHASE 2

The objective of the Phase 1 study of the Recharge Master Plan is to determine the potential for artificial recharge given the resources in the Chino Basin. This was accomplished through data collection, research, and a massive computational and engineering assessment. In Section 3, the current level of storm water recharge was estimated at about 12,000 acre-ft/yr. The potential storm water recharge was estimated to range from about 25,000 to 30,000 acre-ft/yr given proper routine maintenance. Most basins are not maintained to optimize recharge and there is no quantitative information on basin conditions or current recharge performance. Recharge of storm flows could reach 40,000 acre-ft/yr under ultimate land use conditions and expansion of conservation storage. The present value benefit from increasing storm water recharge is about $6,500 per acre-ft. Thus the basin-wide benefit of optimizing storm water recharge could range from about $85,000,000 to $176,000,000. In Section 4, the potential capacity and cost for recharge of imported and reclaimed water were developed. Operational plans that specify the amount and scheduling of imported water and reclaimed water recharge were developed. About 17,000 acre-ft/yr of reclaimed water recharge capacity was developed. The potential for imported water recharge ranges from about 119,000 acre-ft/yr to 155,000 acre-ft/yr, assuming that Metropolitan has the capacity to deliver that much water.

Table 5-1 gives an example of how recharge of storm water, reclaimed water and imported water could be integrated over time to reduce the demand for SWP water for replenishment utilizing the information developed in this study. This analysis is based on the results presented in Sections 3 and 4. In this analysis it was assumed that increasing or optimizing the recharge of storm flow would occur first because it would be the least expensive source of recharge. Recharge of reclaimed water in the Ely, Wineville, Riverside and Jurupa Basins would follow in a phased manner as the next least expensive source of recharge. Finally, conservation storage expansion and recharge of reclaimed water at the Etiwanda, Hickory and Victoria Basins would occur in the out years as the next least expensive source of recharge. In this example, significant imported water recharge could be deferred until the year 2009. If the 200,000+ acre-ft of water in local storage accounts were used to offset replenishment obligations then replenishment with imported water could be postponed until the year 2019. Phase 3 will include alternatives for optimizing recharge that will be presented in a format similar to Table 5-1.

PHASE 2 INVESTIGATIONS

Phase 2 of the Recharge Master Plan includes site-specific investigations, percolation monitoring and the preparation of cost estimates for developing and managing spreading basins. The institutional issues regarding ownership of facilities, management of non-Conservation District-owned facilities, disposition of recharged water, Basin Plan modifications and others will be identified. Principles of agreement will be developed that describe the institutional issues and means to resolve these issues through agreements. Based on the work done in Phase 1 the following research questions were developed for Phase 2.

1. What is the range of actual percolation rates that occur at each basin? Surface conditions in each basin and the hydrogeologic conditions beneath each basin control the percolation rate at each basin. Resources should be used on basins that have good percolation rates. Percolation drops off as basins become *silted in* and knowledge of the deterioration in percolation can be used to schedule maintenance. Percolation rates should be determined by installing instrumentation in each basin and monitoring water levels. Percolation tests in small test pits should not be done because they are not reliable.

2. What are the limiting conditions on percolation in each basin? Most of the basins are not properly maintained for recharge. Past maintenance at these basins consists of infrequent ripping of the basin floors. Ripping incorporates the fine-grained materials that accumulate on the top of the basin floor into the basin bottom soils. There is a short-term increase in percolation after ripping but some percolation capacity is lost over time as the amount of fine-grained material builds up in the soil. In addition, the vibration of the equipment consolidates the basin floors making them less permeable. The sediments on the floor of most basins need to be studied to determine the amount and distribution of fine-grained sediments in the soil. The amount of material that needs to be removed to maximize percolation will then be made.

3. Given limited resources, what should be the priority (if any) of the research in questions 1 and 2 for each basin? With the exception of the San Sevaine system, most of the drainage systems have comparable recharge potential. Should priority be given to getting the most recharge for the least cost, or should other factors such as the need to manage groundwater levels under the City of Chino and CIM area be considered first? Table 5-2 shows a budget level cost estimate to answer questions 1 and 2. The basins were prioritized in Table 5-2 assuming that Conservation District facilities would have the highest priority (A) and that the facilities in the *San Sevaine Water Project* would have the lowest priority (C). This prioritization is arbitrary. Conservation District and Watermaster need to determine priority.

4. How flexible will SBCFCD be in modifying its flood control operations to increase conservation?

5. What is the amount of storm water recharge that will occur in each basin? Given the answers to questions 1, 2 and 4, the current recharge capacity and the expected capacity with proper maintenance would be assessed.

6. Can all the new storm water recharge and reclaimed water recharge be recovered by wells in the Chino Basin and put to beneficial use? Some of the new recharge may end up as new rising water in the Santa Ana River and not be put to beneficial use in the Chino Basin. Either the recharge should be limited to ensure it can be put to beneficial use, or a groundwater production pattern should be developed to capture all the recharge. Phase 2 should include a preliminary assessment of the recovery of new recharge. Phase 3 will include a detailed assessment of the capture of new recharge.

7. Will the Regional Board allow the use of new storm water recharge to mitigate the TDS and TIN impacts of reclaimed water recharge? The Regional Board should be formally approached and asked to develop a position on using storm water recharge as mitigation measure for reclaimed water.

PHASE 2 TASKS

Phase 2 consists of five tasks. These tasks have been crafted to answer the seven questions listed above.

Task 1 - Conduct Field Program. The field program recommended for Phase 2 for each basin is listed in Table 5-2. The program includes:

- the installation of water level sensors identical to what Conservation District has installed in some of their basins
- obtaining continuous cores for the upper 100 feet of sediment in each basin
- trenching to observe the near surface soils; and
- gradation tests of materials obtained from the trenches.

The fieldwork shown in Table 5-2 was subdivided into three sub phases to spread the cost out over three years. However, the work shown in Table 5-2 could easily be done in one year. The results of Task 1 would be used to answer questions 1 and 2.

Task 2 - Develop Principles of Agreements. This task involves the development of principles of agreement between SBCFCD, Conservation District and Watermaster regarding the operation of existing and proposed runoff management facilities. The goals of the principles are to maintain flood protection and maximize recharge. This work will involve many meetings and the drafting of mission statements and principles. New technical information will need to be developed on ad hoc basis in response to technical issues that will be involved in the principles. A similar set of principles will be developed with the Regional Board. The results of this task will be the answers to question 4 and 7.

Task 3 - Estimate the Average Annual Recharge for Each Basin. Given the results of Tasks 1 and 2, the input data for the computer simulation codes used in Phase 1 will be updated. The simulation models will be used to estimate the average annual recharge in each basin. Estimates of imported water and reclaimed water recharge capacity will also be updated.

Task 4 - Preliminary Assessment of the Capture of New Recharge. The *Rapid Assessment Model* currently under development by Watermaster and Conservation District, or *Chino Integrated Groundwater Surface Water Model*, will be used to estimate how much of the new recharge can be recovered. New groundwater production patterns will be developed to maximize recovery.

Task 5 - Prepare Report. Technical memoranda will be prepared for Tasks 1 through 4. A final report will be prepared incorporating the Task memoranda and a scope of work for Phase 3.

The cost for Phase 2 by Task is:

Task 1	$358,000
Task 2	$150,000
Task 3	$60,000
Task 4	$40,000
Task 5	$15,000
Total	$623,000

The cost for Task 2 is very approximate due to the nature of the task. The $150,000 estimate includes the cost of engineering and legal services. The staff times of Watermaster and Conservation District are not included. The costs of Tasks 1, 3, 4 and 5 are budget-level cost estimates. The duration of Phase 2 is equal to the duration of Task 1 plus about one year. Thus, if Task 1 is completed in one year then the duration of Phase 2 will be two years. Two years is the minimum time required to complete Phase 2.

IMPLEMENTATION OF PHASE 2

Watermaster and Conservation District need to develop a priority list for Task 1. The priority list should be based on expected return on investment and on the availability of the facility. For example, Conservation District has already completed some of the Phase 2 work for the Montclair, Brooks, lower Cucamonga and Chris Basins – completing the studies of these basins is relatively inexpensive. The Declez and Eighth Street Basins have relatively high returns on investment for recharge from new storage – their priority could be viewed as high. Studies for basins that do not exist or are being substantially modified should have the lowest priorities. Examples of these basins are San Sevaine No. 5, Hickory and Jurupa Basins. Geotechnical consultants should be retained to direct these studies and to analyze the results of the field investigations. The cost estimate for Task 1 is conservatively high and actual cost will probably be less.

For Task 2, Watermaster and Conservation District should form a committee to develop principles of agreement with the SBCFCD and the Regional Board. The committee should be composed of their respective managers, some Board members and producers. The committee should meet regularly, say monthly, and set a regular meeting schedule with SBCFCD. The salt offset issue with the Regional Board is a watershed-wide issue. Watermaster and Conservation District could bring the salt offset issue for storm water recharge to the *TDS and Nitrogen Task Force* for resolution in that study. Exclusive of Watermaster and Conservation District staff time, most of the cost of this task should be legal fees incurred in the drafting of the principles of agreement.

Tasks 1 and 2 should be started as soon as funds can be made available. Tasks 3 and 4 follow Tasks 1 and 2. They should be scoped in detail after Tasks 1 and 2 are substantially completed and could be deferred to Phase 3.

TABLE 5-1
COMPARISON OF ESTIMATED REPLENISHMENT OBLIGATION TO AVAILABILITY OF NEW SUPPLIES OF RECHARGE WATER
(acre-ft/yr)

Year	Replenishment Obligation	Sources of New Recharge Supply					Net Replenishment Obligation	Replenishment Storage Account	Imported Water Recharge
		Storm Water		Reclamation		Total New Recharge			
		Optimize Existing	Expand Conservation Storage	Low Cost	High Cost				
1999 - 2000	25,215	12,000	0	6,650	0	18,650	6,565	0	6,565
2000 - 2001	27,512	16,000	0	6,650	0	22,650	4,862	0	4,862
2001 - 2002	30,880	20,000	0	6,650	0	26,650	4,230	0	4,230
2002 - 2003	33,084	25,000	0	13,300	0	38,300	-5,216	5,216	0
2003 - 2004	35,906	25,000	0	13,300	0	38,300	-2,394	7,611	0
2004 - 2005	38,078	25,000	0	13,300	0	38,300	-222	7,833	0
2005 - 2006	41,249	25,000	0	13,300	0	38,300	2,949	4,884	0
2006 - 2007	44,421	25,000	3,700	13,300	3,300	45,300	-879	5,763	0
2007 - 2008	47,593	25,000	3,700	13,300	3,300	45,300	2,293	3,470	0
2008 - 2009	50,764	25,000	3,700	13,300	3,300	45,300	5,464	0	5,464
2009 - 2010	51,649	25,000	3,700	13,300	3,300	45,300	6,349	0	6,349
2010 - 2011	55,727	25,000	3,700	13,300	3,300	45,300	10,427	0	10,427
2011 - 2012	57,895	25,000	3,700	13,300	3,300	45,300	12,595	0	12,595
2012 - 2013	60,062	25,000	3,700	13,300	3,300	45,300	14,762	0	14,762
2013 - 2014	62,229	25,000	3,700	13,300	3,300	45,300	16,929	0	16,929
2014 - 2015	64,397	25,000	3,700	13,300	3,300	45,300	19,097	0	19,097
2015 - 2016	66,564	25,000	3,700	13,300	3,300	45,300	21,264	0	21,264
2016 - 2017	68,732	25,000	3,700	13,300	3,300	45,300	23,432	0	23,432
2017 - 2018	70,899	25,000	3,700	13,300	3,300	45,300	25,599	0	25,599
2018 - 2019	73,066	25,000	3,700	13,300	3,300	45,300	27,766	0	27,766
2019 - 2020	75,027	25,000	3,700	13,300	3,300	45,300	29,727	0	29,727

TABLE 5-2
BUDGET-LEVEL COST ESTIMATE FOR FIELD PROGRAMS IN PHASE 2

Basins	Phase 2 Priority	Cost of New Water to Basin: Storm Water Low ($/acre-ft)	Storm Water High ($/acre-ft)	Reclaimed Water Low ($/acre-ft)	Reclaimed Water High ($/acre-ft)	Unit Cost to Recharge Imported Water Low ($/acre-ft)	Imported Water High ($/acre-ft)	Phase 2 Field Program Costs: Install Water Level Sensors	Cores #	Cores Cost	Trenching #	Trenching Cost	Sieve Tests #	Sieve Tests Cost	Total Field Costs	Analysis of Field Data	Total Field Task Costs
Upland	A	na	na	na	na	$15	$15	$8,000			3	$750	9	$450	$9,200	$5,450	$14,650
Brooks	A	$185	$560	na	na	$43	$43	$8,000	6	$3,000					$11,000	$6,500	$17,500
Montclair 1 and 2	A	na	na	na	na	$1	$1		8	$4,000					$4,000	$7,500	$11,500
Montclair 3 and 4	A	na	na	na	na	$24	$24		8	$4,000					$4,000	$7,500	$11,500
8th and 15th Street	B	$52	$261	na	na	$81	$81	$16,000	8	$4,000	8	$2,000	24	$1,200	$23,200	$12,700	$35,900
Ely	A	na	na	$122	$165	$81	$81	$8,000	9	$4,500	9	$2,250	27	$1,350	$16,100	$13,850	$29,950
Lower Cucamonga West	A	na	na	na	na	na	na		8	$4,000					$4,000	$7,500	$11,500
Lower Cucamonga East	A	$132	$560	na	na	na	na		10	$5,000					$5,000	$8,500	$13,500
Church and Turner	B	$128	$560	na	na	$7	$9	$24,000	8	$4,000	8	$2,000	24	$1,200	$31,200	$12,700	$43,900
Lower Day	C	na	na	na	na	$81	$81	$8,000							$8,000	$3,500	$11,500
Wineville and Riverside	B	na	na	$143	$181	$7	$7	$16,000	10	$5,000	8	$2,000	24	$1,200	$24,200	$13,700	$37,900
Etiwanda	C	na	na	$517	$517	$4	$4	$8,000	4	$2,000	4	$1,000	12	$600	$11,600	$8,100	$19,700
Victoria	C	$177	$560	$517	$517	$20	$20	$8,000	4	$2,000	4	$1,000	12	$600	$11,600	$8,100	$19,700
Rich and San Sevaine 1 through 5	C	$177	$560	na	na	$5	$13	$24,000			10	$2,500	30	$1,500	$28,000	$10,000	$38,000
Jurupa	C	$177	$560	$196	$196	$8	$8	$8,000	4	$2,000	6	$1,500	18	$900	$12,400	$9,400	$21,800
Declez	A	$36	$181	na	na	na	na	$8,000	4	$2,000	4	$1,000	12	$600	$11,600	$8,100	$19,700
Totals								$144,000		$45,500		$16,000		$9,600	$215,100	$143,100	$358,200
Subtotals by Subphase																	
2A																	$129,800
2B																	$117,700
2C																	$110,700

note -- na means not applicable; A = highest priority; B = intermediate priority; C = lowest priority

Section 6

SECTION 6
REFERENCES

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CHINO BASIN WATER CONSERVATION DISTRICT
CHINO BASIN WATER MASTER

CHINO BASIN RECHARGE MASTER PLAN

APPENDIX A

STORAGE-AREA-ELEVATION AND OUTFLOW CURVES FOR EACH BASIN

TABLE A-1
15th STREET BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,409.5	0.0	2.0	0.0	0
1,414.5	5.0	5.2	0.8	0
1,416.0	6.5	6.1	5.2	0
1,418.0	8.5	7.1	13.8	0
1,420.0	10.5	8.0	60.3	0
1,428.0	18.5	11.0	108.4	0
1,430.0	20.5	11.6	119.8	5,000

TABLE A-2
7th STREET BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
0.0	0.0	1.0	0.0	0
1.0	1.0	2.0	0.1	0
2.0	2.0	2.6	2.4	0
3.0	3.0	3.3	5.4	0
4.0	4.0	4.0	9.0	0
5.0	5.0	4.6	13.3	161
6.0	6.0	5.3	18.3	472
7.0	7.0	6.0	23.9	899
8.0	8.0	6.6	30.2	1,436
9.0	9.0	7.2	37.1	2,080
10.0	10.0	7.6	44.6	2,829
11.0	11.0	7.7	52.2	3,686
12.0	12.0	8.0	60.1	4,650

TABLE A-3
8th STREET BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
0.0	0.0	0.0	0.0	0
1.0	1.0	6.2	2.3	30
2.0	2.0	12.0	12.2	80
3.0	3.0	14.5	26.5	150
4.0	4.0	14.6	41.0	250
6.0	6.0	15.0	71.5	700
8.0	8.0	15.4	101.0	1,200
10.0	10.0	15.7	132.0	1,660
12.0	12.0	16.2	164.0	2,090
16.0	16.0	17.0	230.0	2,750
20.0	20.0	17.8	300.0	3,320
21.0	21.0	18.0	318.0	3,630
22.0	22.0	18.2	336.0	4,040
24.0	24.0	19.0	373.0	5,080

TABLE A-4
BROOKS BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
872.0	0.0	7.0	0.0	0
880.0	8.0	8.2	61.0	0
882.0	10.0	8.5	77.0	0
883.0	11.0	8.9	86.0	50
890.0	18.0	9.8	150.0	50
900.0	28.0	11.4	256.0	50
910.0	38.0	13.2	380.0	50
915.0	43.0	14.2	448.0	50

TABLE A-5
CHURCH STREET BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,239.0	0.0	8.8	0.0	0
1,241.0	2.0	9.3	18.0	0
1,243.0	4.0	9.7	37.0	0
1,245.0	6.0	10.1	57.0	0
1,247.0	8.0	10.5	77.0	0
1,249.0	10.0	10.9	99.0	378
1,250.0	11.0	11.2	110.0	746

TABLE A-6
DECLEZ BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
819.6	0.0	0.0	0.0	0
820.6	1.0	0.1	0.1	11
821.0	1.4	0.3	0.1	27
822.0	2.4	0.6	0.6	69
823.0	3.4	2.1	2.1	112
824.0	4.4	4.2	5.4	127
825.0	5.4	5.7	10.4	145
830.0	10.4	6.9	41.9	219
835.0	15.4	7.3	77.5	293
840.0	20.4	7.9	115.6	367
842.0	22.4	8.1	131.6	396
845.0	25.4	8.4	156.4	2,750
849.0	29.4	9.0	191.2	5,850

TABLE A-7
ELY BASINS
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
830.0	0.0	29.1	0.0	0
840.0	10.0	35.7	324.0	0
841.0	11.0	36.3	360.0	0
842.0	12.0	37.0	396.0	180
843.0	13.0	37.6	434.0	560
844.0	14.0	38.3	472.0	1,100
845.0	15.0	39.0	510.0	1,770
846.0	16.0	39.6	550.0	2,530
847.0	17.0	40.3	590.0	3,380
848.0	18.0	40.9	630.0	4,310
849.0	19.0	41.6	671.0	5,300
850.0	20.0	42.2	713.0	6,370

TABLE A-8
ETIWANDA DEBRIS BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,632.9	0.0	35.0	0.0	0
1,636.0	3.1	36.0	111.0	0
1,638.0	5.1	37.0	241.0	0
1,640.0	7.1	38.0	411.0	1,200
1,642.0	9.1	39.0	621.0	3,000
1,645.0	12.1	40.0	914.0	5,000

TABLE A-9
ETIWANDA SPREADING GROUNDS
STORAGE-ELEVATION-OUTFLOW CURVE

Length (feet)	Channel Chareristics					
	b (feet)	s (feet/feet)	z (feet : feet)	n	perc rate (b) (ft/day)	perc rate (z) (ft/day)
3,800	10	0.0205	1:3	0.035	15	15

TABLE A-10
HICKORY BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1105	0	6.4	0	0
1109	4	7.0	27	0
1112	7	7.4	62	184
1117	12	8.3	128	241
1122	17	9.1	221	287
1130	25	10.5	377	9,775

TABLE A-11
JURUPA BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
892.5	0	0	0	0
899.6	7	30.6	217	0
900	8	31.6	237	294
902	10	35.1	334	471
904	12	37.6	432	627
905	13	38.8	485	682
907.37	15	40.7	605	796
908	16	41.1	638	966
909	17	41.8	690	1,098
911	19	43	795	1,305
913	21	44	902	1,488
915	23	44.9	1,011	1,646
917	25	45.8	1,121	1,770
919	27	46.6	1,234	1,886
921	29	47.3	1,348	2,002
923	31	48	1,464	2,118
925	33	48.6	1,582	2,222
927	35	49.3	1,701	2,316
928	36	49.6	1,760	2,360
929	37	49.9	1,821	2,895
930	38	50.2	1,884	3,786

TABLE A-12
EAST LOWER CUCAMONGA AND CHRIS BASINS
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
714.0	0.0	10.0	0.0	0
715.0	1.0	16.0	13.0	0
720.0	6.0	20.0	104.0	0
725.0	11.0	23.0	212.0	5,550
730.0	16.0	26.0	336.0	15,690

TABLE A-13
WEST LOWER CUCAMONGA BASINS
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
714.0	0.0	21.0	0.0	0
720.0	6.0	24.0	135.0	0
725.0	11.0	27.0	260.0	0
730.0	16.0	29.0	400.0	0
731.0	17.0	29.0	429.0	10,000

TABLE A-14
LOWER DAY SPREADING GROUNDS
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,368.0	0.0	0.0	0.0	0
1,372.0	4.0	2.2	8.9	65
1,374.0	6.0	3.7	22.0	104
1,376.0	8.0	5.1	41.0	132
1,378.0	10.0	6.5	65.0	156
1,380.0	12.0	7.8	94.0	176
1,382.0	14.0	9.2	129.0	194
1,384.0	16.0	10.5	168.0	210
1,386.0	18.0	13.0	260.0	240
1,391.0	23.0	15.6	389.0	273
1,396.0	28.0	17.7	530.0	302

TABLE A-15
MONTCLAIR 1 BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,102.0	0.0	0.0	0.0	0
1,104.0	2.0	1.1	1.0	0
1,106.0	4.0	2.0	4.0	0
1,108.0	6.0	2.8	9.0	0
1,110.0	8.0	3.8	16.0	0
1,120.0	18.0	6.1	65.0	0
1,127.0	25.0	7.4	111.0	0
1,130.0	28.0	7.9	135.0	300
1,132.0	30.0	8.4	152.0	800
1,134.0	32.0	9.0	169.0	1,350

TABLE A-16
MONTCLAIR 2 BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)	Outflow (cfs)
1,070.0	0.0	4.5	0.0	0	0
1,080.0	10.0	8.7	66.0	0	0
1,090.0	20.0	10.5	162.0	0	0
1,095.0	25.0	11.1	218.0	2	0
1,100.0	30.0	11.7	273.0	380	161
1,105.0	35.0	12.4	335.0	480	2,360
1,106.0	36.0	12.5	347.0	505	2,860
1,107.0	37.0	12.7	360.0	540	3,490
1,108.0	38.0	12.8	372.0	580	4,170
1,109.0	39.0	13.0	384.0	610	4,880
1,110.0	40.0	13.1	397.0	640	5,600

TABLE A-17
MONTCLAIR 3 BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,044.0	0.0	1.0	0.0	0
1,046.0	2.0	2.0	3.0	0
1,048.0	4.0	2.6	7.0	0
1,050.0	6.0	3.3	13.0	0
1,055.7	11.7	4.3	43.0	0
1,060.0	16.0	4.7	53.0	700
1,065.0	21.0	5.2	79.0	2,570
1,070.0	26.0	5.8	106.0	5,540

TABLE A-18
MONTCLAIR 4 BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
995.0	0.0	0.2	0.0	0
1,000.0	5.0	2.9	8.0	0
1,010.0	15.0	3.7	41.0	0
1,020.0	25.0	4.6	82.0	0
1,030.0	35.0	5.6	133.0	0
1,038.0	43.0	6.2	181.0	0
1,040.0	45.0	6.4	193.0	260
1,042.0	47.0	6.6	207.0	700
1,044.0	49.0	6.9	221.0	1,520
1,046.0	51.0	7.1	235.0	2,670
1,048.0	53.0	7.4	249.0	3,990
1,050.0	55.0	7.6	263.0	5,600

TABLE A-19
RICH BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
N/A	0.00	5.00	34.00	0
N/A	1.65	5.50	34.22	0
N/A	1.66	5.67	43.58	91
N/A	2.66	5.72	49.22	185
N/A	4.66	6.79	60.50	429
N/A	6.66	5.80	72.65	733
N/A	7.66	5.95	79.60	905
N/A	9.66	6.16	93.50	1,282
N/A	11.66	6.37	108.24	1,700
N/A	13.66	6.64	124.69	2,156
N/A	15.66	6.84	141.14	2,646
N/A	17.66	7.14	160.14	3,168
N/A	19.66	7.41	179.66	3,722
N/A	21.66	7.63	199.18	4,304

TABLE A-20
RIVERSIDE BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
790.0	0.0	0.0	0.0	0.0
795.0	5.0	40.1	46.7	0.0
796.0	6.0	42.2	87.5	0.0
798.0	8.0	43.3	173.0	0.0
800.0	10.0	44.4	260.7	0.0
804.0	14.0	46.7	443.0	0.0
808.0	18.0	49.0	634.4	0.0
812.0	22.0	51.3	835.1	0.0
812.5	22.5	51.6	860.8	86.0
813.0	23.0	51.9	886.6	245.0
814.0	24.0	52.4	938.8	704.0
815.0	25.0	53.0	991.5	1,317.0
816.0	26.0	53.6	1,044.8	2,064.0
817.0	27.0	54.1	1,098.7	2,924.0
818.0	28.0	54.7	1,153.0	3,924.0
819.0	29.0	55.3	1,208.1	5,028.0
820.0	30.0	55.9	1,263.7	6,245.0
824.0	34.0	58.1	1,491.7	12,221.0

TABLE A-21
SAN SEVAINE BASIN 1
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,481.0	0.0	0.0	0.0	0.0
1,483.0	2.0	0.6	0.5	0.0
1,485.0	4.0	2.9	4.1	0.0
1,490.0	9.0	13.3	47.8	0.0
1,493.0	12.0	15.9	83.3	0.0
1,497.0	16.0	17.9	160.0	0.0
1,504.0	23.0	20.1	293.7	5,000.0

TABLE A-22
SAN SEVAINE BASIN 2
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,460.0	0.0	0.0	0.0	0
1,463.0	3.0	0.4	0.4	0
1,465.0	5.0	1.6	2.1	0
1,468.0	8.0	4.3	10.9	0
1,470.0	10.0	6.1	21.3	0
1,478.0	18.0	11.7	65.1	5,000

TABLE A-23
SAN SEVAINE BASIN 3
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,451.0	0.0	0.0	0.0	0
1,454.0	3.0	3.1	3.2	0
1,456.0	5.0	6.1	12.5	0
1,458.0	7.0	8.4	27.3	0
1,460.0	9.0	9.6	45.4	0
1,465.0	14.0	11.4	98.5	5,000

TABLE A-24
SAN SEVAINE BASIN 4
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
1,434.0	0.0	0.0	0.0	0
1,437.0	3.0	1.3	1.2	0
1,440.0	6.0	3.7	9.1	0
1,442.0	8.0	4.6	17.3	0
1,446.0	12.0	6.0	39.0	5,000

TABLE A-25
SAN SEVAINE BASIN 5
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
N/A	0	0.0	0	0
N/A	2.08	54.8	57	39
N/A	6.08	56.3	171	218
N/A	10.08	56.5	285	362
N/A	14.08	73.6	518	529
N/A	18.08	84.1	760	737
N/A	22.08	93.2	1,029	1,112
N/A	26.08	99.5	1,297	1,523
N/A	30.08	104.1	1,566	2,077
N/A	34.08	108.3	1,845	2,449
N/A	38.08	113.9	2,169	2,821
N/A	42.08	117.5	2,473	3,192
N/A	46.08	120.9	2,786	3,498
N/A	48.08	122.4	2,943	3,634
N/A	50.08	124.4	3,116	7,094
N/A	52.08	126.3	3,290	10,554

TABLE A-26
TURNER #5 BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
990.0	0.0	3.5	0.0	0
992.0	2.0	4.0	7.5	0
994.0	4.0	4.4	15.8	0
996.0	6.0	4.8	25.0	0
998.0	8.0	5.2	35.0	0
1,000.0	10.0	5.7	45.9	0
1,002.0	12.0	6.0	57.6	789
1,003.0	13.0	6.3	63.8	1,610

TABLE A-27
TURNER #8 BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
991.0	0.0	7.3	0.0	0
993.0	2.0	7.9	15.2	0
995.0	4.0	8.4	31.2	0
997.0	6.0	8.9	48.8	0
999.0	8.0	9.5	67.2	0
1,001.0	10.0	10.0	86.7	0
1,003.0	12.0	10.5	107.2	0
1,004.0	13.0	10.8	117.9	0
1,005.0	14.0	11.1	128.8	123
1,006.0	15.0	11.3	140.0	602
1,007.0	16.0	11.6	151.5	1,377

TABLE A-28
TURNER #9 BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
993.0	0.0	1.3	0.0	0
995.0	2.0	1.6	2.9	0
997.0	4.0	1.8	6.3	0
999.0	6.0	2.1	10.2	0
1,001.0	8.0	2.3	14.6	0
1,003.0	10.0	2.6	19.5	0
1,005.0	12.0	2.8	24.9	0
1,006.0	13.0	2.9	27.8	0
1,007.0	14.0	3.1	30.8	123
1,008.0	15.0	3.2	33.9	325
1,009.0	16.0	3.3	37.1	858

TABLE A-29
TURNER #3 & #4 BASIN
STORAGE-ELEVATION-OUTFLOW CURVE

Elevation (msl feet)	Depth (feet)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
983.0	0.0	13.9	0.0	0
985.0	2.0	14.8	28.7	0
987.0	4.0	15.6	59.0	0
989.0	6.0	16.4	91.0	0
991.0	8.0	17.2	124.7	0
993.0	10.0	18.1	160.0	0
995.0	12.0	18.9	196.9	469
996.0	13.0	19.3	216.0	659

CHINO BASIN WATER CONSERVATION DISTRICT
CHINO BASIN WATER MASTER

CHINO BASIN RECHARGE MASTER PLAN

APPENDIX B

BASIN MONITORING PROGRAM LABORATORY RESULTS

Mark J. Wildermuth
Water Resources Engineers

TABLE B-1
BASIN MONITORING PROGRAM LABORATORY RESULTS

Basin Name	Date	Lab	TDS (mg/l)	Hardness (mg/l)	Alkalinity (mg/l)	OH (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	SO4 (mg/l)	Chloride (mg/l)	F (mg/l)	B (mg/l)	Lab EC (umhos/cm)	MBAS (mg/l)	Color (Units)	Odor (Ton)	Turbidity (nTU)	pH (Units)	NH3-N (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	Tot Phos (mg/l)	Mn (mg/l)	Fe (mg/l)	Tot Filt (mg/l)
15 th St.	12/9/97	Truesdail	96	70	57	-1	69.5		17.4	3	8.1	2.9	5.7	11.6	0.13	0.03	191	-0.04	156	2	15	7.1	-0.14	1	0.01	4.1			
Brooks	11/18/97	Truesdail	70	26	28	-1	34.2		8	1.5	4.6	3.7	10.1	-1	0.24	0.04	95.6	0.86	162	-1	7.4	6.7	0.46	-1	0.03	4.4			
Brooks	12/10/97	Truesdail	50	26	21	-1	25.6		5.5	1.1	3	2.7	11.2	2.6	0.12	-0.1	81.2	-0.04	108	2	8.2	7.2	0.44	0.39	0.03	5.1			
Brooks	12/4/97	Truesdail	46	25	22	-1	26.8		7.1	1.3	4.9	3.2	-4	7.5	0.17	0.05	81	-0.04	180	2	10.4	6.1	0.19	0.37	0.12	4.6			
Brooks St.	2/18/97	Truesdail	35	21	17	-1	20.7		5.7	1	3.2	1.9	5.2	2.9	-0.1	-0.01	55	0.05	20	2	3.2	6.6	0.16	0.4	0.03	0.37			
Church	11/20/97	Truesdail	275	124	109	-1	133		35.4	8.7	39.8	8.5	26.9	49.6	0.28	0.19	464	0.32	341	2	38.4	6.9	1.5	2.2	0.11	9.6			
Church	12/9/97	Truesdail	63	37	30	-1	36.6		8.4	2.3	8.7	2.7	5.8	1.3	-0.1	0.04	111	-0.04	176	-1	17.2	7	-0.14	0.79	0.07	5.7			
Cucamonga	4/11/96	Western	388	122	130	-1	140	9	29.7	11.7	73.6	10.4	76	66	0.3		620	-0.02	11		4.32	8.5	1.01	12.1	0.64	0.49	0.02	0.21	-1
Cucamonga	4/29/96	Western	404	158	132	-1	90	35	44.5	11.4	69.4	10.5	76	67	0.3		632	0.2	22		8.77	9.4	0.03	6.28	0.29	1.68	0.05	0.65	28
Cucamonga	5/15/96	Western	392	119	131	-1	48	55	31.4	10	79.1	11.4	72	68	0.3		603	0.35	15	2	6.4	9.8	0.03	0.57	-0.01	-0.31	0.01	0.22	15
Ely No.3	3/28/96	Western	36	16	16	-1	20	-1	5.21	0.75	5.86	1.73	-1	11	0.1		50	0.14	9		2.88	6.9	0.12	3.28	0.07	-0.01	0.01	-0.01	
Ely No.3	4/11/96	Western	128	61	57	-1	70	-1	17.9	3.99	22.2	2.71	4	17	0.2		197	0.19	22		7.04	8.3	0.16	7.59	0.18	0.19	0.03	1.01	9
Ely No.3	4/29/96	Western	156	93	71	-1	72	7	27.6	5.66	21.2	4.43	37	19	0.2		250	0.2	29		8.33	9	1.44	5.16	0.32	0.29	0.04	1.07	14
Ely No.3	11/18/97	Truesdail	100	50	54	-1	65.9		14.3	3.4	6.6	3.9	9.7	6.3	0.23	0.06	153	0.75	174	1	11.9	6.9	0.78	-1	0.49	4.7			
Ely No.3	12/10/97	Truesdail	17	31	20	-1	24.4		9.6	1.9	4	2.3	9.6	3.6	0.1	0.02	90.5	-0.04	112	2	12.2	6.8	0.46	0.71	0.06	9.4			
Ely No.3	12/4/97	Truesdail	100	68	57	-1	69.5		18.4	4	8.4	3.2	17.9	7	0.22	0.08	179	-0.04	97	1	6.4	6.6	0.55	1.2	0.15	8.7			
Ely No.1(GE EFF)	2/18/97	Truesdail	217	153	140	-1	171		47.1	11.7	17	2.7	19.6	10.5	0.22	-0.01	355	0.05	15	2	29	7.5	0.71	4	0.12	0.29			
Ely No.1(GE EFF)	3/4/97	Truesdail	196	166	142	-1	173		46.9	11.8	15.6	2.4	12.7	8.5	0.26	-0.1	363	-0.04	10	2	1.5	8.9	-0.14	6.1	0.02	0.18			
Etiwanda	2/14/97	Truesdail	72	20	109	-1	133		38	7	9.5	2	18.1	2.5	0.24	-0.01	251	-0.04	14	4	2.9	8	-0.14	0.46	-0.02	0.16			
L. Cuca (Chris)	2/18/97	Truesdail	170	89	113	-1	138		27.8	6.6	19.9	19.1	17.6	21.5	0.13	-0.01	316	0.11	35	16	22	8.5	3.8	0.9	0.14	1.8			
L. Cuca (Chris)	3/4/97	Truesdail	208	118	147	-1	179		36.1	7.9	23.6	18.8	-4	22.5	0.18	-0.1	370	0.24	28	4	17	9.1	2.7	1.3	0.01	1.3			
L. Cuca (Chris)	3/28/96	Western	76	52	54	18	66	32	17.2	2.24	13.2	4.17	-1	15	0.1		146	0.28	17		6.19	9.6	0.3	1.92	0.01	0.12	0.07	0.49	
L. Cuca (Chris)	4/11/96	Western	164	50	97	-1	118	-1	13.2	4.17	24.6	5.86	10	17	0.2		260	0.19	35		9.64	7.7	0.87	2.68	0.2	0.34	0.12	0.56	16
L. Cuca (Chris)	4/29/96	Western	175	92	98	-1	105	7	28.1	5.31	19.8	4.89	9	15	0.2		257	0.21	30		8.9	8.8	0.5	2.49	0.07	0.2	0.07	0.66	15
L. Cuca (Chris)	5/15/96	Western	168	62	94	-1	115	-1	15.3	5.79	33.1	8.29	15	21	0.2		263	0.37	21	4	6.4	9.1	0.21	2.22	-0.01	-0.35	0.04	0.62	35
L. Cuca (Chris)	11/18/97	Truesdail	110	46	60	-1	73.2		14.2	2.6	7.4	6.1	10	5.5	0.19	0.04	168	0.64	142	1	14.7	7.1	2.2	1.2	0.08	7.7			
L. Cuca (west)	2/18/97	Truesdail	420	147	106	-1	129		39.8	15.6	79.1	16.9	166	70.1	0.35	0.27	660	0.17	39	16	28	8.5	1.7	0.34	0.06	0.38			
L. Cuca (west)	3/4/97	Truesdail	493	171	130	-1	159		47.1	18.3	88.2	19.7	110	85.5	0.48	-0.1	784	0.28	42	4	35	8.4	2.2	0.27	0.01	1.1			
L. Cuca (west)	3/28/96	Western	384	142	122	-1	149	-1	37.5	11.7	66.3	11	72	63	0.3		617	0.19	9		2.36	8.3	1.37	15.1	0.69	0.37	0.02	0.13	
Lower Day	2/14/97	Truesdail	39	16	13	-1	15.9		4.5	0.64	1.8	0.75	5.4	1.1	-0.1	-0.01	37.6	-0.04	30	4	24	7.5	-0.14	-0.2	-0.2	0.21			
Lower Day	3/3/97	Truesdail	34	14	13	-1	15.9		4.6	0.64	1.9	0.78	7.8	1.5	-0.1	-0.1	36.4	-0.04	18	2	9	7.2	-0.14	-0.2	-0.01	0.15			
Montclair	4/11/96	Western	72	34	34	-1	41	-1	11	1.67	12.3	1.97	6	13	-0.1		116	0.17	19		6.24	7.2	0.54	2.05	0.03	0.18	0.04	0.42	7
Montclair	4/29/96	Western	96	53	47	-1	57	-1	16	3.06	10.6	2.35	11	11	0.1		156	0.24	19		6.58	7.7	0.1	1.8	0.03	0.11	0.04	0.37	8
Montclair	5/15/96	Western	152	69	62	-1	76	-1	20.6	4.35	24.1	3.17	20	24	0.1		244	0.4	25	4	9.6	7.4	0.38	2.54	0.01	-0.21	0.04	0.89	23
Montclair No.1	2/13/97	Truesdail	65	36	33	-1	40.3		11.9	1.9	5	1.3	7.4	2.1	-0.1	-0.01	111	0.13	30	16	4.9	7.4	0.22	0.34	0.02	0.16			
Montclair No.1	3/3/97	Truesdail	96	44	39	-1	47.6		14.4	2.3	7.9	2.2	10.3	5.1	0.1	-0.1	132	0.18	38	1	5	7	0.31	0.98	0.07	0.19			
Montclair No.1	3/28/96	Western	40	20	20	7	24	12	6.43	0.86	7.51	1.57	-1	10	-0.1		74	0.2	14		5.4	10	0.69	1.72	0.03	-0.01	0.01	0.19	
Montclair No.3	3/3/97	Truesdail	134	48	46	-1	56.2		16.1	2	10.9	2	-4	7.6	0.12	-0.1	148	0.29	47	2	5.8	7.9	-0.14	0.04	0.16				
Montclair No.3	2/18/97	Truesdail	75	31	25	-1	30.5		10.5	1.2	5.8	1.4	7.4	4.1	-0.1	-0.01	83.8	0.13	50	1	4.2	7.2	-0.14	0.37	0.03	0.2			
Montclair No.3	12/9/97	Truesdail	80	41	35	-1	42.7		9.4	4.3	15.3	1.7	13.9	11.7	-0.1	0.05	158	-0.04	69	4	6.2	6.9	0.22	0.49	0.03	3.8			
Montclair No.4	3/3/97	Truesdail	90	38	48	-1	58.6		12.1	1.8	7	2.1	8.2	5.1	0.13	-0.1	106	0.24	35	2	4	6.8	0.41	0.33	0.02	0.16			
Montclair No.4	2/13/97	Truesdail	38	16	13	-1	15.9		5.4	0.7	3.5	1.2	5.1	2.3	-0.1	-0.01	56	0.11	20	8	1.9	6.8	0.4	0.3	0.02	0.1			
Montclair No.4	12/9/97	Truesdail	60	30	24	-1	29.3		7.4	2.5	8.6	2	5.6	7.9	0.1	0.05	104	-0.04	130	-1	14.6	6.6	0.25	0.49	0.03	2.3			
Riverside	2/18/97	Truesdail	64	31	26	-1	31.7		11.5	1.5	5.3	2.2	6.7	6.1	0.12	-0.01	92	0.05	18	1	16	7.1	0.19	1	0.02	0.2			
Riverside	3/4/97	Truesdail	53	31	29	-1	35.4		11.2	1.4	5.2	2.2	6.4	4.1	0.12	-0.1	95.6	0.06	20	2	7.2	7.5	0.18	0.96	-0.01	0.22			
Riverside	11/19/97	Truesdail	90	76	68	-1	83		21	3.5	13.3	4.7	19.1	15.6	0.21	-0.1	220	0.14	79	-1	9	7.3	0.56	0.86	0.05	4.4			
Riverside	12/10/97	Truesdail	46	45	42	-1	51.2		14.4	2.1	8.9	3.2	11.7	8.9	0.13	-0.1	148	0.09	49	1	4.3	7.1	0.88	0.43	0.17	2.3			
Riverside	12/4/97	Truesdail	105	63	60	-1	73.2		20.2	3	12	4	10.9	15	0.19	0.04	200	-0.04	64	1	5.5	7.1	0.22	0.78	0.07	5			
San Sevaine 1	12/10/97	Truesdail	130	31	27	-1	37.8		9.3	2.4	5	2.1	78.8	4.4	-0.1	-0.1	89.2	-0.04	321	2	41.7	7.1	-0.14	0.51	-0.01	4.1			
San Sevaine 1	2/18/97	Truesdail	184	89	104	-1	127		36.3	7.2	13.7	2.1	25.2	5.3	0.22	-0.01	256	-0.04	27	1	11	8.2	0.14	0.2	0.02	0.04			
San Sevaine 1	12/3/97	Truesdail	150	37	32	-1	-1		10.4	2.7	6.8	2.6	7.7	7.5	0.13	-0.1	107	-0.04	440	2	131	7.1	-0.14	0.28	0.06	17			
San Sevaine 5	2/14/97	Truesdail	92	26	23	-1	28.1		8.5	1.9	3.7	1.7	7.1	16.5	-0.1	-0.01	76.6	-0.04	40	4	30	8	-0.14	1.2	0.02	0.1			
San Sevaine 5	3/3/97	Truesdail	230	149	130	-1	159		41.6	9.6	12.5	2.5	24.4	4.1	0.14	-0.1	324	-0.04	16	2	16	8.4	-0.14	0.54	0.01	0.09			
San Sevaine 5	3/4/97	Truesdail	90	27	25	-1	30.5		8.3	1.9	3.9	1.7	12.6	2.5	-0.1	-0.1	75.6	-0.04	30	4	24	7.3	-0.14	0.3	-0.01	0.16			
Turner No.5	10/20/97	Truesdail	167	85	90	-1	110		22.7	5.1	11.2	6.9	7.2	12.4	0.3	0.1	262	0.26	149	-1	5.2	8.2	-0.14	1.2	0.08	7.1			
Turner No.5	12/10/97	Truesdail	140	93	70	-1	113		23.6	5.6	11.9	9.8	39.9	8	0.21	0.04	241	0.26	74	2	0.97	7.3	0.45	1.9	0.78	3.8			
Turner No.5	12/3/97	Truesdail	126	77	69	-1	-1		22.6	4.9	11.8	6.2	12	13	0.24	-0.1	218	-0.04	72	-1	4.1	7.3	-0.14	1.2	0.04	5.7			
Turner No.5	2/13/97	Truesdail	240	130	124	-1	151		36.3	10.2	17.8	19.7	14.2	2.8	0.18	-0.01	387	0.13	65	40	15	7.5	1	0.52	0.13	0.92			
Turner No.5	3/4/97	Truesdail	274	150	141	-1	172		44.3	11	20.2	22.1	34.9	25	0.22	-0.1	424	0.12	72	4	40	7.8	0.45	1.8	0.01	1.3			
Upland	12/9/97	Truesdail	37	14	14	-1	17.1		5.1	0.92	2.4	1.9	5.8	1.6	-0.1	-0.1	47.5	-0.04	148	-1	16.1	6.5	0.17	0.5	0.03	2.6			
Wineville	2/18/97	Truesdail	253	139	134	-1	163		48.1	6.9	20.6	6.1	37.4	16.8	0.29	-0.01	378	0.27	30	8	15	8.4	0.28	2.7	0.11	0.62			
Wineville	3/4/97	Truesdail	526	123	118	-1	144		42.5	5.4	21.8	4.4	38.7	15	0.11	-0.1	320	0.38	46	4	10	8	-0.14	1.8	-0.01	0.75			
Wineville	11/19/97	Truesdail	192	110	115	-1	140		30.7	6.5	27.8	6	21	24.9	0.25	0.04	352	0.44	236	-1	32	7.8	-0.14	2.2	0.03	21.7			
Wineville	12/10/97	Truesdail	46	50	43	-1	52.5		13.6	1.7	7.6	2.9	12.2	1.4	0.12	-0.1	130	-0.04	99	2	14	7.2	0.55	0.27	0.19	5.7			

Note: Negative values mean that the reported value is less than the detection limit, with the value being the detection limit. For example, the value -0.1 is <0.1.

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KENNETH R. MANNING
Chief Executive Officer

I, Paula S. Molter, am an employee of the Chino Basin Watermaster ("Watermaster"). As part of its normal course of business, Watermaster maintains a library of documents relevant to the Chino Groundwater Basin and Watermaster's role as the arm of the Court administering the Chino Basin Judgment. It is part of my regular duties to retrieve such documents from the library in response to requests from various parties.

I hereby certify that the attached document, titled ***Chino Basin Recharge Master Plan Phase I, Jan 1998***, is a full, true and accurate copy of that document, on file and of record in the Watermaster library.

Dated: 3-8-07

Paula S. Molter