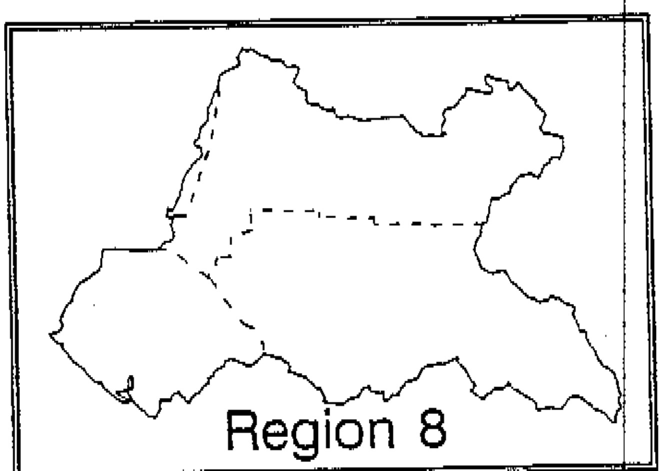
APPENDIX
B

DAIRIES AND THEIR RELATIONSHIP TO WATER QUALITY PROBLEMS IN THE CHINO BASIN



California Regional Water Quality Control Board
Santa Ana Region

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SANTA ANA REGION

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PREFACE

There is growing awareness of and concern about the severe salt imbalance problem now evident in the groundwaters of the Chino Basin. Excess salts (including nitrates) adversely affect the beneficial uses of these waters for municipal, agricultural and industrial supply. The movement of this poor quality groundwater into the Santa Ana River significantly impacts the quality of this surface water body as well. Since the River flows are used to recharge the Orange County drinking water aquifer, the salts contained in Chino Basin groundwaters ultimately affect the quality of water served to Orange County residents. Modeling studies confirm that this salt imbalance problem will increase significantly over time unless appropriate control and/or cleanup measures are successfully implemented.

While there are a number of contributors to this problem, including irrigated agriculture and municipal wastewater discharges, it is clear that dairy operations in the Chino Basin are of overwhelming importance. The Chino Basin contains the highest concentration of dairies found anywhere in the world. The large animal population generates considerable volumes of liquid and solid waste, which contain significant quantities of salts. The Santa Ana Regional Board initiated a regulatory program to address the water quality impacts of the salt loads from dairy operations in 1972. This program has not changed significantly since that time. The severity of the water quality problem now confronting the Region in the Chino Basin demands reconsideration of the Board's dairy regulatory strategy, both in its design and in its implementation.

Accordingly, the Regional Board directed staff to prepare a report which would both describe the present dairy regulatory program and review, in detail, the rationale for the specific strategies employed. This report was prepared in response to that direction.

This report includes a summary of the water quality problems in the Chino Basin, a discussion of possible sources, and a detailed analysis and discussion of the theoretical basis for the Board's dairy regulatory strategies. Finally, the report contains a proposed dairy strategy based on this detailed analysis. The level of detail apparent in the report, and the intensity of staff effort needed to produce it, reflect the severity of the concern about the impacts of dairy operations on water quality, both within and downstream of the Chino Basin.

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I: PROBLEM DESCRIPTION

A. Introduction

As in most of Southern California, the Santa Ana Region is highly dependent on groundwater to meet the needs of an increasing population. The Chino Groundwater Basin is the largest basin in the Santa Ana Region. It is divided into three subbasins, Chino I, Chino II and Chino III (Figure I-1). The Basin covers about 245 square miles and contains about 43 million acre feet (acre-ft) of water, 9.4 million acre-ft of which is producible. The Chino Basin is adjudicated, with the safe yield determined to be 140,000 acre-ft/year. Water extracted from the Basin is divided among three pools, the agricultural pool (primarily dairies), non-agricultural pool (industrial) and appropriative pool (municipal).

The Basin is affected by a long-term adverse salt balance, i.e., more salt enters the Basin than is exported from it. As a result, the total dissolved solids and nitrate quality of the groundwater in the Chino Basin has been deteriorating for many years and is projected to continue to deteriorate.

The groundwater quality of the Chino Basin is of the utmost concern for several reasons. First, groundwater within the Chino Basin is used extensively for municipal, industrial and agricultural supply.

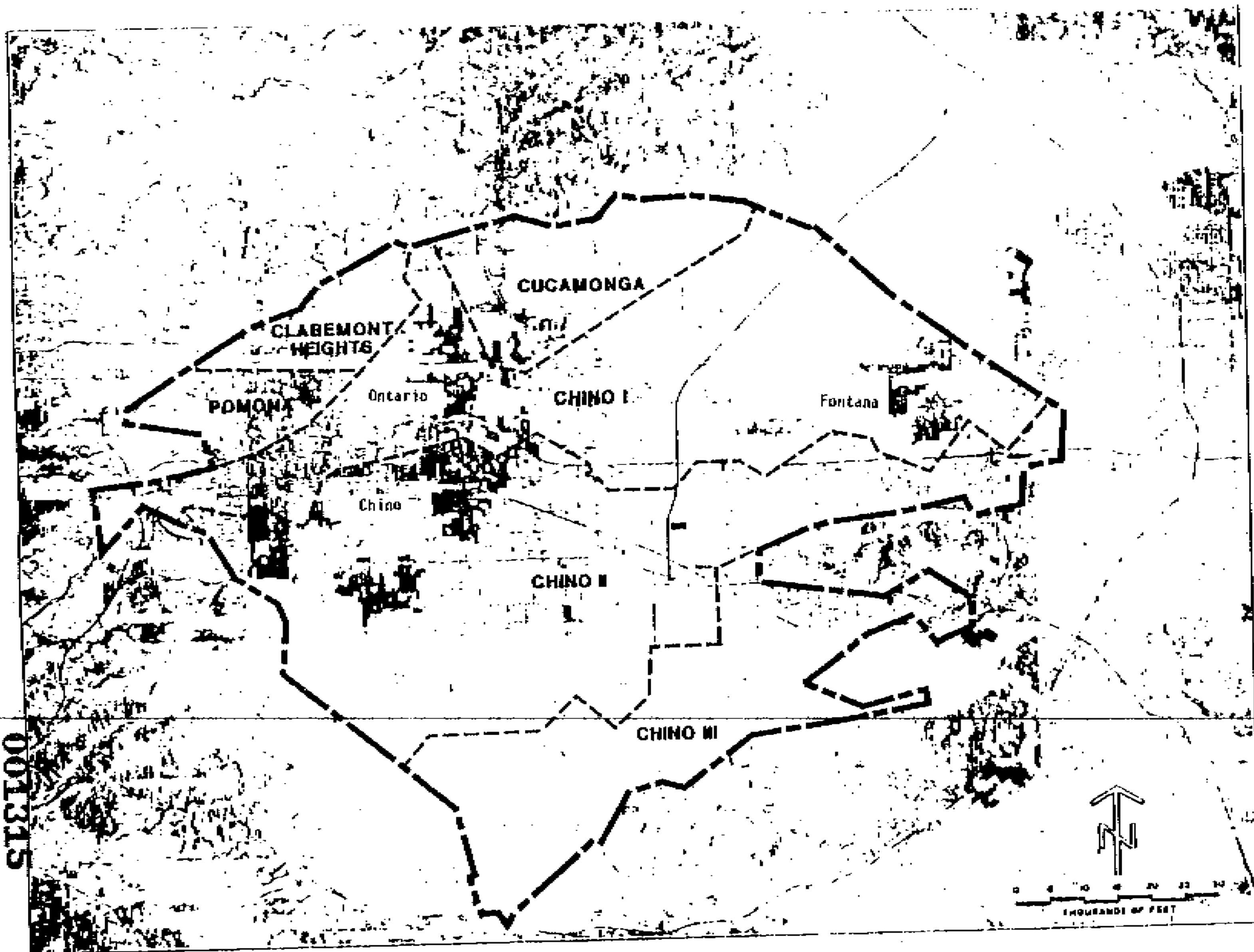

FIGURE I-1

CHINO BASIN
STORAGE PROGRAM AREA
AND GROUNDWATER BASIN
BOUNDARIES

SOURCE: MWD CHINO BASIN GROUNDWATER STORAGE PROGRAM EIR (1987)

LEGEND

PROGRAM AREA

BASIN/SUBBASIN BOUNDARY

Second, poor quality groundwater (and salts present in unsaturated soils overlying the groundwater aquifer) may adversely affect the implementation of a Groundwater Storage Program (Storage Program) proposed by the Metropolitan Water District of Southern California (MWD). Under this Storage Program, 300,000 to 700,000 acre-ft of high quality water from the State Water Project would be stored in the Chino Basin for use in emergency and drought conditions when imported water is either limited or not available. Such a program would be highly advantageous to water purveyors within the Region.

The third major concern is that poor groundwater quality in the Chino Basin adversely affects the quality of water in the Santa Ana River (River) and, ultimately, the quality of water supplied to Orange County residents. A brief explanation of this problem is warranted:

At the southern end of the Chino Basin, approximately 10,000 acre-ft/year of rising groundwater surfaces and enters the River just upstream of Prado Dam. It is estimated that this rising groundwater accounts for 5 to 10 percent of the River base flow, and it has the worst quality of any single input into the River (municipal sewage treatment plant effluents discharged to the River constitute 90 percent or more of the base flow, but are of better quality with respect to TDS and nitrate than rising groundwater). Recent findings from the watershed-wide nitrogen study (see discussion below) indicate that rising groundwater accounts for approximately

30% to 40% of the nitrate measured at Prado and about 50% of the TDS. As the quality of groundwater within the Chino Basin deteriorates, the quality of rising groundwater that enters the River will also continue to degrade. The River flows through Prado Dam and into Orange County, where it is captured by the Orange County Water District for recharge of the Orange County groundwater basin. The River flows constitute approximately 60 percent of the recharge to this basin, which is the primary source of drinking water in Orange County. Thus, poor quality groundwater in the Basin will ultimately have a significant impact on the quality of drinking water in Orange County.

The Regional Water Quality Control Board - Santa Ana Region (Board) and other agencies and parties have made intensive efforts to protect and enhance the quality of the River and, thereby, to protect the downstream municipal supply beneficial uses. The Board has established water quality objectives for TDS and nitrogen (and other constituents) for the River at Prado Dam. To ensure that these objectives are met, the Board has adopted wasteload allocations for both of these parameters. Each point source discharger to the River (i.e. sewage treatment plants) has been allocated a portion of the total nitrogen and TDS wasteloads to the River. These allocations are implemented through effluent limitations in discharge permits issued by the Board (nonpoint sources such as rising groundwater, are also taken into account in the allocation process). This regulatory program has contributed to an overall improvement in the TDS concentration in the River over time. However, monitoring data collected the last several years indicates the water quality objective for nitrogen (10 mg/l total nitrogen (filtered sample)) is now being exceeded. In response to these findings, a $1,000,000 watershed-wide nitrogen study is now in progress under the auspices of the Santa Ana Watershed Project Authority, Santa Ana River Dischargers Association, the Board, MWD and other local agencies. A primary objective of this study is to recommend measures which should be employed to ensure that the nitrogen objective for the River is met. This is likely to include a recommendation for a revised nitrogen wasteload allocation. The effectiveness of any measures which are implemented at sewage treatment plants may well be compromised by inputs of increasingly poor quality groundwater rising into the River from the Basin, unless corrective actions are taken.

B. Groundwater Quality Problems in the Chino Basin

A recent comprehensive evaluation of the quality of groundwater in the Chino Basin was performed by MWD in 1986 as part of an environmental impact report for MWD's proposed Storage Program. Through the initial feasibility study, Interim Environmental Study and Notice of Preparation process, several concerns regarding the proposed Storage Program were identified. These concerns included groundwater level changes in the Basin and groundwater quality changes in the Basin and the Santa Ana River. As a result, MWD examined historical water quality in the Basin and conducted an extensive sampling program. The data obtained were used in modeling efforts in which the water quality impacts associated with two alternative operational scenarios for the Storage Program were examined. An evaluation of the water quality impacts that would occur in the Chino Basin and the River without the Storage Program was also conducted as a third scenario. The Regional Board's groundwater quality and quantity models (known collectively as the Basin Planning Procedure or BPP) were used for these evaluations. Historically, the BPP has been calibrated only to examine TDS quality impacts. However, for MWD's work, modifications to the BPP were made so that water quality impacts with respect to nitrate could be investigated as well.

MWD found that groundwater quality becomes progressively worse as the groundwater moves south toward the River. Water recharging the groundwater in the Chino I subbasin, in the northern area of the Basin, has a TDS concentration of about 180-200 mg/l, and a nitrate concentration of about 2 mg/l. TDS and nitrate concentrations increase steadily in the direction of the River, reaching 1000+ mg/l of TDS and 200+ mg/l of nitrate in portions of Chino III (1986 data). MWD concluded that the distribution of TDS and nitrate concentrations in the Basin is consistent with waste water discharges associated with historical land uses, and that the increase in TDS and nitrate concentrations are the result of discharges of agricultural and municipal wastewater.

MWD's evaluation of historic TDS and nitrate quality in the Chino Basin confirmed previous findings that TDS and nitrate concentrations have been increasing in the Basin. Their review of the TDS and nitrate concentrations in the Chino Basin since 1950 indicates an interesting but alarming trend.

In 1950, groundwater in Chino I had a TDS concentration of generally less than 200 mg/l, Chino II about 200-300+ mg/l and Chino III about 300-500+ mg/l (Figure I-2). By 1986, groundwater quality had significantly worsened (Figure I-3). MWD determined that TDS concentrations in pumped groundwater in 1986 were 240 mg/l in Chino I, 333 mg/l in Chino II and 709 mg/l in Chino III. MWD also projected the future TDS and nitrate quality of the Chino Basin using baseline conditions without the Storage Program. The MWD runs for TDS for the year 2000 showed that while the TDS quality of Chino I and Chino II did not significantly change, the TDS quality of pumped water from Chino III rose to 753 mg/l. Projections for the year 2045 showed that the TDS quality in pumped water from the Chino Basin rose to 249 mg/l in Chino I, 408 mg/l in Chino II, and 995 mg/l in Chino III. TDS concentrations in portions of Chino II were shown to be as high as 1000 mg/l, and in Chino III as high as 1600 mg/l (Figure I-4). This information is summarized in Table I-1.

The same water quality trend between 1950 and 2045 is even more evident for nitrate. In 1950, the entire Basin exhibited nitrate concentrations less than 20 mg/l, with much of the Basin less than 10 mg/l. An exception was a small area of groundwater in the southern-central area of Chino II which was about 50 mg/l, exceeding the drinking water standard of 45 mg/l (Figure I-5). Between 1950 and 1986, nitrate concentrations steadily increased, and the area exceeding 45 mg/l gradually enlarged. As with TDS, sampling in 1986 showed dramatic increases in nitrate concentrations, especially in the southern part of Chino II and the northern part of Chino III (Figure I-6). Not surprisingly, these groundwater areas underlie or are down gradient from the dairy area. MWD determined that the average nitrate concentration in pumped groundwater from the Basin in 1986 was 23 mg/l in Chino I, 40 mg/l in Chino II, and 63 mg/l in Chino III. Projections for the year 2000 did not show a significant change in nitrate concentrations in Chino I, but nitrate concentrations in Chino II rose to 49 mg/l and to 98 mg/l in Chino III. Projections for the year 2045 showed that nitrate concentrations in pumped groundwater were 25 mg/l in Chino I, 85 mg/l in Chino II, and 211 mg/l in Chino III. Almost the entire southern half of the Basin was found to exceed the drinking water standard of 45 mg/l (Figure I-7). This information is summarized in Table I-2.

TABLE I-1

PUMPED TDS CONCENTRATION
PROJECTIONS BY SUBBASIN (mg/L)

	YEAR			
Subbasin	1950	1986	2000[1]	2045[1]
Chino I	200	240	239	249
Chino II	200-300	333	343	408
Chino III	300-500	709	753	995

1. Model results without the Storage Program.

SOURCE: MWD Chino Basin Groundwater Storage Program EIR (1987)

TABLE I-2

PUMPED NITRATE CONCENTRATIONS
PROJECTIONS BY SUBBASIN (mg/L)

	YEAR			
Subbasin	1950	1986	2000[2]	2045[2]
Chino I	10	23	22	25
Chino II	15	40	49	85
Chino III	15	63	98	211

2. Model results without the Storage Program.

SOURCE: MWD Chino Basin Groundwater Storage Program EIR (1987)

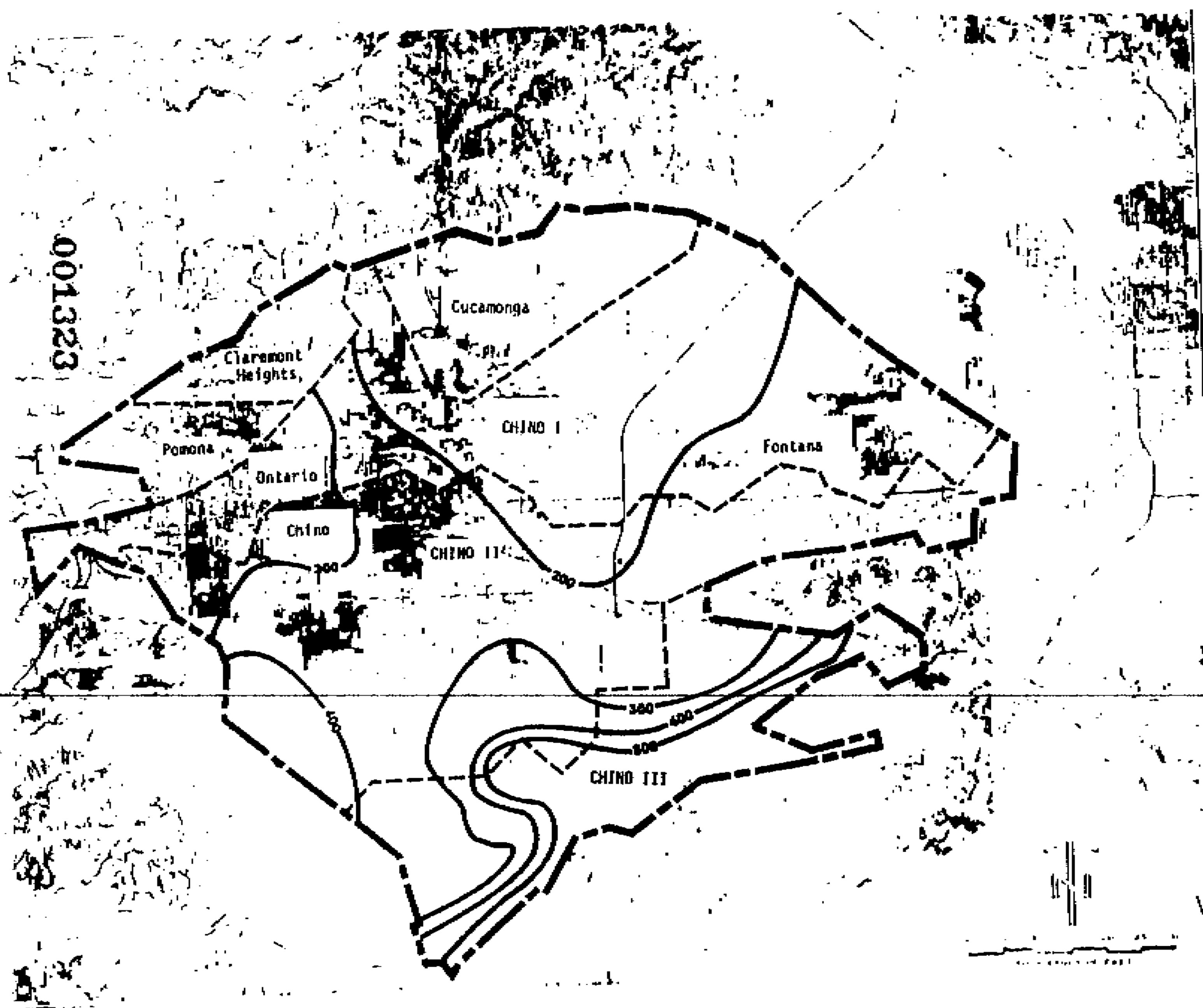

FIGURE I-2

YEAR 1960
TOTAL DISSOLVED SOLIDS
CONCENTRATION IN PUMPED
GROUNDWATER

SOURCE: MWD CHINO BASIN GROUNDWATER STORAGE PROGRAM EIR (1987)

LEGEND

400 CONTOUR OF EQUAL CONCENTRATION (mg/L)
SOURCE: WRE, 1970b

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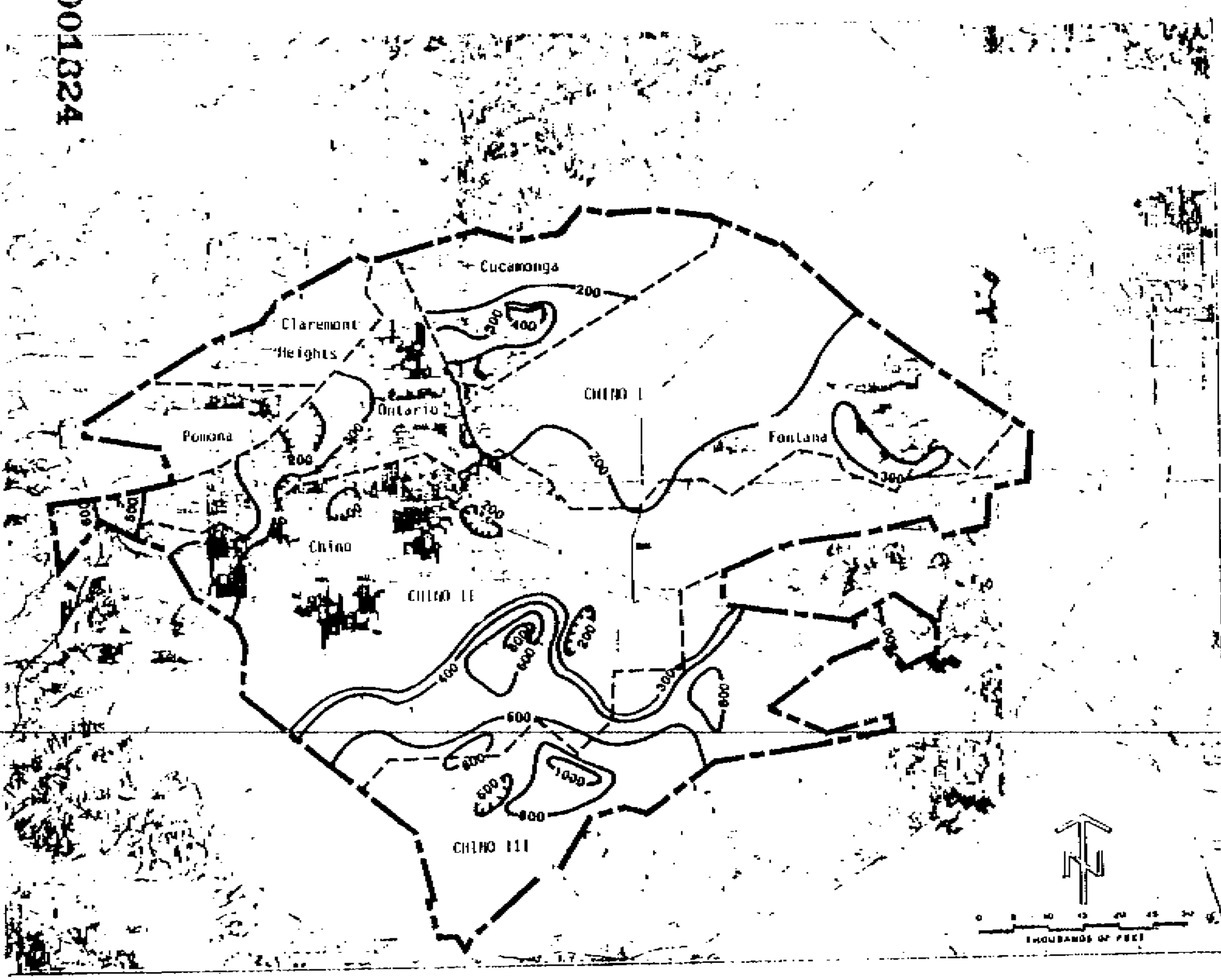

FIGURE I-3

YEAR 1986
TOTAL DISSOLVED SOLIDS
CONCENTRATION IN PUMPED
GROUNDWATER

SOURCE: MWD CHINO BASIN GROUNDWATER STORAGE PROGRAM EIR (1987)

LEGEND

400 CONTOUR OF EQUAL CONCENTRATION (mg/L)

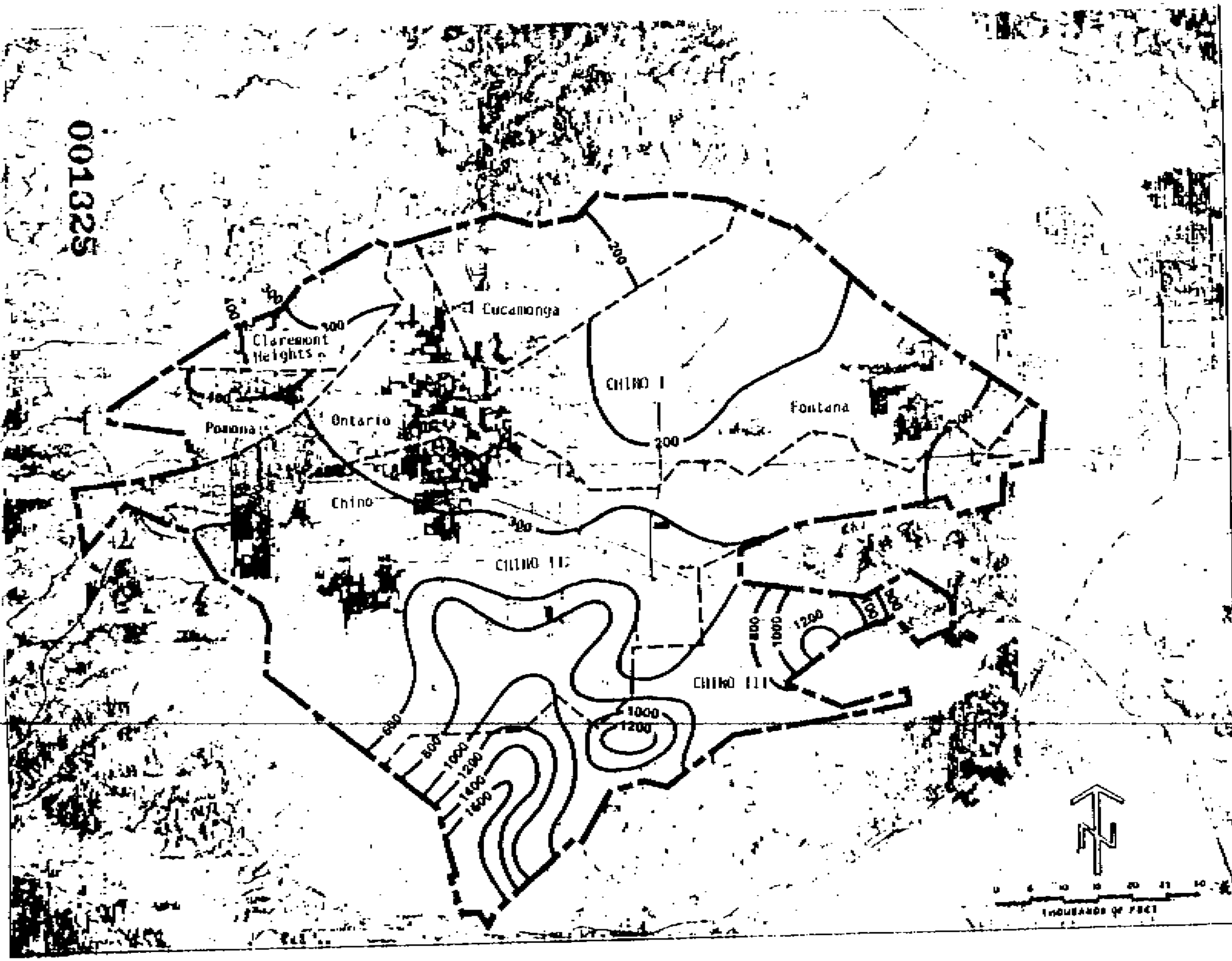

FIGURE I-4

YEAR 2045
TOTAL DISSOLVED SOLIDS
CONCENTRATION WITHOUT
STORAGE PROGRAM

SOURCE: MWD CHINO BASIN GROUNDWATER STORAGE PROGRAM EIR (1987)

LEGEND

400 CONTOUR OF EQUAL CONCENTRATION (mg/L)

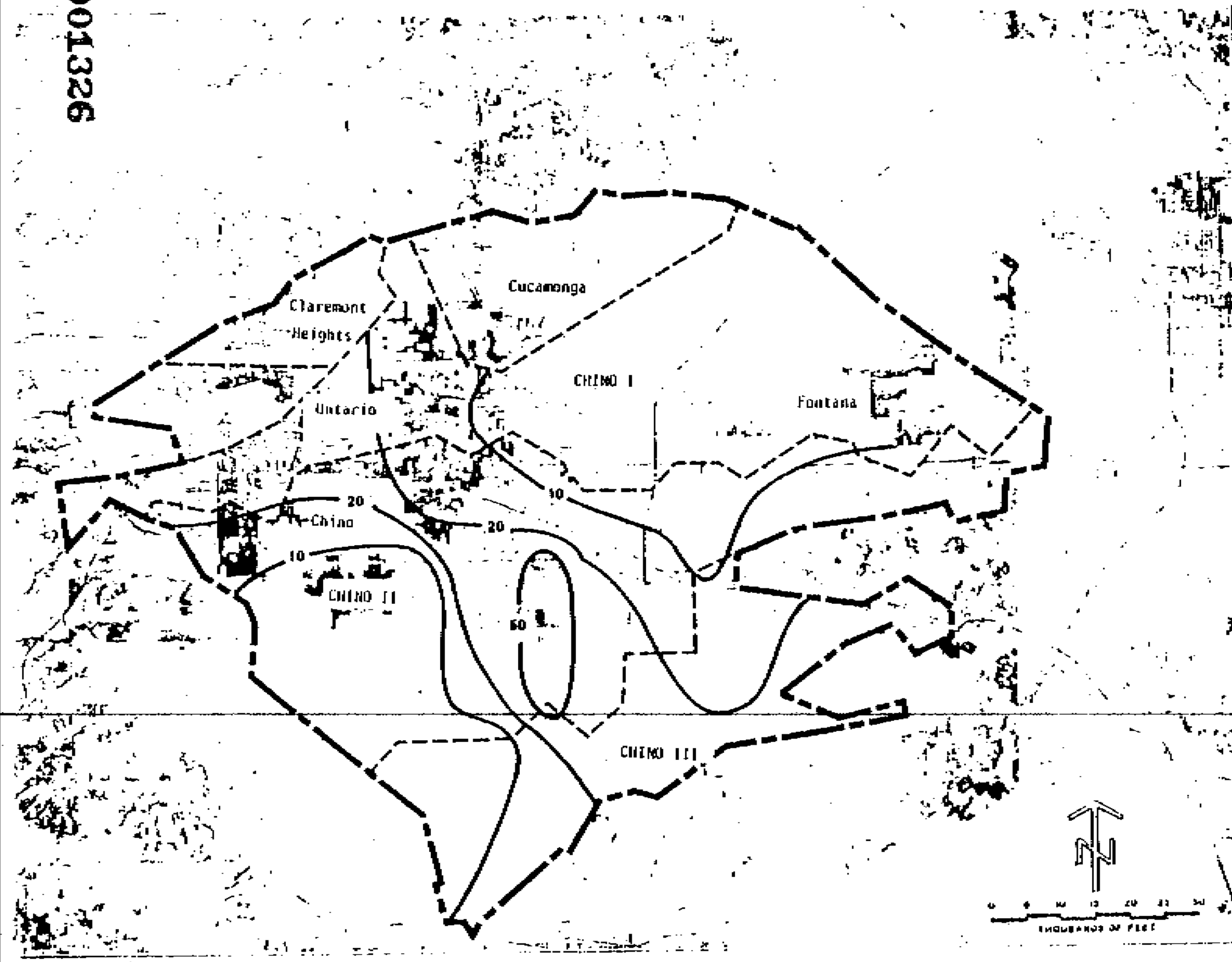

FIGURE I-5

YEAR 1950
NITRATE CONCENTRATION IN
PUMPED GROUNDWATER

SOURCE: MWD CHINO BASIN GROUNDWATER STORAGE PROGRAM EIR (1987)

LEGEND

50 — CONTOURS OF EQUAL CONCENTRATION (mg/L)

■ NITRATE CONCENTRATION EXCEEDING DRINKING WATER STANDARD OF 45 mg/L

SOURCE: WRE, 1970b

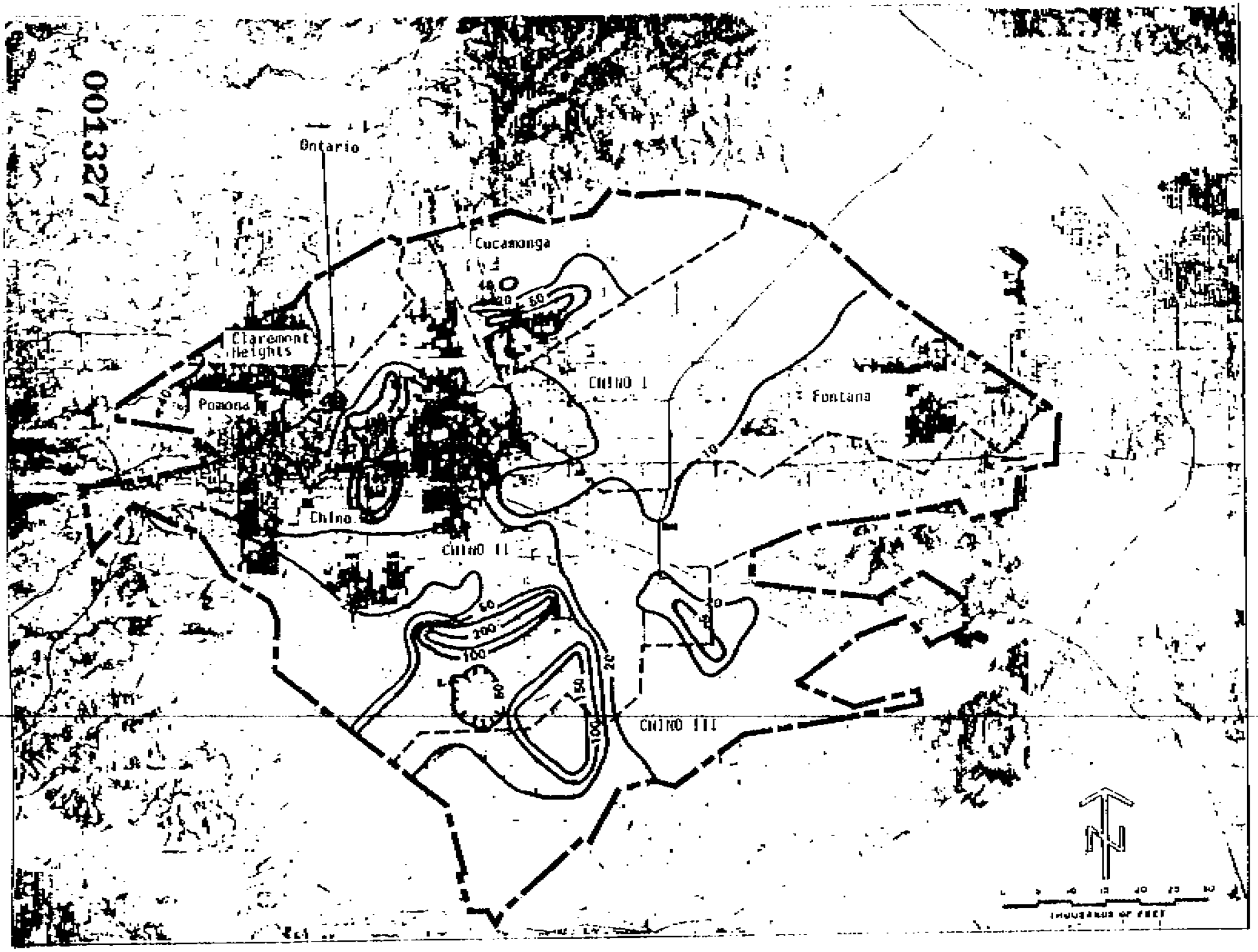

FIGURE 1-6

YEAR 1986
NITRATE CONCENTRATION IN
PUMPED GROUNDWATER

SOURCE: MWD CHINO BASIN GROUNDWATER STORAGE PROGRAM EIR (1987)

LEGEND

50 CONTOUR OF EQUAL CONCENTRATION (mg/L)

NITRATE CONCENTRATION EXCEEDING DRINKING WATER STANDARD OF 45 mg/L

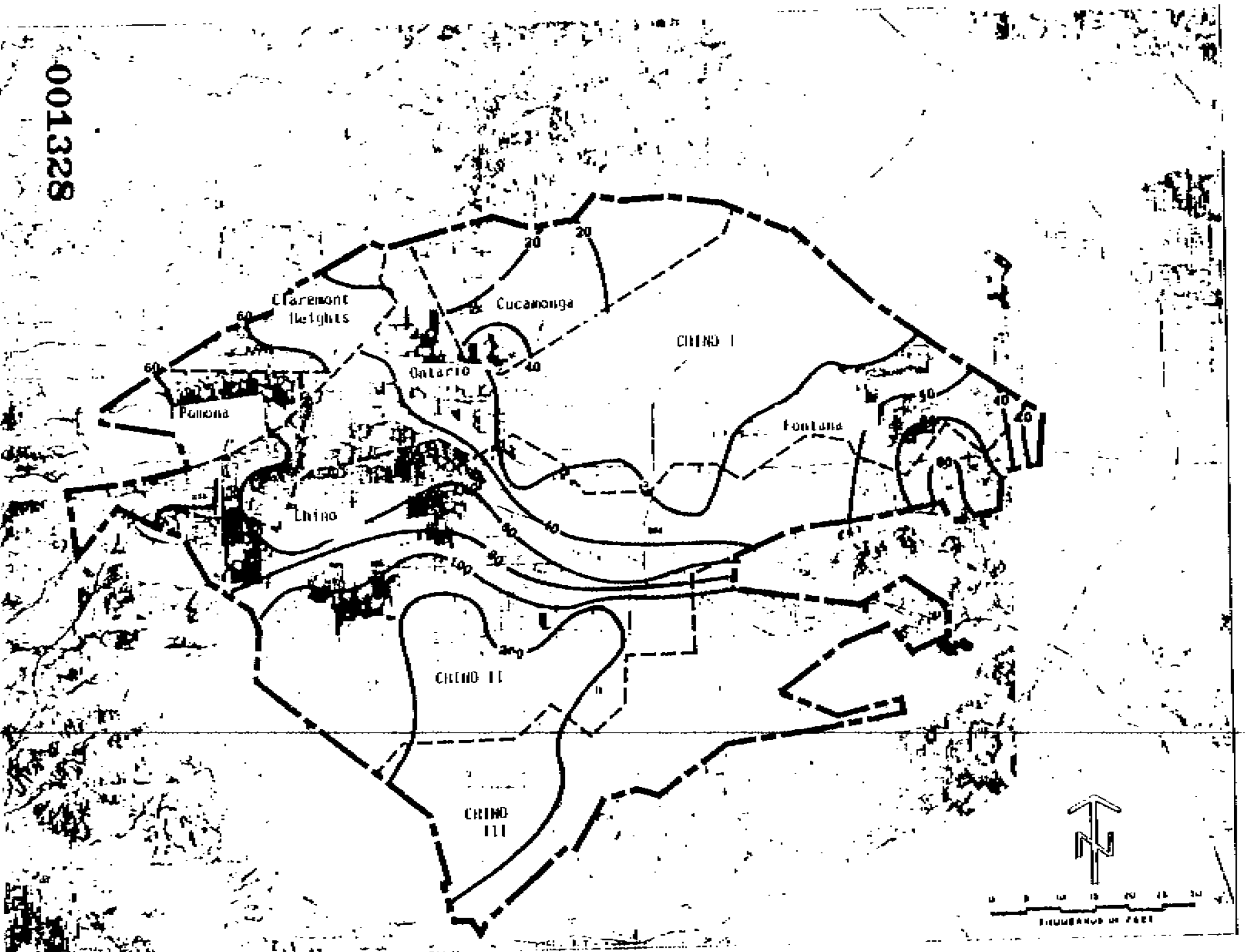

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FIGURE I-7

YEAR 2045
NITRATE CONCENTRATION
WITHOUT STORAGE PROGRAM

SOURCE: MWD CHINO BASIN GROUNDWATER STORAGE PROGRAM EIR

LEGEND

50 — CONTOUR OF EQUAL CONCENTRATION (mg/L)

NITRATE CONCENTRATION EXCEEDING DRINKING WATER STANDARD OF 45 mg/L

These model evaluations provide valuable information with respect to surface water quality in the Santa Ana River as well as groundwater quality in the Chino Basin. The model runs indicate that the nitrogen concentrations in the Santa Ana River will increase from 9 mg/l (1985) to about 22 mg/l of nitrogen (NO_3-N) (99 mg/l as nitrate) by the year 2000, far exceeding the water quality objective for total nitrogen of 10 mg/l. Poor quality groundwater rising into the River from the Chino Basin is a significant contributor to this problem; as noted earlier, recent sampling in the River (1988) as part of the watershed-wide nitrogen study showed that rising groundwater accounted for about 30% to 40% of the nitrate measured at Prado.

The findings of other BPP work which has been conducted over the years are consistent with MWD's results. Model runs executed in conjunction with the development and update of the 1975 and 1983 Basin Plans projected continued deterioration of groundwater quality in the Chino Basin over time. The Regional Board and SAWPA are currently coming to the end of a three year Basin Plan update study (1987-1990). A baseline BPP run was performed at the outset of the study (a baseline run is an extension into the future of present water/wastewater management conditions; the results of this run form the basis for developing and evaluating alternative water and wastewater management strategies); the results again project water quality degradation in the Chino Basin. The baseline run shows that TDS quality in the Chino II groundwater subbasin will increase from 347 mg/l to 387 mg/l by the year 2015, about a 12% increase (Figure I-8). TDS in the Chino III subbasin is projected to increase from about 700 mg/l to 915 mg/l (31% increase) (Figure I-9). Alternative strategies to address this problem have been evaluated in the course of both prior and current Basin Plan update work. The results of some of these alternative analyses will be described later in this section.

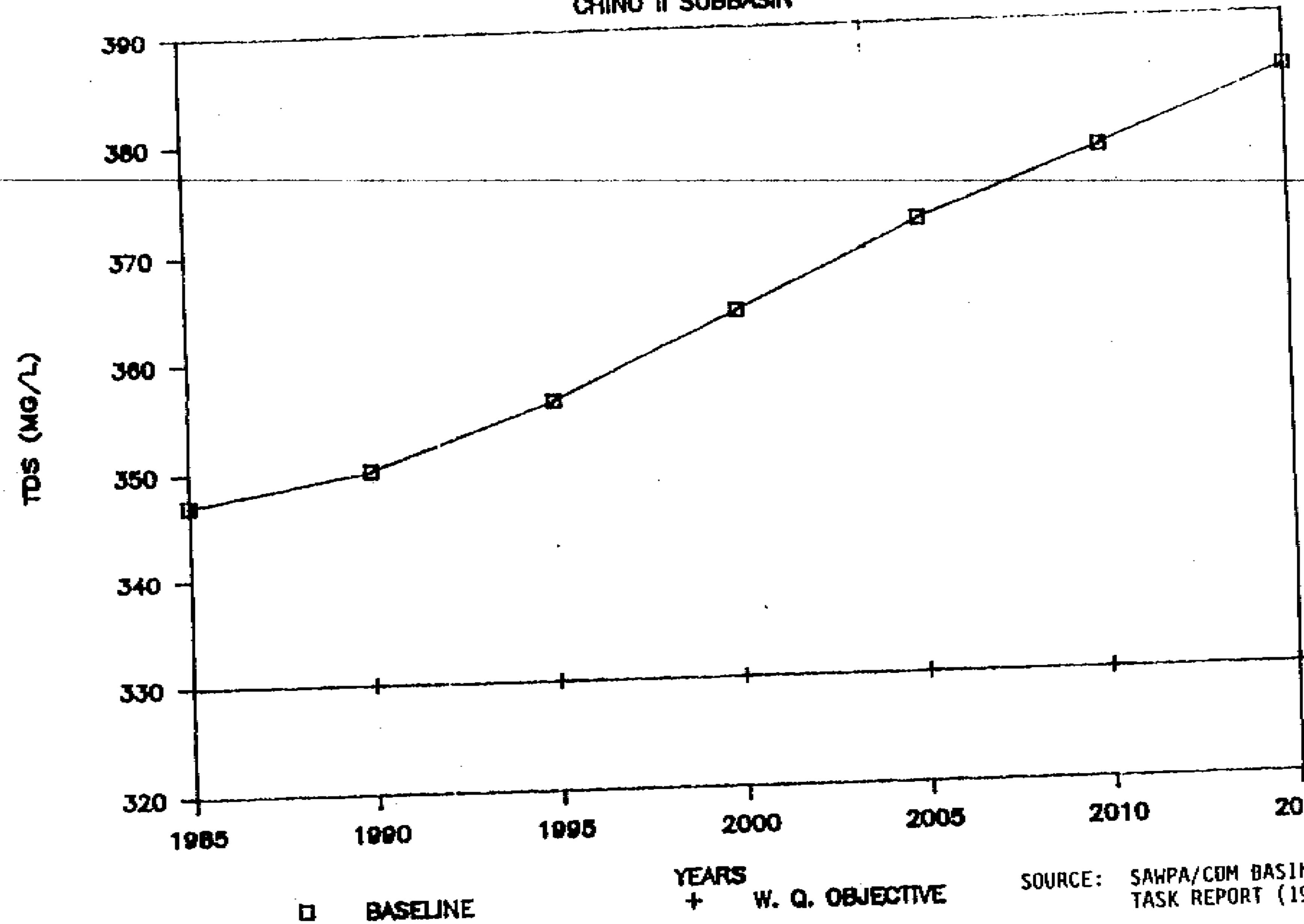
It should be noted that the Chino Basin Watermaster has recently completed the first year's sampling of a comprehensive monitoring network which includes 198 wells. Of these 198 wells, 67 were selected primarily to cover the agricultural area south of the Pomona Freeway. The data obtained from this sampling effort support the BPP projections. The data show high nitrate and TDS concentrations in shallow wells in many areas of the Basin. Some deep wells also show elevated nitrate and TDS concentrations. This poor quality groundwater (and additional salts now in transient in the unsaturated zone) will, sooner or later, adversely affect the groundwater basin as a whole, as indicated by the BPP.

Before moving to a discussion of the possible sources of this severe water quality problem, a final note with respect to the BPP work conducted to date is appropriate. As was stated previously, historically, the BPP was calibrated only for TDS; Basin Plan update model work through 1988 focused solely on TDS water quality projection. To explore the various potential water quality impacts of implementation of their proposed Storage Program, MWD had modifications made to the BPP such that nitrate impacts in the Chino Basin specifically could be examined as well. More recently, the BPP was actually calibrated for nitrate (and TDS) so that impacts can be explored throughout the Upper Santa Ana and San Jacinto Basins. This work was conducted as part of the watershed-wide nitrogen study. The revised BPP provides more reliable projections of nitrate quality than MWD's work (since the BPP was calibrated for nitrogen) and will substantially enhance the Region's planning capabilities.

FIGURE I-8

GROUND WATER QUALITY

CHINO II SUBBASIN



SOURCE: SAWPA/CDM BASIN PLAN UP: TASK REPORT (1989)

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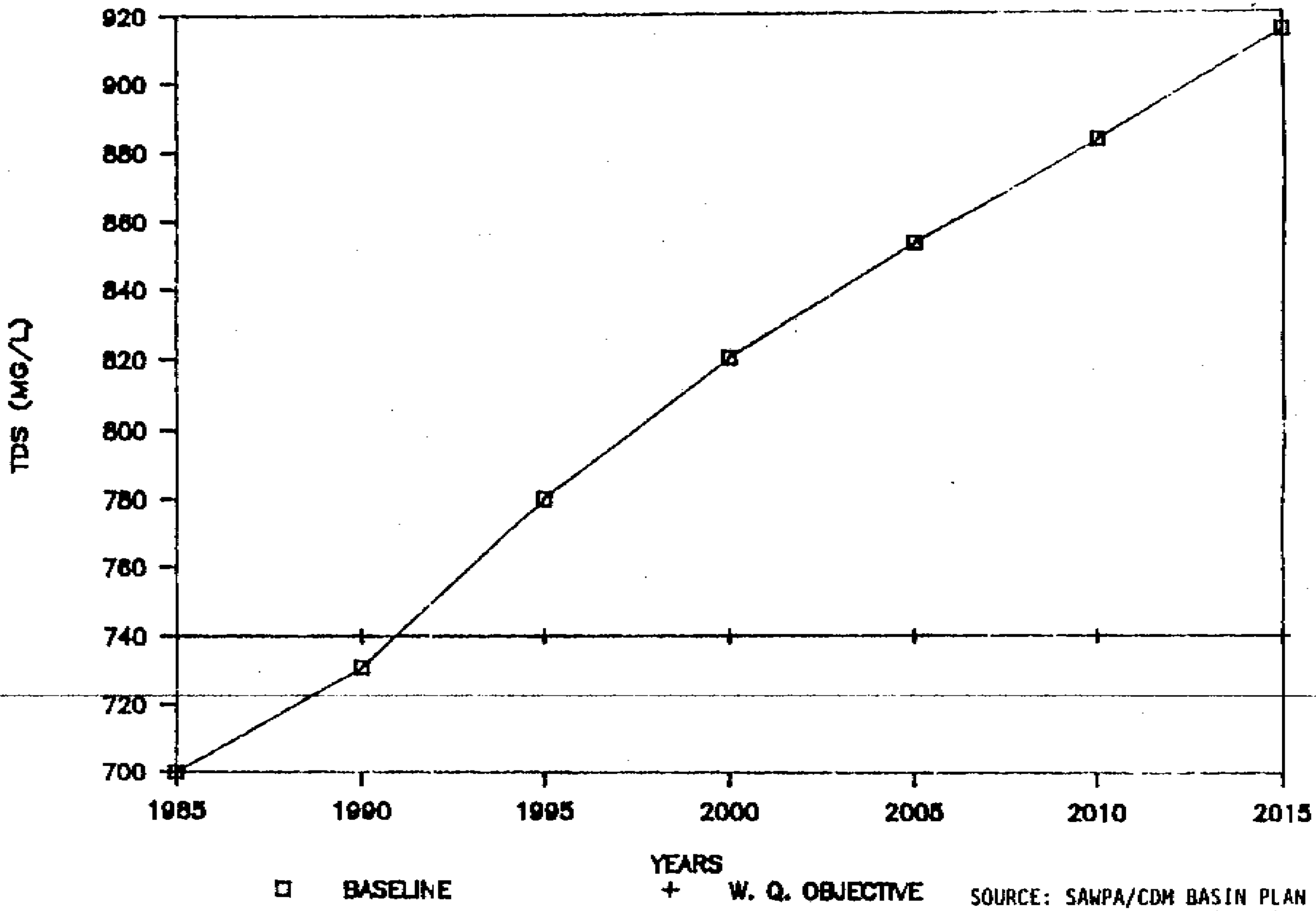
FIGURE I-9

GROUND WATER QUALITY

CHINO III SUBBASIN



SOURCE: SAWPA/CDM BASIN PLAN UPDATE TASK REPORT (1989)

C. Sources of Groundwater Degradation in the Basin

As noted earlier, the sources of groundwater degradation in the Basin include agricultural and municipal waste waters; the areas exhibiting the worst degradation reflect these historical land uses. But while irrigated agriculture and municipal wastewater disposal are certainly contributors to the degradation, it is evident that dairy wastes play an overwhelmingly significant role in waste loads discharged to the Basin. As early as the 1970's, it was well recognized that the application of dairy manure and dairy washwater was threatening underlying groundwater quality (Adriano et al., 1971; Pratt et al., 1972; Pratt et al., 1976a; Pratt et al., 1976b). These studies documented high concentrations of nitrate and salt within the soil profile underneath dairies within the Basin dairy area (Adriano et al., 1971; Chang et al., 1973).

The relative significance of dairies as contributors to the groundwater quality problem is evident if one compares the salt loads which result from these operations to those from other types of land use. These comparisons can be made using data from the BPP. A detailed discussion of the BPP is not possible or appropriate here. Suffice it to say that a critical first step in the model operations is the calculation of the salt waste loads which result from various land uses. The model performs these calculations by multiplying land use acreages in various categories (e.g., dairies, irrigated agriculture, etc.) by salt loading factors (unit factors) which are specific to each type of land use. (A more detailed discussion of this computational step is provided in Appendix A). These salt load data are then entered into the quality model portion of the BPP and projections of ground (and surface) water quality can be made over time.

Staff took two comparative approaches, both using BPP salt input data, to investigate the relative significance of dairies as salt contributors. One analysis was conducted using data from the 1983 Basin Plan update BPP runs. For the second analysis, data from the recent calibration of the BPP was utilized. Each of these analyses is discussed below.

In the first approach, staff analyzed BPP data used in the 1983 Basin Plan update BPP runs. The salt loads to groundwater which were calculated for the year 1990 for the Chino Basin dairy area (which included about 19,300 acres of agricultural land and about 1,900 acres of residential-commercial-industrial land[1]) are shown in Table I-3. Note that agricultural land use accounts for about 97% of the salt load added to groundwater.

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[1]The 1983 model runs show the Chino dairy area to be contained in two Water Supply Agency areas (these are artificial agencies used for modeling purposes). These agencies are No. 371 (called the "West of Corona City") and No. 381 ("South of Ontario"). The "agency" boundaries are depicted in Appendix C.

To determine the amount of salt added to the groundwater by dairy operations in the Chino dairy area relative to other agricultural land uses, staff made changes to the model input and portions of the model were rerun. Specifically, the dairy salt unit factor was set to zero (from 2.4 tons salt/acre/year), while the other unit factors were left unchanged. The results show that about 88% of the agricultural salt load within the dairy area is due to dairy operations (Table I-4).

Under the second approach, staff analyzed data on historical salt contributions to the Chino Basin by various types of land use, including dairy operations. Data used in the recent BPP calibration indicate that significant dairy land use within the Chino Basin began about 1958 and has increased steadily since that time. Data on salt added to the Basin by dairies and other land uses since 1958 are presented in Table I-5. This data represents salts that are added to water as a result of use and that will reach groundwater. Salt additions as a result of consumptive use (concentration of salts as a result of evaporation and/or transpiration) are not included. Note that this table includes data for land uses in the Chino I, II and III groundwater subbasins), as well as land uses in the Cucamonga subbasin area (this area is much larger than that considered in the first analysis described above (the Chino Basin dairy area)).

TABLE I-3

Salts Added to the Ground Water for Projected Year 1990

Land Use	Wastewater Returns AF/Y	Salt Added Tons/Year
Residential/Commercial	778	697
Agricultural	20,013	22,725
Industrial	43	17
		23,439

TABLE I-4

AGRICULTURAL WASTE LOADS
Salt Added to Groundwater (Tons/Acre/Year)

Total Dissolved Solids (mg/l) for year 1990

Original Waste Load	Revised Waste Load
airy Waste Load = 2.4 T/A/Y	Dairy Waste Load = 0.0 T/A/Y[1]
22,725	2,756

ltural wasteload with dairies: 22,725 T/A/Y

ltural wasteload w/out dairies: 2,756 T/A/Y

ricultural wasteload due to dairies:

22,725 - 2,756 = 19,969

19,969/22,725 x 100 = 88%

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y agricultural salt unit factors assumed for "dairy

TABLE I-5

CHINO BASIN[1]

SALT ADDED: (1958 - 1986)

(SALT ADDED (TDS)[2])

	Land Use	Tons of Salt[4]	% of Total	Adjusted Tons of Salt	Adjusted % of Total[3]
1.	Non - Irrigated field crops	14,033	2	0	0
2.	Irrigated field crops	152,803	19	94,738	12
3.	Citrus	38,532	5	38,532	5
4.	Irrigated Vineyards	54,714	6	54,714	6
5.	Non - Irrigated Vineyards	27	0	27	0
6.	Dairy	416,778	51	488,876	60
7.	Urban Outside	139,942	17	139,942	17
8.	Special Impervious	0	0	0	0
9.	Native Vegetation	0	0	0	0
	Total:	816,829(tons)	100%	816,829(tons)	100%

1. Chino I, II, III and Cucamonga subbasins.
2. "Salt added" is salt (Total Dissolved Solids) that is added to water as a result of use and that will reach groundwater. This does not include consumptive use additions (concentration of salts as a result of evaporation and/or transpiration).
3. Total area receiving dairy waste loads:

Land Use 6 (Dairy)	7,070 acres	416,778 Tons
Land Use 1 (Non Irrigated Field Crops)	2,440 acres	14,033 Tons
38% of Land Use 2 (Irrigated Crops)	5,490 acres	58,065 Tons
Total:	15,000 acres	488,876 Tons

4. Salt accumulated as of 1986 minus salt accumulated as of 1958. Data provided by J.M. Montgomery, Inc. (4-12-90) from BPP TDS/NO_3 calibration.

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Table I-5 shows the tons of salt added to the Basin by each of nine (9) different land use types, and the percentage of the total salt load contributed by each of these uses. It can be seen that dairy land use (#6) appears to account for 51% of the salt added to the Basin between 1958 - 1986. Adjusted data on salt load additions and the percentage contributions by each land use type are also shown in this Table. These adjustments are necessary because of a problem with the way dairy acreage is accounted for in the BPP. In the BPP, dairy acreage is considered to include only those areas occupied by dairy animals; the BPP does not accurately reflect the total acreage affected by dairy waste disposal practices (e.g. cropland). To account for this, the salt loads associated with non-irrigated field crop acreage (land use #1) and a portion (38%) of irrigated crop acreage (land use #2) where dairy wastes are presumed to be applied were added to the dairy (land use #6) figure (see footnote #3 on Table I-5). When the data are adjusted in this way dairy land use accounts for 60% of the total salt added to Chino Basin groundwater from 1958 to 1986. [Note that this percentage differs from the 88% figure previously presented for dairy salt contributions; this difference is due to size of the area considered in each analysis (Chino Basin versus only the Chino Basin dairy area).]

Another method of demonstrating the relative significance of dairy salt loads was also employed in the preparation of this report. A special BPP model run was performed for the Board by James M.

Montgomery Engineers, Inc., using the newly calibrated model. This run was conducted to determine what the groundwater quality conditions in the Chino Basin would be if the dairies were not in operation in the Basin and the land was used instead for other types of agriculture. This simulation was performed by assuming that the dairy land use in the model was replaced by irrigated agriculture[1]. The model run was conducted for the period 1990-2015[2], and the results were compared to the so-called baseline run for the same period. The baseline run was conducted as part of the ongoing watershed-wide nitrogen study and assumes the present pattern of dairy land use.

The differences between the special model run, without the dairy waste load, and the baseline run at the end of the 25 year planning period (2015) are shown in Tables I-6 (a) and (b) and I-7 (a) and (b). Table I-6 (a) and (b) show the decrease in concentrations of TDS and nitrate, respectively, which result from the removal of

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[2]To perform this simulation, the TDS and nitrate loading unit factors utilized in the model for dairy land use were replaced with the unit factors for irrigated field crops. (Irrigated field crop salt unit factors are lower than those for dairies). (Salt loading unit factors and their application in the BPP are described in detail in Section III and Appendix A).

[3]To make water quality projections beyond the year 1990 based on this revised land use scenario, it was first necessary to establish the groundwater quality conditions (initial conditions) that would have existed in the Basin in 1990 had dairies never been in operation in the Basin. This was done by running the calibration model, which utilizes data for the period 1960 - 1986 (substantial dairy land use began in the Basin about 1958), with the same changes to the unit factors described in footnote 2, above.

the dairy operations. These concentration decreases apply to pumped water quality (or available water). The amount of available water in storage that is affected by the concentration decrease is shown in the tables. When the concentration data is considered together with the volume of water affected, it is evident that the dairies have a significant effect on the quality of groundwaters, particularly in the Chino II and III subbasins.

Tables I-7 (a) and (b) show the decrease in the mass of TDS and nitrates in the Chino Basin which result from the removal of dairy operations. The change in TDS and nitrate mass observed applies to the total water in storage (also shown in the tables). It is evident from this data also that dairy operations have a significant impact on Chino Basin water quality.

TABLE I-6(a)

Difference in Total Dissolved Solids Concentration Between Baseline and "Without-Dairy", Model Runs After 25 years of Simulation (Year 2015).

Subbasin	Total Dissolved Solids Concentration Decrease (mg/l)	Volume Available Water (AF)
Chino I	2	3.8 million
Chino II	32	4.6 million
Chino III	45	1.3 million

TABLE I-6(b)

Difference in Nitrate Concentration Between Baseline and "Without-Dairy", Model Runs After 25 Years of Simulation (Year 2015).

Subbasin	Nitrate Concentration Decrease (mg/l)	Volume Available Water (AF)
Chino I	2	3.8 million
Chino II	8	4.6 million
Chino III	12	1.3 million

TABLE I-7(a)

Difference in Total Dissolved Solids Mass Between Baseline and "Without-Dairy", Model Runs After 25 Years of Simulation (Year 2015).

Subbasin	Total Dissolved Solids Mass Decrease (tons)	Volume Available Water (AF)
Chino I	30,069	20.7 million
Chino II	382,976	18.8 million
Chino III	193,195	3.2 million

TABLE I-7(b)

Difference in Nitrate Mass Between Baseline and "Without-Dairy", Model Runs After 25 Years of Simulation (Year 2015).

Subbasin	Nitrate Mass Decrease (mg/l)	Volume Available Water (AF)
Chino I	21,561	20.7 million
Chino II	103,607	18.8 million
Chino III	43,118	3.2 million

Table I-8 provides a summary of pertinent data with respect to the Chino Basin dairy area. It is generally accepted that dairies in the Chino Basin represent the largest concentration of dairies in the world. Data compiled from the 1988 Annual Reports submitted to the Board by the dairy operators show that, within an area of about 15,000 acres (Figure I-10), there are approximately 300 dairies in the Basin which contain about 289,600 animals. These animals produce about 460,000 tons (dry weight)/year of manure, of which about 246,578 tons appears to be discharged ultimately within the Chino Basin. (As will be discussed elsewhere in this report, there is no definitive information on the fate of most of the manure generated in the Chino Basin). The total manure generated in the Chino Basin correlates to 132,020 tons/year of salt per year, of which 14,720 tons is nitrogen (as N)(Webb, 1974). On the order of 70,768 tons of salt appear to remain in the Chino Basin each year, of which about 27,631 tons reaches groundwater (see Appendix B).

TABLE I-8

CHINO BASIN DAIRY DATA SHEET[1]

NUMBER OF DAIRIES IN THE CHINO BASIN IS APPROXIMATELY 300

NUMBER OF ANIMALS IN THE CHINO BASIN DAIRY AREA

Milking Cows	166,900
Dry Cows	33,300
Heifers	39,400
Calves	50,000
Total:	289,600

MANURE DISTRIBUTION IN THE CHINO AREA 1988

Total corral manure production	460,000 Tons
Amount of manure reported spread on disposal land	11,100 Tons
Amount of manure stockpiled	16,500 Tons
Amount of manure spread on croplands associated with dairies	45,500 Tons
Amount of manure reported hauled away	387,200 Tons
Amount of manure received by composters	70,355 Tons
Amount of manure hauled by others	316,845 Tons
Amount of manure hauled out of the Chino Basin by others (assumed 1/2 of the above)	158,422 Tons
Amount of manure reported by composters to be hauled out of the Chino Basin	55,000 Tons
Amount of manure remaining within the Chino Basin	**246,578 Tons**
Resulting amount of Salt (TDS) being discharged within the Chino Basin	**70,768 Tons**
Amount of Salt (TDS) reaching Chino Basin ground water (applied over 15,000 acres) (see Appendix B)	**27,631 Tons**

[1]Data compiled from 1988 Dairy Annual Report

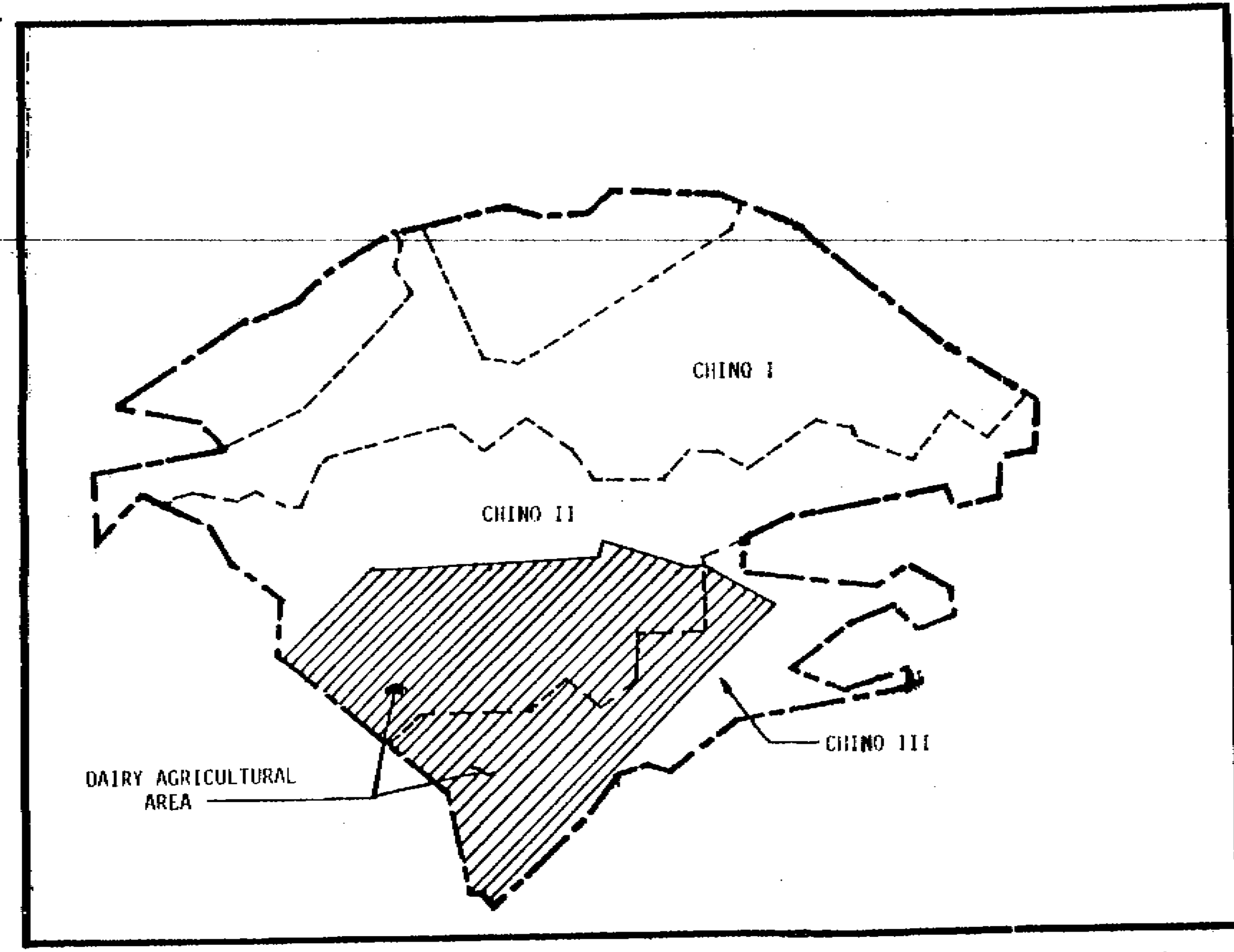

FIGURE I-10

CHINO BASIN
STORAGE PROGRAM AR
AND GROUNDWATER BA
BOUNDARIES

DAIRY AGRICULTUR/
AREA

LEGEND

PROGRAM AREA

BASIN/SUBBASIN BOUNDARY

001346

D. BPP - Alternative Analysis

The results of all model simulations described earlier, whether from the Regional Board's Basin Planning efforts or through the work of other agencies such as MWD, indicate similar conclusions. Excessively large salt loads have been entering the ground as a result of waste discharges from dairies. These salt loads, with their high nitrate concentrations, appear to have impacted and certainly will continue to impact groundwater in the Chino Basin and, ultimately, surface water quality in the Santa Ana River. In order to prevent, or at least minimize, this water quality degradation, it is clear that measures must be considered to reduce the dairy waste loads (TDS and nitrate), as well as methods that could be employed to remove salts already present in the groundwater. Such alternatives were considered in the 1975 and 1983 Basin Plan update work. Alternatives are also being considered as part of the current Basin Plan review. The alternatives that are now being evaluated with the BPP include a reduction in the dairy salt waste load (which might be accomplished through additional manure removal and/or washwater removal (see Section III of this report)) and the removal of salts now in the groundwater through the operation of desalting facilities in the Chino II and Chino III subbasins. Unfortunately, these alternative runs include other assumed water/wastewater management strategies (e.g., increased reclamation in specific areas of Chino Basin) which complicate the interpretation of the model results. That is, it is not possible to distinguish the water quality impacts of the measures described above from those of other components of the alternative run. Ideally, additional, more specific model runs will be conducted if resource constraints will allow it. Nonetheless, it is clear from the alternative analysis that has been conducted that, irrespective of any other measures which might be implemented to address water quality problems in the Chino Basin, the construction and operation of desalters will be absolutely essential. Perhaps the most significant effect of these desalters will be to retard the movement of poor quality groundwater into the Santa Ana River. The Santa Ana Watershed Project Authority is already pursuing the implementation of these facilities. Experience with desalting operations elsewhere in the Region (the Arlington desalter) and recent desalter feasibility studies indicate that the cost of these desalters will be on the order of <u>$320 - $690 for every ton of salt removed</u>.

E. Other Considerations

<u>Groundwater Quality Data:</u>

There is another important consideration with respect to the BPP projections discussed above which warrants separate attention. This pertains to the water quality data used for input into the BPP.

The data on which the modeling projections are based were derived from available sampling results from a limited number of wells within the Chino Basin. Although this information is sufficient to conclude that significant degradation is occurring in the Chino Basin, a clearer understanding of the extent and nature of this degradation is needed for future planning and mitigation activities. Some of the best available information was obtained in 1986 when MWD sampled 148 wells in the Chino Basin. However, there are currently over 500 wells in the Chino Basin, and existing groundwater data is limited to only a portion of these wells with many years separating sampling events.

In recognition of the need to obtain data from more wells on a more frequent basis, several agencies are expending resources to obtain more reliable groundwater data in the Chino Basin. The Santa Ana Watershed Project Authority has contracted with a consultant to determine where data gaps exist in the Chino Basin; the Chino Basin Watermaster has expedited efforts to improve its sampling program, and MWD will be developing a monitoring program with local agencies in the event MWD proceeds with its proposed Storage Program.

Throughout the Santa Ana Region, the Regional Board requires waste dischargers to monitor the quality of their discharges and the quality of the receiving water body. However, this has not been the case with dairies, all of which are operating under waste discharge requirements. In order to remedy this situation, Regional Board staff contacted the Milk Producers Council and the California Milk Producers in early 1989, and requested their assistance in developing a groundwater monitoring program for dairies within the Santa Ana Region. The Regional Board could amend waste discharge requirements to include a monitoring program for each dairy, resulting in the need for each dairy to sample existing wells or to install monitoring wells on their property to assess the impacts their waste discharges are having on the underlying groundwater. However, this may be more extensive than what is actually necessary, and Regional Board staff believed that a more limited, efficient, and less expensive program could be developed and implemented in the dairy area under the direction of the two major dairy organizations in the Chino Basin. Despite the apparent advantages of such a program, the Milk Producers Council has refused to participate in this endeavor. The California Milk Producers (CMP) board also declined to fund the monitoring work because members outside the Chino Basin did not want to pay for monitoring solely within the Basin. However, the CMP has actively worked with the engineering contractor who will be sampling wells within the dairy area to identify the wells which must be sampled within the Chino Basin to evaluate dairy impacts. CMP has also actively lobbied the Chino Basin Watermaster to sample the above-described wells. In addition, CMP has volunteered to provide previously unreleased groundwater quality data which were generated in the recent past.

The Watermaster completed its first sponsored Basin-wide monitoring program for the Chino Basin in April 1990. The monitoring program included the dairy area wells as well as a representative sample of wells throughout the Basin. It is anticipated that this program will be continued.

Additional discussion regarding the need for a comprehensive groundwater monitoring program is to be found later in this report.

Surface Water Quality Problems:

The preceding discussion of water quality problems in the Chino Basin focused primarily on groundwater, although the significant effects of rising groundwater on Santa Ana River quality was also described. Dairy operations can also affect surface waters within the Chino Basin, and the Santa Ana River in a more direct fashion. Runoff of dairy washwater or stormwater which have come into contact with manured areas adversely affects the quality of those surface waters.

As described later in this report (Section III), the Board has adopted requirements on dairy operators which are designed to prevent these impacts. These include requirements for the containment of all washwater and all storm water runoff from manured areas (up to and including the 25-year, 24-hour storm), and for the protection of the facility from inundation by 100-year peak storm flows. Unfortunately, these containment controls are not always constructed or maintained properly by the dairy operators, and discharges of wastewater to local surface drains occur. This surface water drainage problem is exacerbated in some areas by the extensive urban development occurring upstream of the dairy area. The significant increase in impervious surfaces associated with this urban development causes the amount and velocity of storm water runoff entering parts of the dairy area to increase dramatically. This, in turn, significantly affects the integrity of the containment controls implemented by the dairy operators and, therefore, the dairy operators' ability to comply with their waste discharge requirements. A number of studies have been conducted to determine effective solutions to this problem. Specific recommendations for the control of surface water impacts from dairy operations, in part based on the results of these studies, are included in the dairy strategy which is proposed at the end of this report.

II. DAIRY REGULATION IN THE SANTA ANA REGION: A BRIEF BACKGROUND AND OVERVIEW

In the 1950's, the center of the dairy population in Southern California was in Los Angeles County. There was, for example, a concentration of dairies in Torrance. Short haul distances had led the dairymen to locate there initially, but urban crowding soon induced them to move elsewhere. Many of the dairies that left the Los Angeles metropolitan area relocated in the unincorporated communities of Dairyland and Dairy Valley in southeastern Los Angeles County and western Orange County. Most of Orange County was still largely undeveloped and agricultural in the late 1950's and early 1960's.

Orange County urbanized rapidly in the 1960's and '70's. Pressure on operating dairies from encroaching urban development takes several forms: odor and nuisance complaints increase, runoff from additional paved areas leads to greater drainage problems, and traffic becomes a problem. Increases in land value, however, tend to make the necessary relocation easier and more acceptable. In addition, each time a dairy facility is rebuilt, there is an opportunity to improve on the design and increase efficiency.

Several dairies stayed on in Orange County as long as they could, but by the late 1970's, they were essentially all gone. Some of the dairies scattered, but a great many relocated in the Chino Valley, a very attractive location for a number of reasons. It was generally warm and dry, reasonably level for the most part, and had nice morning and evening breezes. Land was reasonably priced, since it was farther from the centers of urban pressure. The haul distance to the creameries was longer than it had been, of course, but Chino was still a very acceptable compromise.

Historically, dairy corral design called for a slope away from the milk barn, usually toward the nearest stream or ditch. That way, when it rained in the winter, the milk barn stayed dry and excess manure was washed out of the corrals and off the property. From the point of view of the dairyman, there was no manure management problem with that arrangement. A number of the dairies established in the Chino area were built that way.

The very wet winter of 1968-69 made it clear that the dairies could not be allowed to continue to use local surface waters to dispose of their manure. When the storms ended and the water behind Prado Dam receded, the sight and smell of a great many tons of dairy manure were both obvious and overwhelming. This was one of the influences that motivated the Regional Board staff to begin thinking of ways to control the impacts of the dairies.

In 1972, the first sets of waste discharge requirements for the dairies were adopted by the Regional Board. It was felt that the first, easiest and most reasonable step in the control strategy was to manage and prevent runoff from corrals and manured areas. Once that was under control, the rates of application and/or disposal of manure could then be limited as the second step. The third and most difficult phase, if it could be achieved, would be total control of all waste materials through limits on wash water disposal.

The dairy community argued successfully that they could not fairly be held responsible for all rainfall circumstances and conditions, and a compromise formula was developed. At a minimum, dairies would be responsible for installing and maintaining runoff control facilities (dikes, berms, ponds, etc.) to address 24-hour rainfall events which were less than or equal to 1.3 times the 10-year storm (equal to the 25-year, 24-hour storm event). Despite the intent of the Regional Board staff, this formula had only minor effects on most existing dairy operations. A low berm was generally put up across the lower side of the property, and the subject was dismissed. Where it did have an effect, however, was when a new dairy was being designed, or an existing dairy was trying to come into compliance.

Multiplying the manured area (corrals and stockpile areas) times the rainfall figure allowed dairymen to calculate how much water they had to manage. Appropriately-sized retention ponds and disposal areas could be designed using the formula. Because of steeper slopes and other features related to the location of some properties, however, there were still some dairies that found it difficult, if not impossible, to control storm-induced runoff, flooding, and other such problems.

In the process of developing the data and information needed for the computer modeling necessary to produce the 1975 Basin Plan, Albert A. Webb and Associates was contracted to study waste disposal in the dairy industry. Board staff worked closely with Webb and with the Santa Ana Watershed Project Authority (SAWPA), the Board's basin plan contractor, to develop acceptable salt loading rates from dairies and other agriculture (see Section III and Appendix A). The manure disposal limit that appears in the waste discharge requirements issued to the dairies, three tons per acre per year, resulted from those efforts. As the next section of this report discusses in detail, the objective in specifying the three tons per acre per year limit was to ensure that the dairy salt load was reasonably comparable to that from other land uses (e.g., urban and agricultural uses).

Manure is the major waste disposal problem at most dairies. Corrals are convenient, in that they keep the cows close to the barn; milking, feeding and watering are more efficient, as are the necessary routine veterinary procedures. But the manure is concentrated in a much smaller area where nothing grows, and it has to be cleaned out, or at least scraped and piled, a couple times a year.

Permits that limited manure disposal to 3 tons/acre/year quickly made it clear to the dairymen that agricultural application at 10 to 20 tons/acre/year made a lot more sense, since they removed a lot more manure than simple disposal could. This issue will be covered in detail later in this report.

As a hydrologic system, the Chino Basin is closed. Water, salt and/or pollutants discharged to the ground in the Chino Basin move down toward Prado Basin and appear as rising water flows in the Santa Ana River. What has kept these pollutants from showing up sooner is a combination of the slow movement of these materials down through the unsaturated zone, and the slow movement of groundwater toward the River. Knowing that the impacts of waste disposal from the dairies would appear sooner or later, and that this activity would have serious water quality effects if it were unregulated, SAWPA and the Regional Board proposed during 1975 that the area be sewered and the wastewater flows be treated. The wastewater would then have been discharged to the Santa Ana Regional Interceptor (SARI), the brine line, effectively exporting the washwater salts to the ocean.

The SARI line was approved by EPA, but the scheme to sewer the dairy area was not. EPA reportedly felt that sewering this agricultural area would benefit the dairy industry, and would make urbanization much more likely to occur sooner. They did not want to encourage growth. This threat of growth must have seemed to EPA to be more serious than the threat to water quality. The ramifications of this failure to adequately address washwater disposal will be discussed in detail in a later section of this report.

In summary, the Regional Board dairy regulatory program developed in the early '70's addresses surface water protection through runoff controls and groundwater quality protection by means of limits on manure application rates. This program remains essentially unchanged today. The water quality problems described earlier in this report indicate that changes in this regulatory program are necessary. To understand these changes, a more detailed review of the rationale for specific aspects of the Board's requirements is necessary. That will be the focus of the next section of this report.

III. THE DEVELOPMENT OF THE REGIONAL BOARD'S DAIRY REGULATORY PROGRAM

A. Introduction

Manure wastes generated at dairies are temporarily or permanently deposited in areas that may impact both surface water and underlying groundwater. These areas include the corrals, washwater holding ponds, pasture, and croplands associated with the dairies. As described previously in this report, the Regional Board has established waste discharge requirements for dairies to protect surface and groundwater quality. These requirements are summarized in Table III-1. As shown in this Table, the Board's regulatory program addresses surface water protection through requirements for the containment of all dairy washwater and manured storm water (up to and including the 25-year, 24-hour storm), and for protection from 100-year storm flows which would inundate manured areas. To protect groundwater quality, the Board's requirements limit the application of manure to pasture (also known as disposal acreage (see Subsection C)) and croplands. Note that specific information is obtained from the dairy operator when a new or substantially modified dairy operation is proposed; annual reports submitted by the dairy operators allow Board staff to assess compliance with waste discharge requirements. To date, the Regional Board has not implemented any requirements to prevent groundwater degradation

TABLE III-1

SUMMARY OF THE CURRENT DAIRY REGULATORY PROGRAM

Santa Ana Region

REPORTS OF WASTE DISCHARGE

- .Name, address, phone number, etc
- .Proposed animal population
- .Dairy, disposal land, and cropland acreage
- .Plot plan (sketch) of the dairy and disposal areas
- .Proposed method(s) of manure disposal
- .General description of proposed wastewater disposal method and containment controls

WASTE DISCHARGE REQUIREMENTS

Surface Water Protection

- .Containment of all washwater and storm runoff from up to and including a 25-year, 24-hour storm
- .Protection from inundation from 100-year peak stream flows

Groundwater Protection

- .3 tons/acre of manure on disposal land
- .Agronomic rates for manure application to cropland

ANNUAL REPORTS

- .Name, address, phone number, etc.
- .Animal population
- .Dairy, disposal land, and cropland acreage
- .Manure disposition (amount spread on disposal land, spread on cropland, stockpiled, or hauled away)
- .Types of crops grown (if manure was spread on cropland)
- .Hauler's name and location where manure was hauled
- .Type of wash water disposal method used
- .Statement regarding problems encountered during previous year

from manure deposition in corrals or from the application of nutrients and salts deposited on the soil by the application of the dairy wash water to pasture. The following sections provide a detailed discussion of the rationale for each of these aspects of the Board's dairy regulatory program.

It should be noted that a significant portion of the manure that is generated by the dairies is reported to be transported away from the dairy areas; some is even hauled outside of the Santa Ana Region (see Chino Basin Dairy Data Sheet, Table I-8). Manure waste deposition in these areas can also pose water quality problems, however, the Board has not implemented any requirements to address such impacts. Any effort to do so would require the implementation of a manure accounting system to track the fate of manure wastes generated within the Region. This issue will be addressed in a later section of this report (see Section IV).

B. Dairy Operations

In order to understand the rationale that the Regional Board has employed to protect ground and surface waters from wastes generated by the dairies, it is first necessary to review the typical operation of the dairies, the sources and types of wastes generated, and typical disposal methods.

Most of the animals at an efficiently operated dairy will consist of milking cows which are maintained in corrals most of the time. Much of the waste generated by these animals remains in the corrals until it is removed on approximately a semiannual basis. The manure[1] deposited in the corrals undergoes various degrees of decomposition, and since most of the corral floors are earth, the salts and nutrients that are present in dairy manure are subject to transport into and through the underlying soil of the corral by the infiltration of precipitation and moisture from fresh manure.

Dairy cows are typically removed from their corral twice each day for milking. Webb (1974) reported that approximately ten percent (10%) of the manure generated by milking cows is deposited in the water which is used to wash the cows prior to milking. Manured wash water is applied directly to pasture or cropland or is stored in a pond and then applied to pasture/cropland. Pond capacities generally prevent long-term storage of the manured wash water, and thus, the wastewater generated each day is usually applied to the agricultural land on a daily basis.

Approximately twice a year, the manure that has accumulated in the corrals is removed and applied to pasture and/or cropland or hauled away from the dairy. Pasture and cropland also receive the dairy wash water, which, as stated above, contains approximately 10%

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[1]The term manure, as used in this report, includes all feces and urine excreted from the dairy cattle.

percent of the total waste generated by the milking cows. A small percentage of dairies employ a "flush out" waste disposal system for their corrals. At these dairies, manure is routinely washed out of the corrals with water, routed to a holding pond and applied to pasture and cropland.

A typical dairy will also support nonmilking cows, replacement dairy cows, heifers and calves. When the condition of the pasture will allow (sufficiently dry with substantial grass), these animals are commonly maintained on pasture. Thus, the pasture will receive the manure excreted from these animals. However, much of the pasture also receives dairy wash water and manure from the corrals, which adds to the salts and nutrients applied to these lands.

For the purpose of understanding the relative proportion of lands that are being subjected to temporary or permanent manure deposition, the following table shows the amount of land in the Chino Basin dairy area used for corrals, pasture, and croplands:

Table III-2

Dairy Manure Land Use Within the Chino Basin Dairy Area

Land Use	Acreage	Percent of Total
Crops and Hay[1]	6,700	45
Pasture[1]	6,280	42
Corrals[2]	2,000	13
Total	14,980	100

[1]SCS (1988). Pasture = disposal acreage (see Subsection D)

[2]Estimated from the 167,000 milk cows present in the Chino Basin dairy (Regional Board staff 1988 dairy survey) and assuming that each cow requires approximately 500 ft^2 of corral area.

Thus, it appears that of the land which comes in contact with manure in the Chino Basin dairy area, approximately 45 percent is used for crops and hay, 42 percent is pasture and 13 percent has been developed as corrals.

C. Regional Board Dairy Requirements

The rationale for the Regional Board's surface water protection requirements is clear: washwater (which, again, contains about 10% of the total manure generated by milking cows) and stormwater runoff which has come into contact with manured areas must be contained on site in order to prevent adverse impacts to local and downstream surface waters. Surface runoff of such wastes in the Chino dairy area can ultimately affect the Santa Ana River. The Board's requirements are consistent with all the other extensive efforts being made to control water quality in that critical water body.

In the following subsections, those requirements which pertain specifically to groundwater quality protection are discussed in detail relative to the dairy land use identified above (Table III-2).

D. Pasture or Disposal Land

As previously noted, the Regional Board has specifically limited the amount of manure that can be applied to "disposal land" to 3 tons of manure (dry weight) per acre per year. This manure disposal requirement was developed in the early 1970's. At that generated by dairies and the amount of salt from those wastes that would be expected to migrate to underlying groundwater (University of California Committee of Consultants (UCCC, 1973a; UCCC, 1973b)). Using this information, the amount of manure that could be applied to achieve the 0.3 ton/acre/year salt loading rate to groundwater was calculated to be 3 tons manure (dry weight)/acre/year (Appendix B).

In summary, then, in establishing the 3 tons dry manure/acre/year disposal requirement, the Regional Board's intent was to implement a regulatory mechanism which would limit the amount of salt leaching to groundwater from dairy operations to 0.3 tons/acre/year, consistent with other permitted salt loading rates. <u>It is imperative to understand</u> that, in order to achieve this salt loading objective, two things were required (and assumed):

> The first requirement was that there be 100% compliance with the manure disposal requirement (3 tons/acre/year). Clearly, lack of compliance (i.e., manure application in excess of 3 tons/acre/year) results in salt loads in excess of the desired 0.3 tons/acre/year. The information provided in the 1987 Dairy Annual Reports submitted by the dairy operators indicated that there was good (95% or so) compliance with the manure disposal requirement. However, the fate of <u>most</u> of the manure generated is not clear. (The need for an improved reporting system to document the fate of manure within the

Region will be addressed in a subsequent section of this report.) If it is assumed that 50% of the manure is removed from the Chino Basin (an assumption which staff believes is rather generous) and the remainder is deposited within the Basin, the effective salt loading rate to groundwater from manure application alone was closer to 2 tons/acre/year.

The second requirement (and planning assumption) was that all dairy washwater be removed from the dairy area. As discussed earlier in this report (Section II), the third phase of the Board's proposed dairy regulatory strategy was the removal of dairy washwater from the area by sewering. At the time the manure disposal requirement was imposed (early 1970's), it was assumed that this phase would be implemented and that, therefore, no salt loading from washwater would occur. The maximum dairy salt load of 0.3 tons/acre/year could then be achieved. However, sewering of the washwater was not found to be feasible. No other equally suitable mechanism for washwater disposal has been identified or implemented to date. As described earlier, washwater continues to be applied daily to pasture and/or cropland as the primary means of disposal. Webb (1974) estimated that about 10% of the waste generated by a dairy cow is excreted in the washwater; therefore, washwater application results in an additional salt loading to groundwater of about 0.41 tons/acre/year.

It should be noted also that, at the time the manure disposal requirement was adopted, it was assumed that the application of manure as a fertilizer on cropland would not result in salt loads to groundwater in excess of typical, nondairy agricultural rates. As will be discussed below (Subsection F), this assumption was not justified.

Cumulatively, the effect of the degree of manure removal (about 50%) and the continued application of washwater in the dairy area results in a salt loading rate to groundwater of about <u>2.4</u> tons/ acre/year, which is 8 times the salt loading unit factor sought by the Regional Board for the dairy industry[1,2]. This is summarized in Table III-3, below. Possible methods of addressing this excessive salt loading problem are discussed in a subsequent section of this report (Section IV).

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[1]As noted in Appendix A (unit factors), detailed model calibration work has been performed to update unit factors in conjunction with the watershed-wide Nitrogen study. Two recommendations regarding dairy salt unit factors have resulted (James M. Montgomery, Engineers, 5/1989 SAWPA Task Report). Montgomery found that the 2.4 tons/acre/year unit factor developed based on estimates of dairy waste removal (see Table III-3) was correct for historic dairy land use. But a salt unit factor of 2.54 tons/ acre/year was recommended for present dairy operations.

[2]Note from Appendix A, Table A-1 that the 2.4 dairy unit factor is 8 or more times the unit factors for other agricultural land uses and is 5 times the factor for residential and commercial uses (inside and outside).

TABLE III-3

Salt Loading to Dairy Area (Pasture + Corrals)
(tons/acre/year)

ObjectiveActual		
3 tons manure/acre/year	0.3	2.0*
Dairy Wash Water	0.0	0.41
Total	0.3	2.41

*Assumes approximately 50% removal of dairy manure.

It must be emphasized that the figures shown in this Table for actual dairy salt loading are estimates (which recent model calibration studies have independently confirmed). In particular, the reporting system presently used to track manure disposal compliance is not sufficient to document the fate of all manure generated in the dairy area. As stated at the outset of this section, the fate of the manure that is reported to be hauled away is not known. An improved manure tracking system is necessary to accurately identify the salt loading to groundwater that can be attributed to dairy operations.

Certain issues have been raised concerning manure application on disposal land. It is appropriate to discuss these issues before moving to the discussion of the rationale for the Board's regulatory program with respect to dairy cropland and corral areas.

It has been recently debated whether pasture should be considered as "disposal land" or as "cropland", which is permitted a larger manure application rate (12 dry tons/acre/year). It is argued that nitrogen uptake in pastures is at least equivalent to that in cultivated croplands, and that, therefore, a higher application rate of manure should be permitted on pasture. It is true that from the standpoint of nitrogen removal, a bermuda grass pasture <u>in good condition</u> will take up approximately 225 pounds of nitrogen per acre, which is similar to many other nonlegume forage crops and exceeds the nitrogen requirements of most field crops (ie. barley, oats, corn, and wheat). Thus, from a nitrogen removal standpoint, a bermuda grass pasture, in good condition, will utilize nitrogen as much as other plants, which are considered to be crops. An even greater nitrogen uptake rate can be realized if the pasture is seeded with a winter grass to facilitate the utilization of nutrients on a year-round basis. However, an inspection of the Chino Basin dairy area provides insight as to why pasture has always been considered as disposal land and not cropland. In many cases, dairy manure is simply applied to the land without any effort to cultivate a pasture and the land remains fallow throughout the year since it is not seeded and irrigated. In other cases, marginal bermuda grass pastures have developed, but, during the winter months when the bermuda grass becomes dormant, no annual grasses are seeded to carry the pasture over to take up salts and nutrients in the manure applied during the winter. Under some conditions, the pasture is irrigated with manured wash water, but is not seeded, which only promotes weed growth. The weeds are simply plowed under before the next application of manure. Under these conditions, crops are not consistently cultivated to remove the nutrients in the applied manure. These practices seem to be the rule rather than the exception, and for these reasons, staff continues to consider all pasture as disposal land. Moreover, as discussed above, pastures already receive additional nitrogen inputs through the application of dairy wash water.

E. Corral Areas

To date, the Regional Board has not regulated the deposition of manure waste in corral areas. Corral areas compose approximately 13 percent of the land that comes in contact with dairy manure and large quantities of manure are permitted to accumulate between corral cleanings. Since the manure contains substantial quantities of salts and nutrients, it is logical to assume that underlying groundwater quality is significantly threatened by the leaching and subsequent infiltration of these constituents into the underlying soils. However, while it may appear that the salt and nutrient loadings from corral areas are a significant source of dairy manure contamination, several studies suggest otherwise.

Nitrate and salt in soils underlying corrals, pasture and cropland in the Chino Basin dairy area was studied by Adriano <u>et al.</u> (1971). Soil borings were performed in corrals, pasture, croplands, and in undisturbed areas. The highest concentrations of nitrate and chloride measured in saturated soil extracts were observed beneath the corral area at depths to 9 meters (100 ppm NO_3-N, 1000 ppm Cl), as compared with pasture concentrations (35 ppm NO_3-N, 100 ppm Cl), cropland concentrations (25 ppm NO_3-N, 50 ppm Cl), or background concentrations (10 ppm NO_3-N, 15 ppm Cl). However, the concentrations of nitrate and chloride in the shallow groundwater (approximately 11 to 17 meters beneath the ground surface) collected at each of the 15 sites was greater under the pasture (5.27 ppm NO_3-N, 7.09 ppm Cl), when compared with corrals (4.10 ppm NO_3-N, 3.88 ppm Cl), cropland (3.21 ppm NO_3-N, 2.86 ppm Cl), or undisturbed background concentrations (1.86 ppm NO_3-N, 3.15 ppm Cl). It was concluded that corrals contributed more nitrates than pasture or cropland on a unit area basis, but that the area of corrals constitutes only 5 percent of the total land area available for irrigation (this report has estimated 13 percent of the land subject to the application of manure). Therefore, Adriano <u>et al.</u> (1971) suggested that the mass of salts and nutrients leaching from cropland or pasture is greater since the land area is much larger.

The leaching of salts from corrals can also be expected to be less than pasture and cropland because irrigation water is not applied to the corral areas. Only precipitation that falls directly within the corrals or rainfall runoff that enters the corrals and infiltrates into the underlying soil will transport salts and nutrients to the underlying groundwater. Thus, salt and nitrate movement is probably much slower below corrals when compared with transport of these constituents through the soil from pasture or croplands. The soils under corrals are also heavily compacted from the continuous load of the dairy cows, which may reduce the hydraulic conductivity of the soil (and, therefore, the transport of salt and nitrate) significantly (Chang, 1973).

To date, the Regional Board has not regulated the deposition of manure in the corral areas because the contribution of salts and nitrates to groundwater from these areas is small compared with the leaching of salts from pasture and croplands.

F. Croplands

Within the last few years, the Regional Board has implemented a requirement limiting manure loading to croplands to agronomic rates. As a general rule of thumb, staff considers application rates in excess of 12 tons/acre/year to be of concern, unless the dairyman can demonstrate that more manure is required to meet the agronomic needs of the crops. The 12 tons/acre/year "flag" was implemented by staff because 12 tons of manure meets the necessary nitrogen requirements of many double cropped land management scenarios employed within the Santa Ana Region.

Figures III-1a and III-1b present the estimated salt (TDS) and nitrate loading to the groundwater and the amount of nitrogen applied to the soil for manure application rates varying from 0 to 24 tons/acre/year. The TDS loadings were determined using the rationale developed by the University of California Water Quality Task Force, Committee of Consultants (UCCC), as presented by Webb (1974) (see Subsection D, p.III-8 and 9; Appendix B). The regression equation used for the computation of these loadings is shown in Appendix B. As shown in Figure III-1b, the total nitrogen applied each year to the soil is approximately 400 lbs. N/acre at the 12 ton/acre manure application rate. The loading rate of nitrogen assumes that 50 percent of the nitrogen present in the fresh manure has volatilized. This total nitrogen application rate appears to be sufficient for many double crop management systems such as oats-sudan grass or barley-corn. However, it is possible to cultivate crops which require more nitrogen such as the combination of barley in the winter and sudan grass in the summer. Triple cropping has also been reported in some instances. The utilization of nitrogen by crops commonly cultivated in the Santa Ana Region are listed Table III-4.

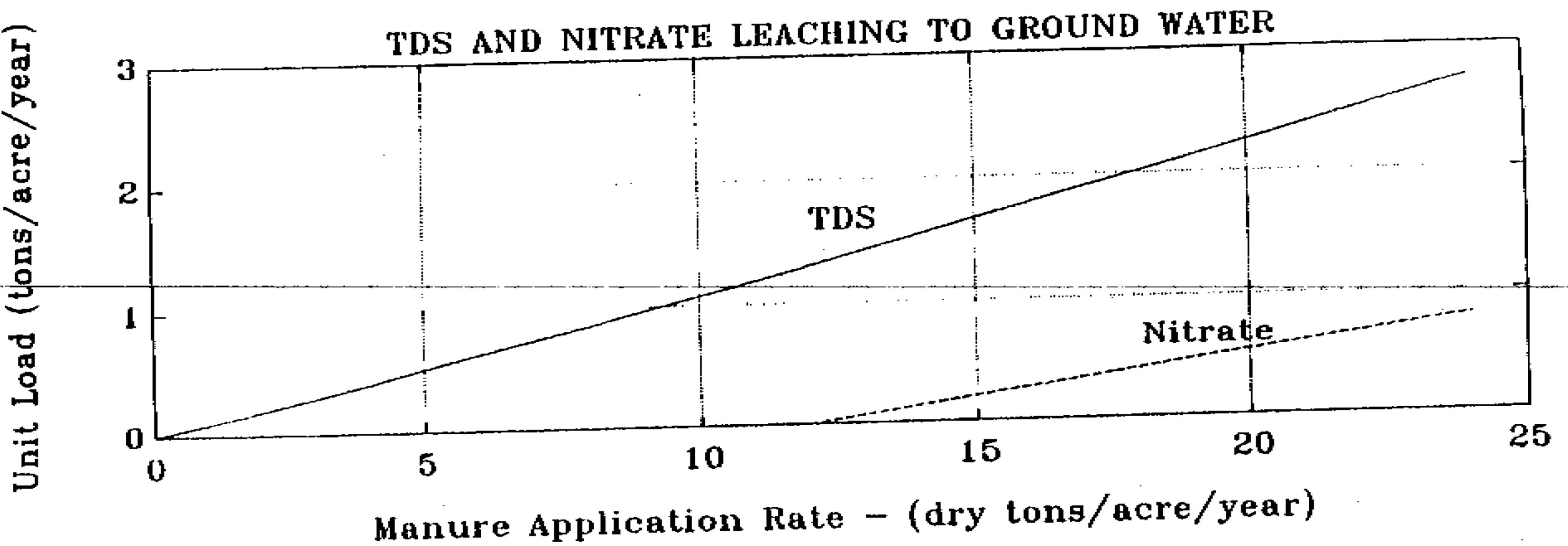

Figure III-1a

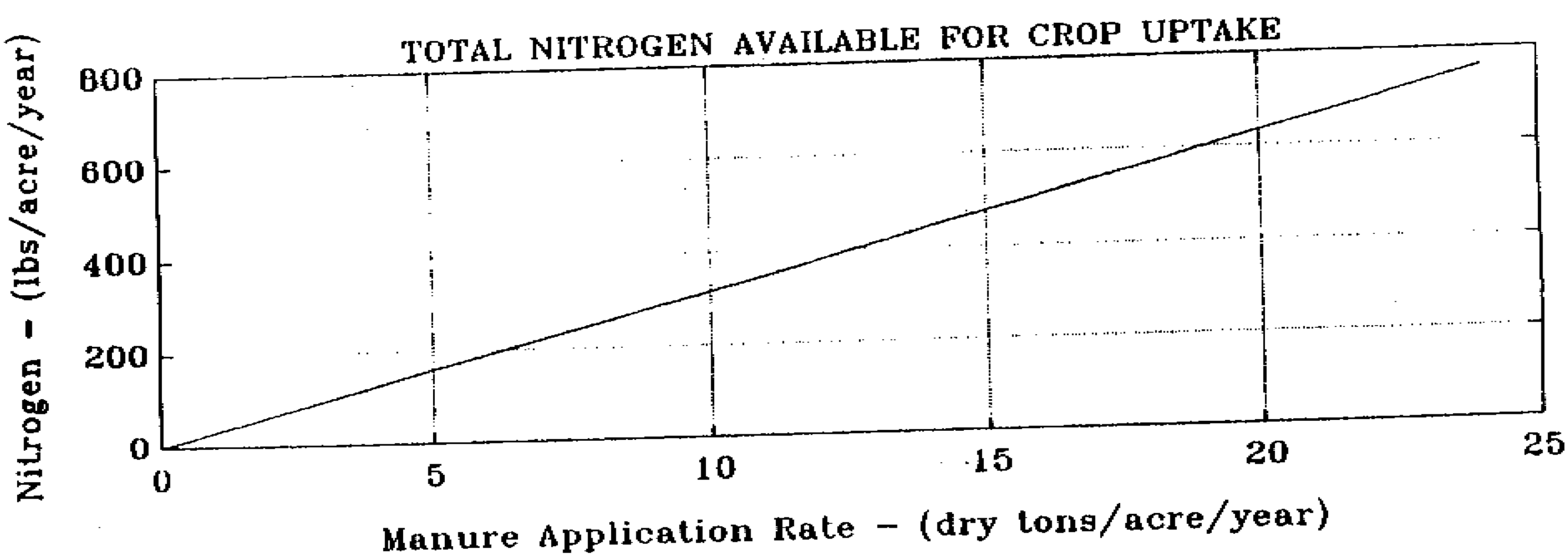

Figure III-1b

TABLE III-4

Nitrogen Utilization by Various Crops[1]

(Western Fertilizer Handbook)

Crop	Pounds Per Acre
Barley	160
Oats	115
Corn (silage)	250
Sudan grass	325
Alfalfa[2]	480

[1]Total uptake in harvested portion.

[2]Legumes are capable of fixing nitrogen from the atmosphere and, therefore, actual application of fertilizer can be significantly less.

As shown above, a winter crop of barley combined with a summer crop of corn (silage) requires approximately 400 lbs. of nitrogen. Similarly, sudan grass and oats need approximately 440 lbs. of nitrogen.

There is concern by staff that the use of manure on cropland, even at agronomic rates, may not be protective of underlying groundwater quality. Specifically, the concern is that the use of manure to meet the nutrient requirements of crops results in the excessive application of salts which are not utilized by plants and which can, therefore, migrate to groundwater. This concern is described in more detail below.

Dairy manure contains much more salt per unit of nitrogen than other types of chemical fertilizers. A comparison of the types of fertilizer that might be applied to land and their respective salt content is informative. Table III-5 presents the salt content of three fertilizers that might be utilized.

Table III-5

Comparison of Salt Compositions in Fertilizers

Pounds of salts per 100 lbs. of Nitrogen

Ion	Regional Mix[1]	15:15:15 Blend[2]	Dairy Manure
Ca	126	0	147
Mg	4	0	67
Na	5	0	292
K	23	80	28
Cl	8	73	82
SO_4	45	173	123
HPO_4	14	143	188
NO_3	359[3]	443	443
Total Salts	584	912	1,370
Nonnitrogen Salts	225	469	927
Non Nitrogen/ Total Salts Ratio:	39%	52%	68%

[1]For the purpose of developing a salt loading unit factor for agricultural uses other than dairies, a regional fertilizer mix was formulated on a weighted basis using fertilizers commonly used within the Region (WRE, 1970). See Appendix A for additional discussion.

[2]40% ammonia sulfate, 33% diammonium phosphate, 25% muriate of potash, and 2.5% urea.

[3]Soil microorganisms uptake and volatilization of ammonia were estimated by WRE (1970) to reduce this value from 443 lbs. to 359lbs. Volatilization losses for the 15:15:15 Mix and dairy manure were accounted for before application to land and microorganism uptake was assumed to be negligible.

As shown in Table III-5, dairy manure contains much more salt per unit of nitrogen (68%) than either the 15:15:15 fertilizer mix (52%) or the regional mix (39%). The 15:15:15 mix was specifically selected for comparison because it represents a chemical fertilizer with a relatively high salt index. On the basis of fertilizer applied to the land, dairy manure contains at least twice as much total salt as commercial fertilizers. The regional fertilizer mix has less than half of salts contained in the high salt index 15:15:15 mix and one-fourth of salts present in dairy manure. The regional mix consists primarily of urea and anhydrous ammonia which are referred to as high analysis fertilizers. Generally, high analysis fertilizers exhibit lower salt indexes, and the prudent use of such fertilizers may result in much less salt applied to agricultural land.

Not all of the salt that is applied to land from fertilizer will leach to the groundwater table. Plants will take up significant amounts of nitrogen and, to a much lesser degree, some of the other salts contained in the fertilizer. Some of these other salts will precipitate to form relatively insoluble compounds that remain in the soil. On the order of one-half of the salts originally applied to the soil will be transported to the groundwater; the actual amount depends on a variety of factors which can be considered in a computer model. Staff conducted some model simulations to evaluate the amount of salt which leaches to groundwater from each of the three fertilizer types identified above. The modelling techniques employed are described in Appendix A (Model Evaluation of Salt Leaching from Fertilizers). The results of the simulations are summarized below:

Figure III-2 presents the total salt (TDS) loading rates for dairy manure, the 15:15:15 fertilizer blend, and the regional fertilizer mix relative to the amount of nitrogen applied to agricultural land. Table III-6 exhibits the data which were used in Figure III-2. As shown in Figure III-2, the dairy manure salt loading rate to the groundwater table is approximately twice as much as the salt loading rate for the high salt index 15:15:15 blend and four times as great as the regional mix. For applications of fertilizers at application rates common for the Chino Basin dairy area, the relationship of application rate and groundwater loading rate is relatively linear. Thus, increases in the amount of fertilizers applied to the soil will result in a proportionate increase in the amount of salt entering the underlying groundwater aquifer.

Table III-6

Total Salt Loading Rates (tons/acre/year) vs Fertilizer Types

Fertilizer	Total Nitrogen Application Rate (lbs. N/acre/year)			
	100	200	400	800
Dairy Manure	0.48	0.97	2.0	4.1
15:15:15 Blend	0.29	0.58	1.2	2.4
Regional Mix	0.12	0.24	0.49	1.0

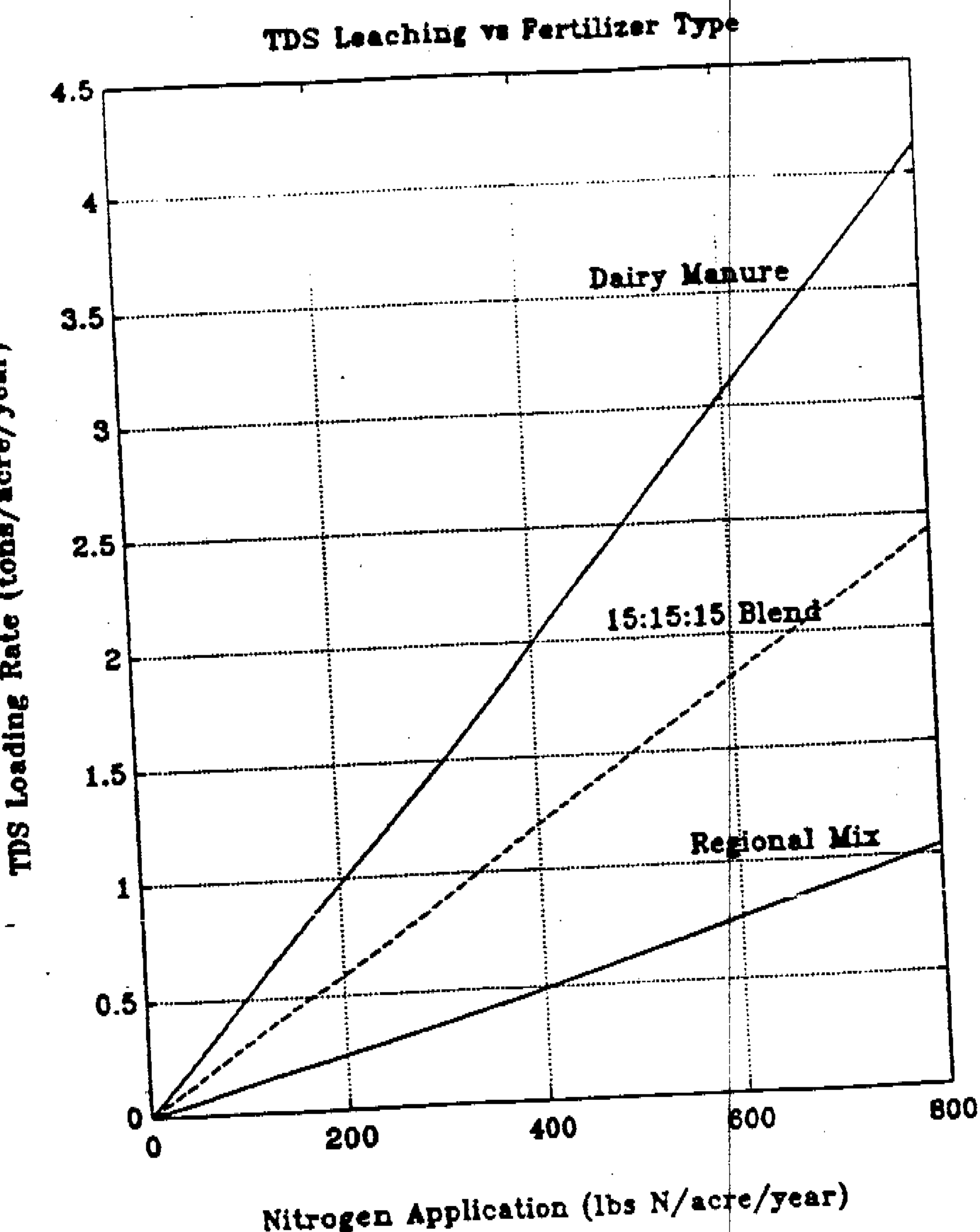

Figure III-2

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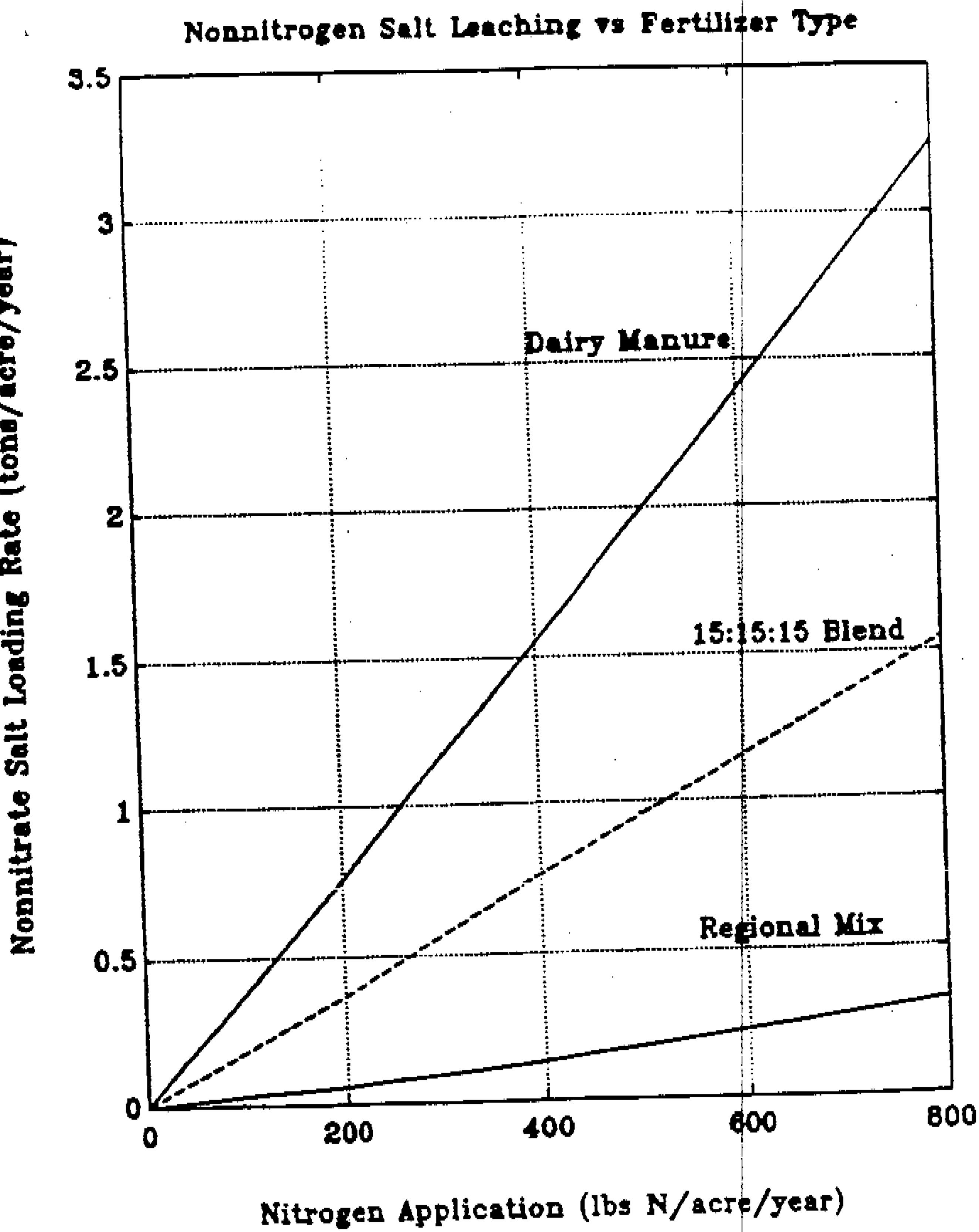
A second evaluation was performed to determine the amount of nonnitrogen salts leaching to groundwater for the three fertilizer types. This evaluation was performed by subtracting out the nitrogen from the total salt loading factor. For these fertilizer types, the amount of nitrogen (nitrate) leaching to groundwater was similar for the total nitrogen application rates considered. Figure III-3 presents the nonnitrogen salt loading rates to groundwater. The specific loading rates used to generate Figure III-3 are exhibited in Table III-7. Again, the comparison shows that the application of dairy manure to the soil results in a much higher loading rate for nonnitrate salts when compared with the other fertilizers. In addition, by comparing Figures III-2 and III-3 it can be observed that approximately 25 percent of the total salts leaching to the groundwater are nitrogen, which will be in the form of nitrate. For the other fertilizers, the amount of nitrogen leaching beyond the root zone is approximately 50 percent of the total salt load. This is not surprising since dairy manures contain significantly more salt than other types of the fertilizers.



Nonnitrogen Salt Leaching vs Fertilizer Type
Nonnitrate Salt Loading Rate (tons/acre/year)
3.5
3
2.5
2
1.5
1
0.5
0
Dairy Manure
15:15:15 Blend
Regional Mix
0
200
400
600
800
Nitrogen Application (lbs N/acre/year)

Figure III-3

Table III-7

Nonnitrate Salt Loading Rates (tons nonnitrate salts/acre/year) vs Fertilizer Types

Fertilizer	Total Nitrogen Application Rate (lbs. N/acre/year)			
	100	200	400	800
Dairy Manure	0.37	0.75	1.5	3.2
15:15:15 Blend	0.18	0.36	0.76	1.5
Regional Mix	0.03	0.06	0.13	0.32

In summary, dairy manure contains much more salt per unit of nitrogen than the other fertilizer types evaluated. For this reason, the use of manure to meet the nutrient needs of crops results in excessive application of salts which migrate to groundwater. Based on these findings, staff believes that it is appropriate to consider revising the Board's present regulatory strategy with respect to manure application on cropland. These and other conclusions and recommendations regarding the Board's dairy regulatory program as a whole are discussed in a subsequent section of this report.

Before moving to this discussion, it is appropriate to emphasize an important point regarding the preceding discussion. The salt loading unit factors described here and in Appendix A are used in the Region's computer models (the BPP) to make projections of water quality over time. These projections, in turn, have proven extremely useful in identifying optimal waste management and regulatory strategies (which have been incorporated in the Basin Plan and implemented through waste discharge requirements). But it should not be construed from this that our knowledge of dairy waste impacts on groundwater quality in the Region is a truly exact science. The figures given for salt loading to groundwater from present dairy operations are estimates, based largely on the information submitted in the dairy annual reports. As previously noted, the information submitted in the annual reports is not adequate to identify the fate of all the manure generated and potentially disposed of in this Region. Because of this inadequacy, our understanding of the real impacts to groundwater of dairy waste management and disposal practices, both within the dairy area per se and elsewhere in the Region, is necessarily limited. This signals the need both for an improved manure disposal tracking and reporting system and for a comprehensive groundwater monitoring program so that more accurate, in the field knowledge of the impacts of dairy operations on groundwater quality can be obtained (and used to refine our chief basin planning tool, the BPP). Additional discussion regarding these needs is to be found in the final section of this report.

IV. SUMMARY AND PROPOSED REGULATORY STRATEGY

As stated earlier in this report, the Regional Board's dairy regulatory program has not changed significantly since its inception in 1972. Based on the findings presented herein, Board staff believes that it is imperative to consider methods of addressing the excessive salt loads which result from dairy operations. Clearly, such methods could include substantive modifications of the Board's regulatory approach. Staff has developed a proposed dairy regulatory strategy which should allow the dairy industry to continue doing business while at the same time protect surface and groundwater resources. To put the proposed measures in context, it is worthwhile to review the salient points made in the preceding sections of this report.

Summary of Key Points

1. There is a severe groundwater quality problem with respect to TDS and nitrate in the Chino Basin. Modelling projections show that TDS and nitrate concentrations will continue to increase significantly over time. Both the Chino II and Chino III groundwater subbasins lack assimilative capacity for additional salt inputs.

2. This groundwater quality problem causes three major concerns:

a. High nitrate and TDS concentrations adversely affect the use of Chino Basin groundwater for municipal, agricultural and industrial supply.

b. Poor quality groundwater (and salts now present in the unsaturated soils overlying the groundwater aquifer) may adversely affect the implementation of MWD's proposed Storage Program.

c. Poor quality groundwater in the Chino Basin ultimately rises into the Santa Ana River, significantly affecting surface water quality. Recent studies (watershed-wide nitrogen study) show that rising groundwater accounts for approximately 30% to 40% of the nitrates measured at Prado Dam and about 50% of the TDS. Since Santa Ana River flows are used to recharge the Orange County drinking water aquifer, poor quality rising groundwater from the Chino Basin ultimately affects the quality of waters supplied to Orange County residents.

3. Recent Basin Plan update modelling studies have shown that the construction and operation of groundwater desalters will be necessary to address this groundwater quality problem. SAWPA is already pursuing the implementation of these

facilities in conjunction with other agencies. A primary effect of the operation of these desalters will be to retard the movement of poor quality groundwater into the Santa Ana River. It is estimated that the cost of desalter operations will be in the range of <u>$320 to $690 for every ton of salt</u> removed.

4. It is evident that while irrigated agriculture and municipal wastewater disposal have contributed to this groundwater quality problem, dairy wastes play an overwhelmingly significant role:

   a. Basin Planning Procedure (BPP) results (1983 model runs) show that agricultural land uses account for about 97% of the salt load added to groundwater in the Chino basin dairy area; dairies account for about <u>88%</u> of this agricultural salt load.

   b. Basin Planning Procedure (BPP) data indicate that dairy waste discharges account for about <u>60%</u> of the total salt load added to groundwater in the Chino Basin as a whole between 1958 and 1986.

   c. A special model run was made in order to determine what the groundwater quality conditions in the Chino Basin would be if the dairies were not in operation in the Basin. This model run shows that the dairies have a significant effect on the quality of groundwater, particularly in the Chino II and III groundwater subbasins. The removal of dairy operations results in significant decreases in both the concentrations and total masses of TDS and Nitrate .

d. Based on data compiled from the 1988 Dairy Annual Reports, dairies in the Chino Basin area generated a total of 132,020 tons of salt (see Chino Basin Dairy Data Sheet (Table I-8)). Of this amount, approximately 70,768 tons per year are estimated to remain in the Chino Basin. Using the regression equation described in Appendix B, approximately 27,631 tons of this salt load will reach Chino Basin groundwater per year. Note that if we assume that the cost of a desalter is $320 per ton of salt removed, the total cost of removing this dairy salt load to groundwater would be roughly $8.8 million per year. This would be the cost to mitigate only the impacts of ongoing operations, not historic impacts.

5. The Regional Board's dairy regulatory program, developed in the early 1970's, includes requirements for both surface water and groundwater protection (see Table III-1).

In formulating groundwater protection requirements, the Board's intent was to ensure that the dairy salt load to groundwater was reasonably comparable to that from other land uses (urban, other agriculture, etc.), that is, approximately 0.3 tons salt/acre/year (this is roughly equivalent to the 230 mg/l mineral increment permitted at that time). To reach this objective, the Board limited manure disposal on disposal acreage to 3 tons (dry)/ acre/year. It was thought that this limitation would meet the Board's salt loading objective for dairies, provided that:

a. There would be 100% compliance with the manure disposal requirement (3 tons/acre/year); and,

b. All dairy washwater would be removed from the dairy area. (Wash water contains about 10% of the total salt load generated by dairy operations.)

It was assumed in the early 1970's that the application of manure as a fertilizer on cropland would not result in salt loads in excess of nondairy agricultural rates. However, this assumption was not justified (see #6, below).

6. Within the last few years, the Regional Board has implemented a requirement limiting manure application to croplands to agronomic rates. Staff's recent analysis of this regulatory

approach indicates that manure application on croplands, even at agronomic rates, is not protective of water quality. Dairy manure contains much more salt per unit of nitrogen than other types of fertilizers. For this reason, the use of manure to meet the nutrient needs of crops results in excessive application of salts which are not utilized by plants and which can, therefore, migrate to groundwater.

7. The actual salt loading rate to groundwater from dairy operations is about 2.4 tons salt/acre/year, or roughly 8 times the Board's objective (0.3 tons/acre/year). [Recent studies (watershed-wide nitrogen study) indicate that the dairy salt unit factor should be 2.54 tons/acre/year]. Several factors are responsible for this excessive salt loading :

   a. It is estimated that only about 50% of the manure generated in the dairy area is exported from Chino Basin (while dairy annual reports suggest generally good compliance with the Board's manure disposal limitation, the fate of the remaining manure is not documented. Independent model studies confirm that the estimate of 50% manure removal is reasonable.)

b. No washwater has been removed from the dairy area; wash water (with its associated salt loads) continues to be applied to dairy pasture and cropland.

c. There is ongoing manure application to cropland. Even at agronomic rates, cropland application results in the migration of excess salts to groundwater.

8. The dairy salt unit factor is used in the BPP to make water quality projections over time. These projections have proven extremely useful in identifying optimal waste management and regulatory strategies. But our knowledge of the impacts of dairy waste management and disposal practices on groundwater quality in the Region is not an exact science:

a. The dairy salt loading unit factor used in the BPP is an estimate, based largely on the information supplied in the Dairy Annual Reports. (Recent BPP calibration studies indicate that it is a reasonable estimate). However, this reporting system is not adequate to document the fate of all manure generated in the dairy area. A significant portion of this manure is reported to be hauled out of the dairy area, but the fate of this manure is not known. It is assumed that 50% of this manure remains in the Chino Basin and, thereby, significantly increases the dairy salt load to groundwater. Because of our incomplete knowledge of manure disposal practices, our understanding of the real impacts of dairy operations on groundwater is necessarily limited. An improved manure tracking and reporting system is necessary to accurately document the fate of the manure (and associated salts) generated in the dairy area.

b. The groundwater quality data used in the BPP to make future quality projections were derived from available sampling results from a limited number of wells within the Chino Basin. While these data are sufficient to conclude that significant degradation is occurring in the Chino Basin, additional data are needed to obtain a clearer understanding of the extent and nature of this problem. Such data would be used to refine the BPP, which, in turn, would be used for future planning and mitigation activities. A comprehensive groundwater monitoring program is necessary to provide accurate, in-the-field knowledge of the impacts of dairy operations on groundwater quality. The implementation of groundwater monitoring requirements on dairy operators would be consistent with established practice for other waste dischargers in the Region.

9. Surface waters within and downstream of the Chino Basin are also adversely affected by dairy operations. This problem results , in part, from inadequate dairy waste management programs, including containment controls. In addition, uncontrolled stormwater runoff from rapidly developing urban areas upstream of the dairy area impacts the integrity of the dairy containment controls that are in place, leading to discharges of manured wastewater to surface waters.

Proposed Dairy Regulatory Strategy

Based on the findings summarized above, staff believes that the following measures should be considered to understand, control and correct the water quality impacts of dairy and other animal confinement operations in the Chino Basin. These measures constitute a comprehensive three-part program: Part I is designed to address the present and future impacts from ongoing dairy activities in the Basin; Part II addresses the impacts from past dairy activities; and Part III addresses the need for improved drainage facilities upstream of and within the dairy area.

It should be noted that the word "dairy" has been used somewhat loosely throughout this report. The impacts of waste discharges from other types of animal confinement facilities (heifer ranches, calf nurseries, beef cattle feed lots, etc.) are similar to those of dairies. Consequently, any strategy proposed to address the impacts of animal waste discharges in the Chino Basin should apply to all animal confinement facilities, not only dairies. All further references to dairies should therefore be understood to apply to all animal confinement facilities.

Part I - Dairy Waste Discharge Requirements: Impacts of Ongoing Operations

Staff has identified four specific areas in which the Board's present animal confinement facility waste discharge requirement program should be revised and improved to address the impacts of present day discharges of manure and manured wastewater. These are: an improved manure tracking system, an improved groundwater monitoring program, a revision of the manure and wastewater disposal/application requirements, and a requirement for engineered waste management plans to be included as a part of Reports of Waste Discharge. Each of these measures is discussed in detail below:

1. **Implement an improved manure tracking and reporting system.** A manifest system similar to that now used for hazardous waste should be implemented. A sample manure tracking manifest is included as Appendix E. Under this system, written documentation of the amount of manure hauled from a dairy, the hauler's name and the location of final disposal or use as

fertilizer would be described. The owner/responsible party of the land where the manure is applied would acknowledge its final disposition and return the manifest form to the point of origin (dairy operator). The dairy operator would be required to record this information and submit it annually to the Board. Such a manifest system would significantly enhance staff's abilities to: (1) evaluate the full effects of dairy waste management practices on groundwater quality in the Region; and, (2) determine compliance with present (and future) manure disposal requirements. The implementation of this system would likely have significant resource implications for both the dairy industry and Regional Board staff. Given the severe deficiencies of the present reporting system, staff believes that it is essential to implement this program despite the resource constraints.

This manifest program will require that the dairy operators take much more care and time in accounting for the final disposition of each load of manure reported to be hauled away. The dairy operators may have difficulty in obtaining all of the manifests from the landowners/responsible parties who have accepted the manure. This problem can be corrected if the initial agreement between the dairy operator and the landowner/responsible party identifies the use of the manifest system as one of the conditions for receipt of the manure.

2. **Implement groundwater monitoring requirements on dairy operators.**

Several options are available to the Regional Board to obtain the comprehensive groundwater quality data which staff believes is necessary for planning and mitigation activities:

1) The Board could include groundwater monitoring requirements in the waste discharge requirements of every dairy operator;

2) The Board could include groundwater monitoring requirements in waste discharge requirements, as in "1" above, but could also specify an option of participation in a cooperative, comprehensive monitoring program conducted by the dairy industry or other parties; or,

3) The Board could forego the incorporation of monitoring requirements in waste discharge requirements provided that a comprehensive monitoring program is in place.

The inclusion of monitoring requirements for each discharger in waste discharge requirements would be consistent with established regulatory practice. However, staff recognizes that a number of agencies (SAWPA, Chino Basin Watermaster, MWD) are already developing programs to obtain comprehensive, long-term groundwater quality data in the Chino Basin. The Chino Basin Watermaster has recently completed a monitoring program of the Chino Basin and has proposed to continue this effort next year. In light of these efforts, a cooperative program, whereby the dairy industry would participate in the other agencies' monitoring efforts, appears more appropriate and reasonable than individual dairy operator monitoring.

Staff recommends the second option as the most effective and reasonable compromise; that is, incorporate monitoring requirements in each dairy operator's waste discharge requirements, with the option for in-lieu participation in an established, comprehensive monitoring program. Participation in such a comprehensive program should result in substantial cost savings to the dairy operators. For example, the Watermaster's monitoring program was estimated to cost only $8,000 per year for the entire industry. For the current effort, the Watermaster has provided funding to cover the dairy industry portion of this monitoring.

3. **Revise the manure and washwater disposal requirements in dairy Waste Discharge Requirements.**

As described previously, the Chino II and III groundwater subbasins lack assimilative capacity for additional salt inputs. In basins without assimilative capacity, mineral increments are not permitted when regulating waste discharges [1983 Basin Plan (p.4-4) and State Water Resources Control Board Order No. 73-4 (the "Rancho Caballero" decision)]. This means that the quality of waste discharged to such basins must meet Basin Plan objectives. To meet Basin Plan objectives in the Chino Basin and thereby comply with the Basin Plan and the State Water Resources Control Board order, the discharge of manure and washwater, and their application as fertilizer and irrigation water, **cannot** be permitted. Waste Discharge Requirements must be revised to reflect this prohibition. Again, this would apply to the application of manure and washwater to cropland, as well as to the discharge of these wastes to disposal (pasture) land.

Staff recognizes the practical impediments to the prohibition of manure and washwater disposal/application. It was recognized in the early 1970's that washwater removal would be necessary to meet the dairy salt loading objective, but no practical method for washwater disposal has, as yet, been identified. Similarly, suitable methods/locations for manure disposal have been difficult to identify, although Chino Basin Municipal Water District is now in the process of implementing a manure composting facility which should significantly alleviate manure disposal problems in the Basin. Preliminary information indicates that this facility will have the capacity to handle approximately 50% of the manure now generated in the basin.

Recognizing that it is likely to be difficult to overcome, in whole or in part, the practical constraints to the prohibition of manure and washwater disposal or application in the Chino Basin, staff believes that it would be appropriate to incorporate an offset provision in the dairy waste discharge requirements. Requirements for participation in offset programs have precedence in the Santa Ana Region; where waste discharges cannot be eliminated or improved in quality, the discharger is required to mitigate the impacts of that discharge through an approved offset program. The same approach could be employed with dairy operators; for every ton of salt that will reach groundwater as a result of continued disposal/application of manure or washwater within the Chino Basin, the dairy operator must remove an equivalent amount of salt through participation in an acceptable offset program. Such an offset could include financial participation in the Chino Basin desalter operations which have been discussed previously.

It should be noted that the offsets required would depend on the dairy industry's success in identifying acceptable methods of manure and wastewater disposal; the more manure and wastewater that is removed from the basin, the less the needed offset. Manure and wastewater disposal outside of the Basin is likely to be more cost-effective than participation in desalter operations: generally, it's less expensive to avoid a problem than to correct it. A number of disposal opportunities could be explored by the dairy industry:

a) Hauling the manure out of the basin to areas that can assimilate additional salt loading.

b) Financial participation in proposed composting facilities such as the one being implemented by the Chino Basin Municipal Water District. This would be acceptable only to the extent that the composted manure is removed from the basin. Indications from Chino Basin Municipal Water District are that markets for the composted manure to be produced by their proposed facility will be largely out of the Basin.

c) Financial participation in proposed waste-to-energy facilities. (Facilities have been proposed in the past which will convert manure into electricity and discharge the salt and other waste materials in an environmentally safe manner.)

Again, the amount of financial participation by the dairy industry in any of these, or any other methods of reducing the amount of manure that is discharged, may be considerably less than the cost of extracting the salt from the basin after it reaches groundwater (i.e., through participation in desalters). Note, however, that these manure disposal options do not address washwater; continued washwater application in the Basin will require mitigation through an appropriate offset program.

In summary, staff recommends that the waste discharge requirements for dairy operators in the Chino Basin be revised as follows:

a) Prohibit the disposal of manure and washwater, and their application as fertilizer or irrigation water, in the Chino Basin; and,

b) Incorporate an offset provision, whereby the dairy operator could offset the water quality impacts of continued manure and/or washwater disposal/application practices.

Two things about these recommended changes are important to understand. First, the intent of the changes is to keep pace with ongoing dairy operations to prevent further groundwater quality impacts to the Chino Basin. Second, these changes would not impose any unreasonable burden on the dairy operators; the operators would simply be required to mitigate the impacts of the salt loads for which they are responsible.

4. **Require the preparation and submittal of an engineered waste management plan as part of the Report of Waste Discharge.**

It was noted at the beginning of Section III that the Board has implemented specific requirements on dairy operations to protect surface waters. These include requirements for the containment of all washwater and all storm water runoff from manured areas (up to and including the 25-year, 24-hour storm), and for the protection of the facility from inundation by 100-year peak storm flows. Under the Board's current regulatory program, the dairy operator must provide a general description of the proposed containment controls as part of the Report of Waste Discharge. Staff experience in the dairy area indicates that this is not adequate.

Because of limited staff resources, only a fraction of the dairies within the Region have been routinely inspected over the last several years to evaluate the adequacy of the containment controls proposed and implemented by the dairy operators. Even when inspections are conducted, problems with the controls are not always readily apparent; what may appear to be adequate in the field during the dry season may actually fail to work properly when it rains. Discharges to surface waters may therefore occur. Enforcement actions resulting from these discharges frequently include the requirement that an engineer or other qualified person develop a waste management plan for the facility. This plan must then be implemented by the dairy operator.

It would be far more effective, and more efficient, to require that a properly engineered waste management plan be developed and submitted with the Report of Waste Discharge. This plan would be developed by a civil or agricultural engineer, a member of The West End Resource Conservation District or the Soil Conservation Service, or another qualified individual approved by the Executive Officer. The plan would include an evaluation of the existing waste containment controls and a detailed proposal for the additional containment controls, if any, that would be necessary to insure containment of the wastes generated on the dairy. In addition, the waste management plan would include a description of necessary operations and maintenance procedures [e.g., how often check valves should be left on in various fields, when manure should be removed from holding ponds (if these ponds continue to be utilized), activities necessary to control gopher and/or squirrel problems, etc]. Appendix F contains a sample list of the items that should be included in waste management plans. A stipulation would be included in the waste discharge requirements that the author of the waste management plan inspect the site facilities during construction and at the completion of construction to verify that the waste containment controls were built according to the recommended plan.

This requirement for an engineered waste management plan would be in effect for all animal confinement facilities requiring the submittal of a Report of Waste Discharge (new facilities, as well as existing facilities where the herd size has increased, the type of operation has changed, or the operators have changed). In the case of a change in operators, the submittal of an engineered plan developed by the previous operator would be acceptable, as long as there is no material change in the operation (ie., herd size remained the same).

The implementation of this plan should significantly reduce the frequency and magnitude of surface water discharges from dairies, in addition to protecting water quality. This would have the advantage of reducing staff expenditures on enforcement actions. The Board has recently acted on a number of dairy Administrative Civil Liability complaints resulting from illegal manured wastewater discharges. In each case, the fine was suspended provided that the operator submit and implement an engineered waste management plan. Had this plan been developed and implemented earlier, the discharges and subsequent enforcement action need not have occurred. This recommended approach is consistent with the recommendations of the Department of Water Resources in comments on proposed dairy waste discharge requirements (see Appendix D as an example).

Part II - Impacts From Past Dairy Practices

Part I of the recommended strategy deals with the abatement of the impacts of ongoing discharges of dairy wastes within the Chino Basin. Part II addresses the mitigation of the water quality impacts that past discharges of dairy wastes have caused within the Basin.

Water quality objectives for the Chino II and Chino III groundwater subbasins are being exceeded. Correction of this problem is imperative to protect the beneficial uses of those subbasins, and to prevent adverse impacts to the Santa Ana River and its downstream beneficial uses.

Responsibility for this water quality problem by dairies, other types of agriculture and other sources has been previously delineated in terms of the salt loads contributed to the Basin by each of these sources. Staff recommends that the responsibility for cleanup of the Chino Basin be assigned among these sources in proportion to their salt load contributions. <u>In this way, no one source would be asked to bear an unreasonable share of the cleanup burden: each source would be asked (or required) to assume only their fair share</u>.

A number of different approaches could be utilized to define the of proportional responsibility for each source. One method would be to employ data regarding salt added to the Basin by each source from the time that dairies began operation in the Chino Basin. Basin Plan model data indicate that significant dairy land use within the Chino Basin began about 1958 and has increased steadily since that time. Data on salt added to the Basin by dairies and other land uses since 1958 were presented earlier in this report. Under this approach, the dairies would be responsible for approximately 60% of the cleanup which is ultimately determined necessary to correct water quality degradation in the Chino Basin (see Table 1, Section I). Note that this may not require the removal of <u>all</u> salts added by the dairy industry, or by others.

An alternative method of assigning proportional responsibility could be based on the salt contributions by each of the various sources since the assimilative capacity for additional salt input into the Basin was reached. Other methods using different types or subsets of salt load data (or other data) could also be utilized. The determination of the specific proportional responsibility to be assigned to dairies or any other source is beyond the scope of this report and must await subsequent analysis and consideration. What is being proposed herein is the <u>concept</u> of proportional responsibility and the use of that concept to develop an equitable approach to water quality correction in the Chino Basin.

As stated earlier, Basin Plan modelling studies confirm that desalter operations will be an integral element of any Chino Basin cleanup strategy. The implementation of these desalters is already being pursued by other agencies within the Region. Other measures may be required. Staff believes that the costs of implementation and operation of any of these measures should be borne by all the sources of salt input, again, in proportion to their salt contributions.

It is recognized that the costs of cleanup in the Chino Basin will be large and may impose a significant burden on the dairy industry or other sources. A source of funding which the dairy industry, and other sources, are encouraged to explore is the formation of integrated financing districts, whereby liens would be placed on properties and collected when the properties are sold. The funds would then be used to fund cleanup projects. It has been noted that other agencies with water quality interests in the Chino Basin are already pursuing the implementation of some cleanup measures. Financial participation in these facilities may to some extent alleviate the costs to the dairy industry per se.

The Board could take two approaches to ensure that the dairy industry's portion of the cleanup program described above is achieved. One approach would be through enforcement orders (Cleanup and Abatement Orders) issued to each dairy operator. Alternatively, the Board could accept the voluntary commitment by the dairy industry to ensure that the necessary cleanup is accomplished. If said cleanup was not accomplished in this cooperative atmosphere, the Board could resort to appropriate enforcement. The choice of approach clearly rests with the Board, and with the dairy industry.

Part III - Surface Water Quality Impacts: Control of Urban Drainage in the Chino Agricultural Preserve

The third part of the recommended Chino Basin strategy addresses surface water drainage problems in the dairy area caused by runoff from upstream urban development. As discussed previously, this urban runoff creates additional difficulties for a number of dairy operators in complying with the manured water containment requirements contained in their waste discharge requirements. Recommendations are presented below to address this problem. It must be emphasized that these recommendations are directed to the counties and cities, rather than to the dairy industry.

A number of studies have been conducted to determine the best method of preventing urban stormwater runoff impacts in the Chino Basin dairy area. The most recent study, conducted with federal 205(j) planning funds, was completed in 1987 ("Chino Agricultural Preserve Drainage and Land Use Study"). The recommended solution to urban drainage problems was the construction of a trapezoidal earth swale at the northern boundary of the dairy area (roughly, at Riverside Avenue, between Campus Avenue and the Cucamonga Creek flood control channel (just west of Archibald Avenue)). This swale would intercept flows from upstream urban areas (cities of Ontario and Chino) and convey these flows to the Lower Cucamonga Spreading Grounds, adjacent to the Cucamonga Creek channel.

Funding for this measure was sought through the Agricultural Drainage Water Management Loan Program administered by the State Water Resources Control Board (State Board), but the project did not qualify. A new source of money has recently become available through the State Revolving Fund Loan Program. The State Board is proposing to set aside a minimum of $5 million of FFY 1991 State Revolving Fund monies for the purpose of issuing loans for eligible nonpoint source and/or estuary enhancement activities. Staff believes that the swale project will qualify as a nonpoint source project. The San Bernardino County Department of Transportation and Flood Control has recently applied to the State Board for a loan under this program.

To alleviate drainage problems in the dairy area and thereby reduce surface water quality problems which result from dairy waste inputs, the following measures need to be implemented:

1. Riverside Avenue interceptor swale - San Bernardino County and/or the cities of Ontario and Chino should pursue the funding and implementation of the interceptor swale project at Riverside Avenue.

2. Other drainage controls - Both San Bernardino and Riverside counties and the cities tributary to the dairy area should identify and implement a coordinated program of drainage controls necessary to supplement the interceptor swale and prevent drainage problems within the dairy area.

The Counties will be required to implement such best management practices (BMPs) as part of their upcoming NPDES stormwater permits.

DAIRY OPERATIONS OUTSIDE THE CHINO BASIN

This report has focused on dairy operations and water quality problems in the Chino Basin. Since the greatest concentration of dairies occurs in that area, this focus seems appropriate. But it must be remembered that there are established dairies elsewhere in the Region, specifically, in the San Jacinto Basin. Many new dairies have been established in the San Jacinto Basin in recent years, and this trend appears to be continuing. To prevent the recurrence of the groundwater quality problem now confronting the Region in the Chino Basin, staff believes that an appropriate dairy waste management strategy for the San Jacinto Basin must be developed and implemented. The pattern of dairy land use, the quality of underlying groundwater, the availability of assimilative capacity in the San Jacinto groundwater subbasins should be considered in more detail before recommending a specific strategy. However, it is anticipated that many elements of the strategy recommended for the Chino Basin, particularly those parts which pertain to modifications of Waste Discharge Requirements, would apply also in the San Jacinto Basin. Staff recommends that the Board direct staff to prepare a dairy waste management strategy for the San Jacinto Basin.

APPENDIX A

Salt Loading Unit Factors: Development and Application in the BPP

Since the early 1970's, the Regional Board, in cooperation with the Santa Ana Watershed Planning Agency (SAWPA) (now known as the Santa Ana Watershed Project Authority), has used a water quality-quantity mathematical model called the Basin Planning Procedure (BPP) to estimate the water quality impacts of the dairy industry and other types of land use on the waters of the basin. This modeling procedure is capable of making projections of water quality over time, based on assumptions of future patterns of land use and associated waste loads. The modeling results are used to identify optimal water and wastewater management plans, which are then incorporated in the Basin Plan. The Plan is implemented through the regulatory requirements of the Board and through the participation of interested agencies, such as SAWPA, in implementing programs and facilities found necessary to protect water quality (e.g., the financing and construction of physical facilities such as desalters).

Model Operations: Unit Factors

The BPP calculates waste loads and water demands by multiplying land use acreages in various categories by specific values, known as unit factors. 23 different land uses are identified in the model: six agricultural uses, two industrial uses, nine urban-commercial uses inside the house, and six urban-commercial uses outside the house (Table A-1). Each of these has been assigned a unit factor value for 1) water demand, 2) consumptive use, and 3) salt added to the groundwater (Table A-1: 1a,1b,1c, respectively). The salt loading unit factor for a given land use represents the mass loading of salt (expressed as tons/acre/year) that will be transported through the unsaturated surface soil and enter into the underlying groundwater as a result of that land use. An example of the waste load calculation for dairies is as follows. Assuming that there are 640 acres of dairy land and that the salt loading unit factor for dairies is 2.4 tons/acre/year, the dairy waste load would be :

640 acres x 2.4 tons salt/acre/year = 1536 tons salt/year

The modeling process starts with a baseline table of unit factors. Table A-1 shows the values used in the development of the 1983 Basin Plan (Alternative III). Any of these unit factors can be changed, if appropriate, at five year intervals through the planning period being modeled. The unit factors can also vary spatially, i.e, the unit factors for a specific land use type can vary from one area of the Region to another. These changes in unit factors can reflect changes in waste management practices and

Table A-1

BASIN PLANNING PROCEDURE

General Table of Unit Factors for the 1983 Basin Plan (Alternative III Model Run)

1A Water Demand Unit Factors

Land Use Category	Unit Factor Acre Feet/Acre/Year (or as noted)
Agriculture	
1. Irrigated Pasture & Field Crops	3.4
2. Irrigated Row & Truck Crops	2.8
3. Irrigated Orchards	2.6
4. Vineyards	0.6
5. Dairies, Feedlots, Poultry	0.84
6. Other Agriculture	0.0
Industry	
7. Light Industry	1.35
8. Heavy Industry	0.0
Urban-Commercial (Inside Use)	
9. Single Family Residential	90.0 gpcd
10. Multiple Family Residential	95.0 gpcd
11. Regional & General Commercial	1.2
12. Commercial Strip	1.0
13. Neighborhood Shopping Centers	1.2
14. Public & Institutional Facilities	80.0 gpcd
15. Schools	1.0
16. Transportation/Communication (Airports)	0.0
17. Military	0.1
Urban-Commercial (Outside Use)	
18. Single Family Residential	130.0 gpcd
19. Multiple Family Residential	90.0 gpcd
20. Public & Institutional Facilities	0.4
21. Schools	0.6
22. Irrigated Greenspace	1.3
23. Transportation/Communication	0.1

Table A-1 (cont.)

1B Consumptive Use Unit Factors
Land Use Category

Land Use Category	Unit Factor Percent Consumed
Agriculture	
1. Irrigated Pasture & Field Crops	0.50
2. Irrigated Row & Truck Crops	0.60
3. Irrigated Orchards	0.70
4. Vineyards	0.65
5. Dairies, Feedlots, Poultry	0.60
6. Other Agriculture	0.0
Industry	
7. Light Industry	0.50
8. Heavy Industry	0.50
Urban-Commercial (Inside Use)	
9. Single Family Residential	0.0
10. Multiple Family Residential	0.0
11. Regional & General Commercial	0.333
12. Commercial Strip	0.2
13. Neighborhood Shopping Centers	0.333
14. Public & Institutional Facilities	0.0
15. Schools	0.0
16. Transportation/Communication (Airports)	0.0
17. Military	0.0
Urban-Commercial (Outside Use)	
18. Single Family Residential	0.714
19. Multiple Family Residential	0.714
20. Public & Institutional Facilities	0.667
21. Schools	0.667
22. Irrigated Greenspace	0.692
23. Transportation/Communication	0.600

1C Salt Added Unit Factors
Land Use Category

Land Use Category	Unit Factor Tons/Acre/Year (or as noted)
Agriculture	
1. Irrigated Pasture & Field Crops	0.234
2. Irrigated Row & Truck Crops	0.296
3. Irrigated Orchards	0.312
4. Vineyards	0.142
5. Dairies, Feedlots, Poultry	2.38
6. Other Agriculture	0.0

Table A-1 (cont.)

1C Salt Added Unit Factors

	T/A/Y(returnwater)
Industry	
7. Light Industry	0.408
8. Heavy Industry	0.408
Urban-Commercial (Inside Use)	
9. Single Family Residential	0.34
10. Multiple Family Residential	0.34
11. Regional & General Commercial	0.34
12. Commercial Strip	0.34
13. Neighborhood Shopping Centers	0.34
14. Public & Institutional	
15. Schools	0.34
16. Transportation/Communication (Airports)	0.34
17. Military	0.34
Urban-Commercial (Outside Use)	
18. Single Family Residential	0.147
19. Multiple Family Residential	0.147
20. Public & Institutional Facilities	0.173
21. Schools	0.173
22. Irrigated Greenspace	0.657
23. Transportation/Communication	0.275

requirements. For example, a more restrictive manure disposal requirement (i.e., less than 3 tons/acre/year on disposal land allowed) would translate into a lower salt unit factor for dairy operations (provided that there is compliance). Thus, by adjusting the unit factors assigned, the effectiveness of both present and proposed regulatory strategies (e.g., manure disposal requirements) in protecting water quality can be tested. In this way, the BPP serves as an excellent regulatory tool.

Most of these unit factor values were derived initially in early work by the Department of Water Resources (DWR) and consultants to SAWPA (as the Board's Basin Plan contractor). Some have undergone significant change over time. The evolution of the dairy salt loading unit factor is a case in point; a concise review of this evolutionary process is helpful in understanding the Board's present dairy regulatory program and the use of the BPP to evaluate possible changes in dairy waste management strategy.

Dairy Salt Loading Unit Factors

As stated in the main body of this report, there have been numerous BPP runs made over the past two decades to evaluate the water quality effects of the dairy operations in the Chino Basin. Each time these runs have been conducted, the dairy salt loading unit factor to be used in the model has been considered. Most recently, the dairy salt unit factor (and those for other land uses) was considered in conjunction with the modeling studies being conducted as a part of the ongoing watershed-wide nitrogen study. A summary of the dairy salt loading unit factors which have been or are being employed in BPP modeling efforts to date is provided in Table A-2, below.

TABLE A-2

Dairy Salt Loading Unit Factor
(tons/acre/year)

	TDS	Nitrate
1975 Basin Plan	0.59	---[1]
1983 Basin Plan (Alternative I)	3.38	---[1]
1983 Basin Plan (Alternative II)	2.97	---[1]
1983 Basin Plan (Alternative III) (Recommended Plan)	2.38	---[1]
1988 MWD Chino Basin Conjunctive Use Study	5.94	1.205
1988 Basin Plan Base Plan	2.4	---[1]
1988 Basin Plan Alternative III	1.75	---[1]
1989 Nitrogen Study	2.54 (2.54 (historic)	0.776

[1] BPP calibrated only for TDS through 1988. Model calibration for nitrogen and incorporation of nitrate unit factors are part of 1989 watershed-wide nitrogen study (James M. Montgomery Engineers for SAWPA/SARDA, et al).

The differences among the unit factors shown in Table A-2 are related to actual or assumed dairy waste management practices and the amount of salt thereby removed from the dairy area. The 1975 Basin Plan unit factor was based on the assumption that all wash water would be removed from the dairy area and that all but 10% of the manure generated would be exported (i.e., 90% removal of all dairy salt). The other unit factors reflect different information regarding wash water and manure disposal. As discussed in the main body of this report, wash water removal through sewering (or any other means) has not been accomplished. Therefore, the unit factors used from 1983 and later include the salt associated with wash water disposal on pasture and cropland in the dairy area. These later unit factors also reflect different assumptions or estimates (based on dairy annual reports) of the amount of manure removed from the area. For the 1988 Basin Plan update baseline run (Base Plan), for example, information from the 1987 dairy annual reports indicated that only 50% of the manure generated in the dairy area was removed. This translated to a salt loading factor of 2.4 tons/acre/year (Table A-3). The water quality effects of a proposed alternative plan were also evaluated (Alternative III (1988)); the dairy salt unit factor assumed therein for planning purposes was 1.75 Tons/Ac/Year. Clearly, this lower unit factor implies that more manure was removed from the area. Note that greater manure removal could theoretically be achieved through greater compliance with the Board's existing manure disposal requirement (3 Tons/Ac/Year) or through the adoption of (and full compliance with) a more stringent manure disposal requirement. This illustrates how the BPP can be used to assess the water quality impacts of changes in the nature and/or implementation of the Board's requirements.

Table A-3

1988 Base Plan Dairy Salt Unit Factor

Calculation of 1988 Base Plan (Upper Santa Ana Basin Plan Update) dairy salt unit factor:

a. 4.061 tons salt/acre/year = total unregulated salt loading to groundwater from dairy operations (Webb, 1974, Table 12; 15 cows/acre assumed)

b. 50% removal of dairy manure (see calculation below):
4.061 x 50% = 2.0305 tons salt/acre/year.

c. no wash water removal; wash water applied to dairy land; wash water contains approx. 10% of the total dairy waste salt load (Webb, 1974):
4.061 x 10% = 0.4061

d. total dairy salt load to groundwater:
2.0305 + 0.4061 = 2.436 (2.4) tons/acre/year

Calculation of % manure removal: (data from annual dairy compliance report to the Regional Board (4-10-87))

Manure produced: ~ 448,500 tons(dry weight)

Manure reported hauled: ~ 362,000 tons

fate of manure hauled is unknown: assume that 1/2 of 362,000 hauled is removed from Basin = ~ 181,000 tons

manure reported used on cropland: ~ 57,400 tons

```
 448,500
-181,000
 -------
 267,500
- 57,400
 -------
 210,100  tons
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210,100 / 448,500 = 0.47 or ~50%

Note: For the 1988 year (March 10, 1989 report) the manure removal value came to about 55%.

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A point which was made earlier in this report should be reemphasized here. That is that these salt loading unit factors for dairy operations are estimates. The information which is available concerning manure removal from the dairy area comes almost exclusively from the dairy annual reports submitted by the dairy operators. **It must be emphasized** that this information is neither detailed nor necessarily accurate and is not adequate to provide a true picture of the actual fate of all the manure generated. An improved manure tracking system is definitely necessary for this purpose. Further, we do not consider our understanding of the fate of salts applied to surface soils via dairy waste disposal to be definitive. A comprehensive groundwater monitoring program is necessary to provide actual data on the impacts of dairy operations. The information presented by Webb (1974) regarding salt loading rates from dairy operations to groundwater is widely accepted as the best available at the present time. But it is possible that monitoring data and more refined modeling techniques would suggest that modifications of the salt unit factors, for dairies and other types of land use, would be appropriate.

Nondairy Agricultural Salt Unit Factors

Nondairy agricultural salt loading unit factors were developed by in the early 1970's for use in the BPP (WRE, 1970). Since precise records of crop types and fertilizers for agricultural lands within the Region did not exist, unit salt loading factors were estimated by formulating a regional fertilizer mix on a weighted average basis, with common fertilizers used within the Region. This mix is presented below:

Table A-4

Common Fertilizers and Relative Use[1]

Fertilizer Type	Relative Use
Urea, Anhydrous Ammonia	60%
Calcium Nitrate	10%
Ammonium Sulfate	10%
Dairy Manure	20%

[1] (WRE, 1970)

A fertilizer mix weighted by relative use consists of the following weights of anions and cation per 100 lbs. of total nitrogen:

Table A-5

Ion Content of Regional Fertilizer Mix for 100 Pounds of Nitrogen[1]

Cations	Weight (lbs.)	Anions	Weight (lbs.)
Ca	126	Cl	8
Mg	4	SO_4	45
K	23	NO_3	359
Na	5	PO_4	14

[1] (WRE, 1970)

Note that direct conversion of 100 lbs. of nitrogen to nitrate (NO_3) is 443 lbs. However, Table A-5 lists only 359 lbs. of nitrate for every 100 lbs. of total nitrogen. The reduction from 443 to 359 lbs. is attributable to the assumed volatilization of nitrogen in the form of ammonia and the fixation (uptake) of nitrogen by soil microorganisms (WRE, 1970).

When the regional fertilizer mix is applied to the agricultural soil, crop uptake, volatilization, soil microorganism fixation, and a number of geochemical reactions occur which effectively reduce the amount of salt contained in the fertilizer from leaching to the underlying ground water aquifer. Volatilization and fixation of nitrogen have already been taken into account. Crops will utilize nitrate (NO_3) and ammonium (NH_4), potassium (K), and phosphate (PO_4). Cations will adsorb to and desorb from negatively charged soil particles which constitutes a process known as ion exchange. Available phosphorous may also react with calcium to form a relatively insoluble product, calcium phosphate, which is immobile in the soil. Calcium (Ca) and magnesium (Mg) will react with bicarbonate (HCO_3) in the irrigation water to also form relatively insoluble salts. The anions chloride (Cl), sulfate (SO_4), and nitrate (NO_3) will move readily with the soil water and associate with the most predominant cation, which is also transported through the soil. Since the soils in the Chino Basin dairy area are reported to be rich in calcium, this cation was assumed by WRE (1970) to be transported with the mobile nitrate or sulfate. However, sodium was assumed to be associated with the chloride moving through the soil, which does not result in a significant difference in the total salt unit load factor.

By applying the regional fertilizer mix to similar crop types at application rates developed through consultation with local farm advisors, the salt contribution to ground water was estimated by WRE, (1970). As an example of the detailed computations required for the formulation of each loading factor, the specific case for irrigated citrus was considered by staff, using WRE's methodology.

Table A-6

Development of the Salt Loading Factor for Irrigated Citrus

Ion	Weight Per 100 lbs N (lbs.)	Weight Per 100 lbs N (lbs.)	Crop Uptake (lbs.)	Leaching (lbs.)
Ca	126	202	--	124[$Ca(NO_3)_2$] 32[$Ca(SO_4)$]
Mg	4	23	--	--
K	23	37	37	--
Na	5	8	8	8 [NaCl]
Cl	8	13	--	13
SO_4	45	72	--	72
NO_3	359	574	186	388
PO_4	14	22	--	--
Total Salt				**637 lbs. (0.318 tons)**

Thus, 0.318 tons of salt/acre/year was estimated by staff to be contributed to the ground water from the application of the regional fertilizer mix from citrus agriculture. This value is reasonably consistent with the unit factor reported by WRE (1970) of 0.312. The reason for the difference is unknown, but might be the result of round off error or slight differences in the fertilizer application rate or crop uptake rates, which were reported by Hassan (1969).

The nondairy agricultural salt unit factors developed by WRE have been used in BPP work with only minor modifications since the early 1970's. However, some of these unit factors were recently updated through the calibration of the BPP in work performed by James M. Montgomery Engineers (JMM, 1989) as part of the watershed-wide nitrogen study. Unit factors for nitrate as well as TDS have also been developed by JMM for these nondairy agricultural land uses. An historical listing of the unit factors for nondairy agricultural land use is shown below:

Table A-7

Unit Salt Loading Factors for Nondairy Agricultural Land Use

(Tons/Acre/Year)

Land Use	WRE (1970)*	Basin Plan Update* (1983)	JMM (1989) TDS	JMM (1989) No3
Irrigated Pasture + Field Crops	0.234	0.234	0.23	0.146
Irrigated Row + Truck Crops	0.296	0.296	--	--
Irrigated Orchards	0.312	0.312	0.21	0.0
Vineyards	0.142	0.142	0.142	0.080
Other Agriculture	0.0	0.0		
Non Irrigated Hay and Pasture, Field Crops	0.0	--	0.23	0.146

*Model calibrated only for TDS; no nitrate unit factors.

Model Evaluation of Salt Leaching from Fertilizers

Nondairy agricultural salt unit factors have been considered even more recently by Regional Board staff (as a part of the preparation of this report). In order to evaluate the amount of salt leaching from various fertilizers to the ground water, Regional Board staff employed a computer model developed by the U.S. Salinity Laboratory. The model simulates the steady-state transport of specific ions which comprise the salts in fertilizers. Essentially the same methodology that was used by UCCC (1973) was employed during this analysis. These comparisons[1] were made to provide general insight into the relative amounts of salt contained in fertilizer that leach beyond the plant root zone and enter the underlying ground water. Simulations which consider all factors which will effect salt transport in soil, such as, soil composition and stratigraphy or the addition of soil amendments were not considered in this evaluation.

The computer model developed by the Salinity Laboratory is commonly used to evaluate the suitability of water for irrigation use. The model simulates the concentration (meq/l) of predominant anions and cations in the soil water within the plant root zone. Not all of the salt that is applied to land from fertilizer or irrigation water will leach to the ground water table. Plants will take up significant amounts of nitrogen and to a much smaller degree some of the other salts. Some of the other salts in the soil water will also precipitate to form relatively insoluble compounds that remain in the soil. Thus, only about one-half of the salts originally applied to the soil will actually be transported to the ground water, but the actual amount depends on factors considered in the model, which include the irrigation leaching fraction, the partial pressure of CO_2, and the specific ion characteristics of the irrigation water and applied fertilizer, and the ionic strength of the soil water solution.

The Salinity Laboratory model does not account for plant uptake or the presence of phosphate in the applied water. Thus, a computer program (prepwats.m) was developed by staff to consider these factors before the Salinity Laboratory model (watsuit.for) could be employed. Staff used the same rationale employed by UCCC (1973). A second computer program (convwats.m) was also formulated by staff to convert the results produced by the Salinity Laboratory model into unit loading rates (tons/acre/year) commonly used in the Santa Ana Basin computer model. All of the computer programs employed for these evaluations are included in this Appendix.

The results of these simulations are described in Section III-D.

[1](Presented in Tables 4-10 and 4-11 of this staff report).

APPENDIX B

Calculation of the 3 ton(dry)/acre/year Manure Disposal Requirement

Using data generated by UCCC (1973a) and UCCC (1973b),(and reported by Webb (1974), Regional Board staff developed a regression curve for the relationship between the amount of salt applied to agricultural land in manure and the mass of salt which will migrate to groundwater.

The form of the regression curve is:

$$y=ax^b$$

where:

y = the mass of salt per acre transported to the ground water.

x = the mass of salt per acre applied to the agricultural land in the manure.

a = 0.34988

b = 1.06473

The regression coefficient for this curve fit was 0.99933, where a value of 1.00 represent a perfect fit of the regression curve with the data.

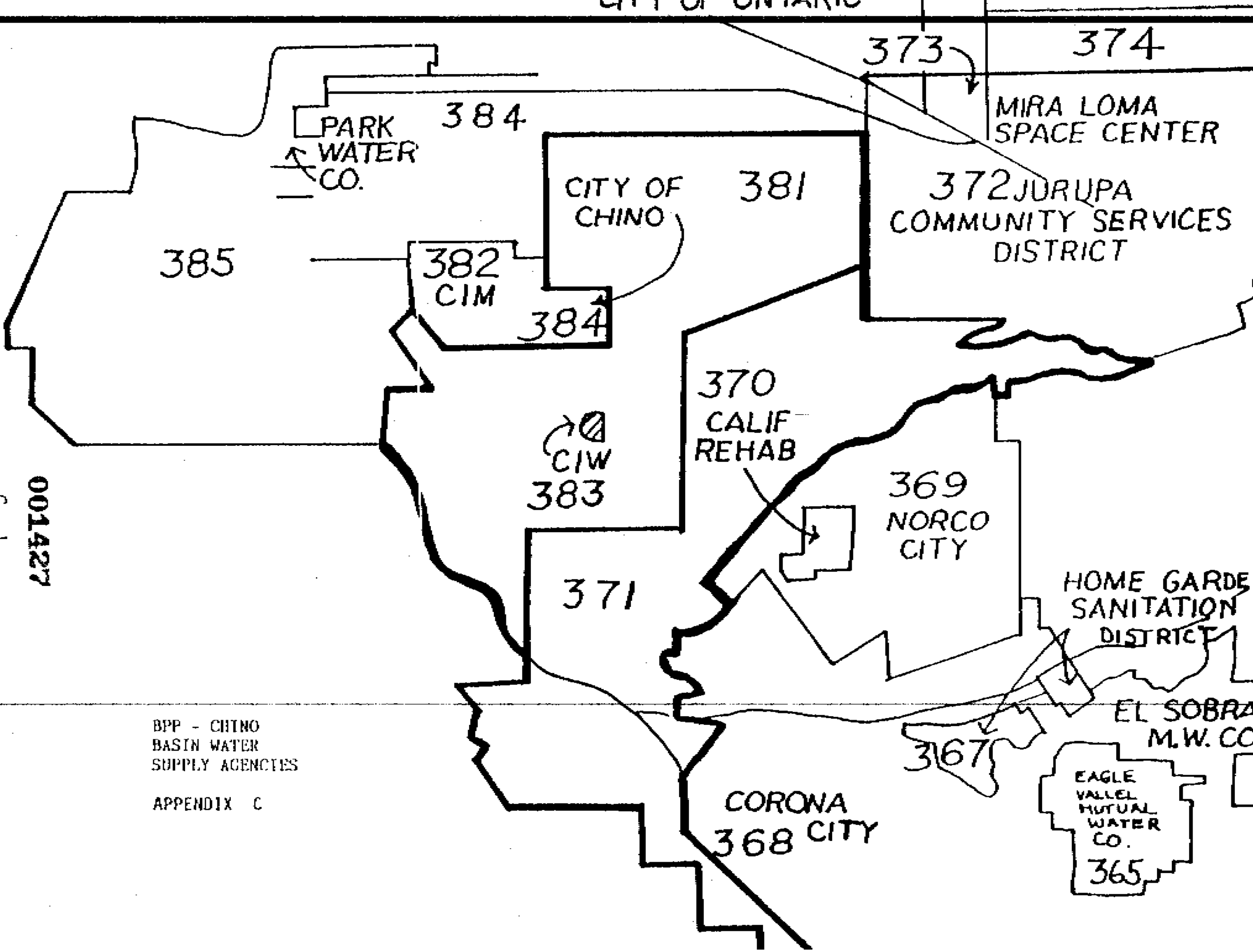
The calculations substantiating the 3 ton dry manure/acre/year application limit uses this regression curve. These calculations are presented below:

Allowable amount of salt that may be applied:

$$(0.30/0.34988)^{1/1.0647} = 0.86 \text{ tons of salt/acre/year}$$

Allowable dry weight of manure that is equivalent to the 0.86 tons/acre loading rate is:

$$\frac{0.86 \text{ tons salt}}{\text{acre}} \times \frac{1 \text{ ton manure}}{0.2873 \text{ tons salt}} = \frac{3.01 \text{ tons dry manure}}{\text{acre year}}$$



BPP - CHINO
BASIN WATER
SUPPLY AGENCIES

APPENDIX C

001427

State of California

Memorandum

Date : September 26, 1989

To : California Regional Water Quality Control Board
Santa Ana Region
6809 Indiana Avenue, Suite 200
Riverside, CA 92506
Attention: Joanne Schneider
Environmental Program Manager

SEP 27 1989
JES 9-27
HOA 9-29
EM 10-2

From : Department of Water Resources
Los Angeles, CA 90055

Subject : Order No. 89-131, Waste Discharge Requirements for J. B. Aquerre, dba J. B.'s Calves, Chino, San Bernardino County

We appreciate the opportunity to review and comment on the subject discharge.

In support of your requirements to protect the local water resources we recommend that the discharger, J.B.'s Calves, be required to submit the following to your Executive Officer for evaluation and approval:

1. A site specific engineering plan to retain all dairy waste water within the dairy including the precipitation on and drainage through manured areas which can result from rain in a 24-hour period in a 25 year, 24-hour storm; and,

2. A site specific engineering plan to divert surface flow to prevent inundation of the disposal and manured areas by runoff that could result from a 24-hour, 100 year frequency storm.

And we recommend that this order stipulate that manure removed from the dairy for offsite disposal be hauled only to sites previously approved by the Board to accept dairy waste.

We also recommend that the underlined be added to requirement No. 3 in the Reporting Program.

3. All reports shall be signed and submitted by a principal executive officer or equivalent or his/her authorized representative under penalty of perjury.

If you have any questions concerning our comments, you may wish to contact Harry Iwanaga of my staff at (213) 620-4836.

Harry Iwanaga

for Ahmad A. Hassan, Ph.D., Chief
Resources Inventory Branch

APPENDIX D

Appendix E

SAMPLE MANURE TRACKING MANIFEST

This form must be completed for each day and each location where manure is transported. All information provided on this form is submitted under penalty of perjury.

Operator's Name: ______________________________

Facility Name: ______________________________

Facility Address: ______________________________

Mailing Address: ______________________________

Hauler's Name: ______________________________

Amount Hauled: ____________Tons Date Hauled: ____________

Hauled to: (address, Township/Range coordinates, or nearest major cross street)

____

Hauler's Signature: ______________________________

Date: ____________

Owner/Responsible Party of Final Destination Point: (print or type)

____

Owner's/ R.P.'s Signature: ______________________________

Date: ____________

This form must be returned to the animal confinement facility operator upon completion.

APPENDIX F

ITEMS THAT SHOULD BE INCLUDED IN ENGINEERED WASTE MANAGEMENT PLANS

The following information shall be submitted as an attachment to Reports of Waste Discharge for all animal confinement facilities. The waste management plan shall be developed by a registered professional engineer, a member of the West End Resource Conservation District, a member of the Soil Conservation Service, or other qualified persons, as approved by the Executive Officer.

SITE PLAN REQUIREMENTS

The Site Plan shall include:

1. Assessor parcel number(s), address and/or legal description of the facility.

2. Name, address, and telephone number of the owner and operator of the proposed facility.

3. The total gross acreage of property, showing all existing and/or proposed facilities [including buildings, storage areas, berms, holding ponds, well sites, pumping facilities, storm water conveyance facilities, culverts, drainage easements, disposal area(s), cropland (whether farmed by the owner/operator or another party), etc]. Include the overall dimensions, north arrow, date the plan was developed, and scale. The site plan shall be submitted at an appropriate scale that shows sufficient detail of the proposed facility and all site operations including all disposal areas and wastewater containment structures. A recommended scale would be 1" = 50'. The plan should be drawn on standard 17 X 36 blue print format.

4. Containment facilities shall be designed to retain on the property all dairy washwater and stormwater runoff due to precipitation on and drainage through manured areas which results from any one storm event up to and including a 25-year, 24-hour storm event. All manured areas shall be protected from inundation resulting from a 100 year frequency storm. The site plan shall show all facilities necessary for containment and management of all storm water flows onsite as well as the interception

and conveyance of any offsite storm water flows through the proposed site.

7. The site plan shall show the size, elevations, and location of all facilities proposed for containment of wastewater and storm water flows on the site (berms, holding ponds, upstream diversion structures, etc.). Cutaway details of these structures shall be shown.

8. A description of all of the existing and proposed disposal areas for washwater shall be provided. This description should include all disposal areas and/or cropland designated to receive dairy wastes.

DESIGN CALCULATIONS

Design calculations shall include:

1. The volume of dairy washwater generated.

2. A determination of the amount of rainfall that will result from a 24-hour, 25-year storm event.

3. The total amount of water that will need to be contained onsite (washwater + stormwater).

4. The volume of upstream flows that will need to be diverted from manured areas from 100 year storm events (a description of the methodology used to determine the volume of the 100 year storm event should also be included).

5. Percolation rates used in determining wastewater management.

CONSTRUCTION SPECIFICATIONS

Construction Specifications shall include:

1. The construction material to be used and the method of compaction of all berms and/or other containment structures.

OPERATIONS PLAN

The Operations Plan shall include:

1. A proposed rodent control program.

2. A proposed pond management program (this program should be directed to providing maximum capacity prior to winter storms, periodic dredging, etc.)

3. A proposed wastewater distribution program (rotation of fields/areas receiving wastewater, etc.)

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