Chapter 4. THE PLANNING FRAMEWORK

Planning takes place within an established framework of public sector policy and law and private sector resource use and management. This framework must be acknowledged in developing plans for solving drainage and related problems, and planning objectives and criteria must be based on it.

This chapter outlines drainage-related public policy, local drainage management initiatives, and the planning objectives, methods, and criteria upon which plans presented in the following chapters are based.

PUBLIC POLICY

The policy base adopted for Drainage Program planning is discussed in the following sections in terms of drainage service, environmental protection, drainage studies and monitoring, and constraints.

Drainage Service

The need for management of drainage water has long been recognized by both the State and Federal governments and has been stated in a number of official documents, especially in the Federal legislation and administrative arrangements for supplying water to the western side of the San Joaquin Valley. Official recognition of the need for solving the drainage problem, if not indeed commitments for actually solving it, appears in legislative statements about "drainage service" or "drainage management plans."

The legislation authorizing the San Luis Unit of the Federal Central Valley Project requires that an interceptor drain be provided for the Unit. Beginning in 1965 and each year since then, Congress has included a provision in the CVP appropriations act that prohibits selection of a final point of discharge for the San Luis Drain until certain conditions have been met. An appraisal-level study of the San Joaquin Valley Drain serving the entire valley was authorized in 1974 and completed in 1979 (IDP, 1979), and a feasibility study was authorized in 1980 but was never completed. The funding of studies indicates the Federal government recognizes the need for a drainage solution. Construction of an 85-mile portion of the San Luis Drain demonstrates a Federal commitment to solve the problem. A 1986 Federal court order in the compromise settlement of *Westlands Water District* v. *United States of America* requires the United States to develop and adopt a drainage plan acceptable to Westlands by December 31, 1991.

The State of California has also acknowledged in a number of documents the need to manage agricultural drainage in the San Joaquin Valley. *The California Water Plan* (DWR, 1957) recognized the need for drainage in areas proposed to be irrigated, especially on the western side of the San Joaquin Valley. The Tulare Basin has subsequently become a part of the area provided irrigation water from the State Water Project. In discussions with the Federal government regarding a master drain from the San Joaquin Valley, the State has, at various times since 1957, tentatively agreed to participate in such a drain, but has never actually done so.

Environmental Protection

Federal and State environmental protection laws, regulations, and local ordinances affect possible drainage-related strategies and provide objectives and constraints that must be satisfied in drainage plans. The primary laws relevant to drainage problems are:

Federal	State
Fish and Wildlife Coordination Act	California Environmental Quality Act
Migratory Bird Treaty Act	California Administrative Code:
National Environmental Policy Act	Title 22 (Hazardous Wastes)
Resource Conservation and Recovery Act	Title 14 (Natural Resources)
Federal Endangered Species Act	California Fish and Game Code
Clean Water Act	California Water Code
	Porter-Cologne Water Quality Control Act
	Toxic Pits Cleanup Act
	California Endangered Species Act

For planning, it is assumed that, at a minimum, drainage plans will have to meet the objectives and standards embodied in or developed pursuant to these laws. The primary standards to be met from both State and Federal laws are included in the Level A performance standards presented in the "Planning Objectives" section of this chapter.

Plans developed to comply only with present laws may not provide sufficient guidance for future decision-making. Efforts are under way to increase protection from additional potentially harmful substances introduced into the environment and to lower the permissible concentration of a toxicant or contaminant in the environment. Moreover, the trend of scientific discovery is toward revealing an increasingly complex natural environment. It is possible that even more stringent standards for environmental protection may apply in the future. To address a range of possible future conditions, plans will be developed for more stringent (Level B) performance standards. These standards are also presented in the "Planning Objectives" section of this chapter.

The A and B levels of performance are presented to bracket a range of probable future conditions. Judgment must be exercised in limiting the enormous range of possible future conditions. For example, the Drainage Program has assumed that water-quality objectives will be set in terms of concentrations of substances allowable in receiving water, rather than in terms of the total load allowed in drainage water. This is a subjective assumption, not a declaration of a preference.

Drainage Studies and Monitoring

Intensive studies of causes and impacts of contaminant-related drainage problems began in 1983 and were continued through the balance of the decade (see "Selected Bibliography" at the back of this report). Although much has been learned, knowledge of some aspects of drainage problems is still limited, and many uncertainties about solving the problems remain. Areas of limited knowledge include interactive and long-term effects of contaminants on fish and wildlife, levels of public health risk posed by contaminants, specific causes of water table rise and deterioration of water quality on small land units, the long-term sustainability of agriculture under existing hydrologic and economic conditions in the valley, and future drainage conditions. To learn more, the effects of the drainage problem on the environment should be monitored.

The basic strategy of monitoring should be to identify and collect information on biota, soils, and the water regime so that changes in drainage problems and conditions can be determined, particularly in response to actions taken to solve the problem. Plans can then be re-evaluated periodically and adjusted in light of new knowledge and new conditions. Design, funding, and implementation of a comprehensive long-term monitoring program are needed.

Constraints

In addition to the laws and performance standards cited previously, two Drainage Program policies further constrain planning. All alternative plans must: (1) Meet the water-quality objectives of the State of California, and (2) focus on in-valley solutions. [Action by the Drainage Program Policy and Management Committee on June 15, 1987.]

Objectives for both surface- and ground-water quality adopted by the Central Valley Regional Water Quality Control Board and approved by the State Water Resources Control Board have become objectives for plan development. Level B performance standards make provision for more stringent standards in the future.

The focus on in-valley solutions precluded study by the Program of the removal of drainage water from the valley by any means other than the San Joaquin River. This policy did recognize, however, the need to study and describe the distribution and fate of salts in the drainage problem area.

LOCAL DRAINAGE MANAGEMENT INITIATIVES

Initiatives by local water management organizations to manage drainage and related problems are presently under way in each subarea, and it appears they will contribute to improving management of the problem. Most local initiatives to improve existing water supply and drainage management practices involve outside cooperators, sponsors, regulators, or other participants. These efforts are typically implemented through a variety of organizational and institutional arrangements that link individual water users, local and regional water management organizations, university researchers, and State and Federal agencies (Coontz, 1990b). Local initiatives should be encouraged, supported, and coordinated as part of an overall management plan.

Many local initiatives are not mentioned in the alternatives and recommended plan presented in the following chapters because the plan is not detailed. Some of the more significant of these include: (1) on-farm water management evaluation and conservation programs; (2) drainage reuse, treatment, and disposal studies and demonstration projects; and (3) construction of new water management facilities and improvements to existing facilities. Local initiatives seeking to reduce drainage volumes, effect institutional change, restore and protect fish and wildlife habitat, and develop workable methods of treating and disposing of drainage water are important contributors to management of the problem and are considered part of the plan.

PLANNING OBJECTIVES

The technical objectives that guided formulation of alternative plans are stated in terms of specific aspects of drainage and drainage-related problems: water quantity, water quality, land use, and public health.

- Water quantity objectives pertain to control of ground-water levels by managing the water in and out of the shallow aquifer and to provision of fish and wildlife water supplies.
- Water quality objectives involve allowable water constituent levels of the San Joaquin River, Salt and Mud Sloughs, ground water pumped to lower water tables, evaporation pond influent, and wetland and agricultural water supplies.
- Land use objectives stress future maintenance of agricultural productivity.
- Public health objectives are concerned with protecting the public from the possibility of contaminated fish, wildlife, and agricultural foodstuffs.

Table 7 lists the planning objectives and quantifies them, where applicable. Performance Levels A and B are shown for each objective, even when they are the same. The need for and use of performance levels were described previously in the section of this chapter on "Environmental Protection."

PROGRAM PLANNING METHODS

The method used to formulate and evaluate alternative plans is described in the Drainage Program's report, *Formulating and Evaluating Drainage Management Plans for the San Joaquin Valley* (1988). [Details of the planning procedures and their application are presented in a Drainage Program technical report (D.G. Swain, 1990).] Early in this Program, over a hundred ideas and concepts for solving part or all of the drainage problem were screened and reduced to some 80 drainage and drainage-related management options. These options were further evaluated through an extensive review period for technical feasibility, potential effectiveness in solving the drainage problem, cost, and acceptability to the public. This reduced the number to about a dozen major options that could be combined in various ways to manage or solve drainage problems on the western side of the valley.

For each subarea, those options effective in reducing the drainage-water problem were combined into three planning alternatives that emphasize: (1) Source Control (the conservation and reuse of agricultural water), (2) Ground-Water Management (the extraction

Table 7. PLANNING OBJECTIVES, CRITERIA, AND STANDARDS

ITEM	OBJECTIVE: Performance Level A	OBJECTIVE: Performance Level B
WATER QUANTITY		
Plan/design average regional deep percolation that must be managed after 0.02-0.35 ac-ft/acre/yr reduction by source control measures	0.4 ac-ft/ac/yr	0.4 ac-ft/ac/yr
Plan/design minimum depth to water table	5 feet	5 feet
Criteria for conditions required for deep pumping of semiconfined aquifer	Minimum combined aquifer thickness of 100 feet	Minimum combined aquifer thickness of 200 feet
Water supply to fish and wildlife	a. Water conserved by reducing deep percolation could be used to meet drainage water replacement water needs and alternative habitat water requirements associated with evaporation ponds. Water for restoration of drainage-contaminated wetlands will also be included. b. Additional water supplies needed to improve fish and wildlife resources will be quantified, and possible sources and means of supply will be identified.	
WATER QUALITY (Mean monthly values, unless otherwise noted)		
San Joaquin River (Mouth of Merced River to Vernalis)		
Total Dissolved Solids, near Newman (ppm)	—[a]	650[b]
Total Dissolved Solids, near Vernalis (ppm)	450[c]	450[c]
Boron, near Newman (ppm)	0.8[d] (3/15 - 9/15) 1.0[d] (9/16 – 3/14) 1.3[d] (Critical year only)	0.7[b]
Selenium, near Newman (ppb)	5[d] 8[d] (Critical year only)	2[k]
Molybdenum, near Newman (ppb)	10[d]	10[b]
Salt and Mud Sloughs and San Joaquin River, Sack Dam to Mouth of Merced River		
TDS (ppm)	—[a]	2,000[b]
Boron (ppm)	2[d]	2[b]
Selenium (ppb)	10[d]	2
Molybdenum (ppb)	19[d]	10[b]
Pumped Ground-Water Aquifer Limits		
TDS (ppm)	1,250	1,250
Boron (ppm)	1.0	0.5
Selenium (ppb)	5.0	2.0

a Objectives not presently established or estimated.

b State Water Resources Control Board staff recommendations in "Regulation of Agricultural Drainage to the San Joaquin River," August 1987. USEPA has disapproved certain of the Board's objectives and the matter is presently unresolved.

c U.S. Bureau of Reclamation and South Delta Water Agency agreement.

d Central Valley Regional Water Quality Control Board Resolution No. 88-195, Adoption of Amendments to the Water-Quality Control Plan for the San Joaquin River Basin (5C).

e Grassland Water District agreement with agricultural drainers.

Table 7. PLANNING OBJECTIVES, CRITERIA, AND STANDARDS (continued)

ITEM	OBJECTIVE: Performance Level A	OBJECTIVE: Performance Level B
WATER QUALITY *(continued)*		
Evaporation Pond Influent (concentrations that may eliminate the need for hazing and alternative habitat)		
Selenium (ppb)	5	2
Molybdenum (ppb)	—[a]	—[a]
Arsenic (ppb)	—[a]	—[a]
Wetland Water Supply (average monthly concentration)		
TDS (ppm)	2,500[e]	1,250
Boron (ppm)	4[e]	1
Selenium (ppb)	2	2
Molybdenum	—[a]	—[a]
Arsenic	—[a]	—[a]
Agricultural Water Supply (average monthly concentration) [f]		
TDS (ppm)	500[g] 2,500[h]	1,250[g] 2,500[h]
Boron (ppm)	0.5[g] 2.0[i]	1.0[g] 4.0[i]
LAND USE		
Agricultural use	Maintain existing irrigable lands in production, except for land needed for drainage water reuse (trees), disposal activities, and urbanization.	Maintain irrigated agriculture on lands overlying exceptionally high concentrations of selenium in ground water, if economically feasible; if not feasible, retire the land.
PUBLIC HEALTH		
Fish		
Selenium objective for San Joaquin River (ppb)	5	2
Wildlife		
Selenium objective for evaporation ponds (ppb)	5[j]	1.0–1.5[k]
Agricultural Foodstuffs	Use irrigation water (both surface & ground water) & soil that will not produce a health risk in agricultural crops, animals, or animal byproducts.	Use irrigation water (both surface & ground water) & soil that will not produce a health risk in agricultural crops, animals, or animal byproducts.

f Level B criteria for agricultural water supply show the effect of increased (compared to Level A) water conservation on farmland and increased restrictions on drainage discharge; that is, more salt and boron would be excluded from receiving water through reuse and recirculation of drainage water.

g This objective is based on crop yield vs. irrigation efficiency and uniformity analysis for beans (a salt/boron-sensitive crop) and cotton (a salt-tolerant crop).

h Water-quality limit for direct use of water (without blending) for irrigation of salt-tolerant crops, using management strategies proposed (Rhodes, 1987).

i Diluted subsurface drainage used for irrigation of cotton and other boron-tolerant agricultural crops.

j Ambient fresh-water aquatic life criterion (USEPA, 1987). May require warnings for consumption of fish and wildlife by pregnant women and young children.

k "No adverse effects level" (UCCC, 1988); "no adverse effects level" (Davis et al., 1988).

of irrigable water from deep within the semiconfined aquifer to lower the near-surface water table in waterlogged land areas), and (3) Land Retirement (the retirement of irrigated agricultural lands overlying shallow ground water that contains greatly elevated concentrations of dissolved selenium and that are difficult to drain). Planning alternatives were devised for both Level A and Level B performance standards.

Comparison of the alternatives permitted drawing conclusions that were useful in formulating the recommended plan. The plan is the optimum mix of the planning alternatives used to reduce the drainage-water problem, coupled with fish and wildlife resource components.

ESTIMATING THE VOLUME OF WATER CAUSING DRAINAGE PROBLEMS

The term *problem water* was coined by the Drainage Program to represent the volume of subsurface water that occurs (or will occur) in a given place to cause a drainage problem. A drainage problem exists when there is a condition of too much shallow ground water occurring in the root zone of crops — associated often with concentrations of dissolved salt or boron in that water that reduce crop production and/or increase farm management costs. A grower experiencing economic loss under this condition has three choices: (1) Grow more salt-tolerant or boron-tolerant plants (at less profit), (2) abandon irrigated agriculture on this land, or (3) apply drainage management to this land. Such management usually begins with installing artificial drains to remove the subsurface drainage volume. If potential toxicants such as selenium are present in the drained water, storage or disposal becomes more difficult, costly, and potentially hazardous to the environment.

Problem water is generally ground water that is less than 5 feet from the surface of the land. In a hydrologic sense, considerably deeper water can move along a pressure gradient and up from greater depths into the 0- to 5-foot zone (Belitz, 1988); thus, as long as the regional water table remains high, other ground water is continually replenishing the problem water. The irrigated area that is, and likely will be, affected by a 0- to 5-foot water table is shown in Table 8. The forecasts are based on observed trends between 1977 and 1987, modified by physical limitations of the total area that will develop high water table conditions. These lands are considered to have a potential drainage problem. They are considered to have an actual drainage problem if and when the quality of water in the root zone causes one of the grower reactions indicated previously. The estimated extent of the drainage problem area (underlain by problem water) is shown in Table 9. The drainage problem area is smaller than the area with a water table less than 5 feet from the ground surface because of water-quality conditions.

The shallow ground-water area (0 to 20 feet from the land surface) was divided into water-quality zones to aid in determining drainage problem areas and to aid in planning. The divisions, which were made on the basis of the concentration of salts and trace elements in the shallow ground water, are shown on Figure 18. Problem water occurs in these zones and, by 2040, will affect most of the land within the zones.

The annual volume of problem water targeted for management is the average annual amount of water added each year to the root zone (largely through irrigation) in excess of water that percolates to deep aquifers. This problem water is water that remains in the root zone area, redissolving salts and other substances, evaporating up through the soil column, and becoming loaded with increasing concentrations of minerals as the summer irrigation season advances. Table 10 provides an estimate of the annual volume of problem water in each subarea for 2000 and 2040. For the whole study area, the unit volume of problem water in 2000 is forecasted as about 0.70 acre-foot per acre of problem area; and for 2040, it is forecasted as about 0.75 acre-foot per acre. The increase is due to the slow but steady trend toward increased mineralization that will occur in some subareas before a coordinated effort to manage the drainage problem can get under way at the scale required.

Table 8. FORECAST OF IRRIGATED AREA WITH WATER TABLE LESS THAN 5 FEET FROM GROUND SURFACE (Based on Existing Trends) In 1,000s of acres

Subarea	1990	2000	2040
Northern	49	49	49
Grasslands[1]	230	230	230
Westlands	104	170	227
Tulare	320	359	387
Kern	62	110	164
TOTAL	**765**	**918**	**1,057**

1 Excludes 90,000 acres of wetland habitat with a high water table.

Note: All currently drained lands are included, even though drainage may have lowered the water table below 5 feet.

Table 9. FORECASTS OF EXTENT OF DRAINAGE PROBLEM AREA In 1,000s of acres

Subarea	2000	2040
Northern	34	44
Grasslands	116	207
Westlands	108	204
Tulare	125	348
Kern	61	148
TOTAL	**444**	**951**

Note: Total area in 2000 revised upward from 409,000 acres in SJVDP's *Preliminary Planning Alternatives,* August 1989.

Table 10. ESTIMATE OF ANNUAL PROBLEM WATER VOLUME
In 1,000s of acre-feet

	2000	2040
Northern	26	38
Grasslands	86	155
Westlands	81	153
Tulare	75	209
Kern	46	111
TOTAL	**314**	**666**

In most areas where the ground-water table is less than 5 feet from the land surface, water is drawn upward and evaporates, leaving a deposit of salts on the surface and in the root zone that retards or prevents the growth of many crops.

Figure 18

SHALLOW GROUND–WATER QUALITY ZONES