Crisis At Kesterson: A Review of San Joaquin Valley Agricultural Drainage Problems and Possible Solutions

I.
INTRODUCTION

Like many other arid regions in the West, California's San Joaquin Valley has had its share of water quality problems. The buildup of crop-damaging salt which concentrates in marginally-productive arid lands has plagued farmers of the western San Joaquin Valley for over a century.[1] With the passage by Congress of the San Luis Unit addition to the Central Valley Project (CVP) in 1960, federally-subsidized irrigation waters enabled farmers to bring these marginal lands into production.

The application of large amounts of water reduced the buildup of salts in the soils, but also created the need to construct an agricultural wastewater drainage system to reduce the resultant high water tables. Wastewater from this system has been shown to accumulate toxic concentrations of selenium, a natural soil element. The impacts of this contamination have shown up at the Kesterson National Wildlife Refuge, a major nesting ground for migratory birds on the Pacific Flyway. The refuge serves as a reservoir for agricultural wastewater collected by the San Luis Drain, which currently receives runoff from 42,000 acres of farmland on the western side of the San Joaquin Valley. In 1983, widespread deformities and high mortality were discovered among the waterfowl residing at Kesterson.[2] Subsequent monitoring tests revealed very high concentrations of selenium in the water, sediments, and vegetation at this site.

Fearing that these findings might constitute a violation of the 1918 Migratory Bird Treaty Act,[3] the Department of Interior (DOI) ordered that all drainage of agricultural wastewater to Kest-

1. Other current water quality problems include overdraft of groundwater acquifers, and groundwater contamination from agricultural pesticide applications.

2. OFF. OF INSPECTOR GENERAL DOI, REPORT OF INVESTIGATION 19 (September 4, 1985) at 20, as referenced in ENVTL. L. REP., (ENVTL. L. INST.), *infra* note 12, at 10390.

3. 16 U.S.C. §§ 703-12.

erson must cease by June 30, 1986.[4] This order has forced the U.S. Bureau of Reclamation (BUREC), the Westlands Water District, and other agricultural interests to find acceptable alternatives to drainage disposal at Kesterson.[5] On July 5, 1985, the California State Water Resources Control Board issued a "Cleanup and Abatement" order at Kesterson, since it was designated an unregulated hazardous waste site.[6]

The objectives of this article are to (1) provide a background and history of the Central Valley Project and the San Luis Drain; (2) summarize the technical aspects of the drainage problem on the west side of the San Joaquin Valley; (3) discuss the causes and biological impacts of selenium contamination at Kesterson; (4) discuss the institutional problems which have lead to the overabundance of contaminated irrigation runoff; and (5) analyze the proposed short- and long-term solutions to the problem.

II.
BACKGROUND AND HISTORY

Today, the San Joaquin Valley is one of the richest agricultural areas in the world, with Fresno, Kern, and Tulare Counties representing the nation's top three farm marketing counties.[7] This success is, in part, due to the BUREC's operation of the Central Valley Project.

The Central Valley Project

The CVP currently delivers about four million acre-feet of water each year[8] which represents about ten percent of all the water used in the state.[9] The major features of the project include the Shasta, Trinity, Folsom, Friant and New Melones dams and lakes, and the

4. *U.S. Agency to Close Polluted Bird Refuge*, L. A. Times, Mar. 16, 1985, Part 1, at 30.

5. BUREC is the operator of the CVP and comanager of the Kesterson National Wildlife Refuge with the U.S. Fish and Wildlife Service (FWS). The Westlands Water District is the deliverer of CVP water to farmers in the western San Joaquin Valley and is responsible for the drainage water being dumped into Kesterson.

6. Order WQ-85-1 for Cleanup and Abatement of Kesterson Reservoir, State Water Resources Control Board, 1985.

7. San Joaquin Valley Interagency Drainage Program, Agricultural Drainage and Salt Management in the San Joaquin Valley (1979), *cited in* Kratzer, *infra* note 14, at 15.

8. BUREC, CVP Rate Setting Policy Proposal, Schedule 8, Mid-Pacific Region (1984) *cited in* LeVeen and King, *infra* note 32, at Appendix C, at 1.

9. COMPETITION FOR CALIFORNIA WATER (E. Englebert & A. Scheuring eds. 1982) at 4, *cited in* Leveen and King, *infra* note 32, at Appendix C, at 1.

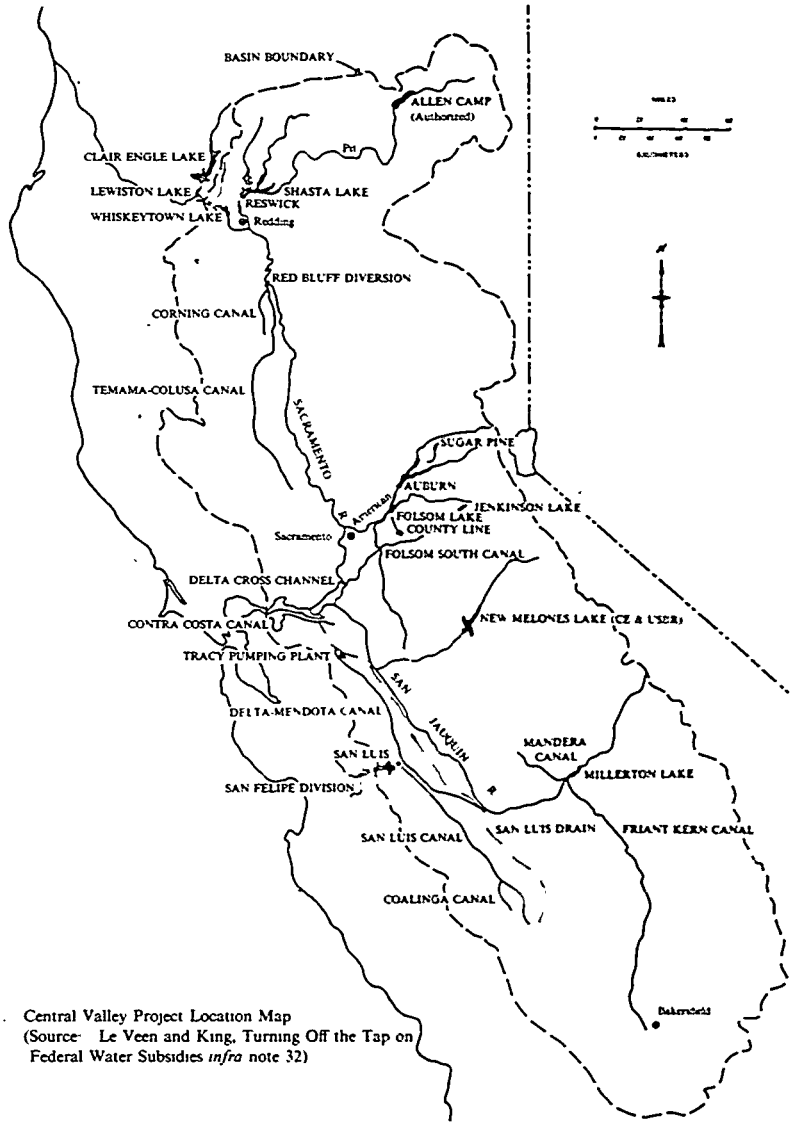

Figure 1. Central Valley Project Location Map
(Source: Le Veen and King, Turning Off the Tap on Federal Water Subsidies *infra* note 32)

Delta-Mendota and Contra Costa Canals, as well as the San Luis Reservoir (see Figure 1).

In 1960, Congress authorized the addition of the San Luis Unit to the CVP.[10] Recognizing the problems caused by salinity in the valley, the legislation called for the construction of a master drain to serve the drainage needs of future and existing farmlands. In 1968, after securing a contract with the Westlands Water District for water and drainage services, BUREC began construction of the 188-mile San Luis Drain and the Kesterson Reservoir to serve only the federal San Luis Unit.[11] However, in 1975, after completing an 82-mile segment of the drain from the town of Five Points to Kesterson, BUREC stopped construction due to funding problems, environmental opposition, and a lack of a definite Delta discharge location.[12]

The 1,280-acre Kesterson Reservoir was originally designed to regulate discharges into the Delta where the drain was to end. Because it was supposed to become an oasis for birds migrating through the dry Central Valley, the U.S. Fish and Wildlife Service (FWS), in 1969, designated a 5,900-acre area (including the reservoir) as a national wildlife refuge.[13] Up until 1978, Kesterson was receiving surface runoff from the drain. Soon after, farmers in Westlands began bringing on-line a series of subsurface tile drains to lower the water table under their fields (see Figure 2). Since 1981, most of the flow into the drain and the reservoir has been subsurface drainage. As a result, today Kesterson serves as a disposal site where contaminants in the agricultural wastewater are accumulating in the vegetation, wildlife, and possibly groundwater.

III.
THE DRAINAGE PROBLEM

Areal Extent

About 1.2 million acres of the western San Joaquin Valley, extending from Kern County northward to the Sacramento-San Joa-

10. San Luis Act of June 3, 1960, Pub. L. No. 86-488, 74 Stat. 156.

11. Passage of the Burns-Porter Act in 1960 (CAL. WATER CODE §§ 12930-12944.5), which authorized the State Water Project, called for the Department of Water Resources (DWR) to jointly build a master drain with BUREC. However, in 1967, DWR pulled out of the project.

12. *Tragedy at Kesterson Reservoir: Death of a Wildlife Refuge Illustrates Failings of Water Law*, [1985 Transfer Binder] 15 ENVTL. L. REP. (ENVTL. L. INST.) 10386, 10390 (Dec. 1985) [hereinafter cited as *Tragedy at Kesterson Reservoir*].

13. 34 Fed. Reg., 15,799 (1969).

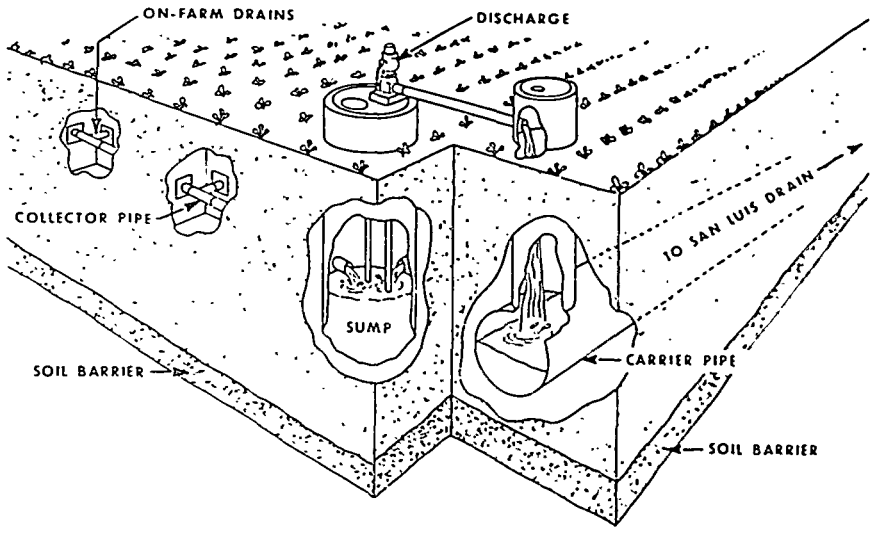

Figure 2. Typical Westlands Water District Drainage System (Source: Kratzer, Agricultural Drainage Problems in the San Joaquin Valley, *infra* note 14)

quin Delta, have immediate or potential drainage problems (see Figure 3). *Immediate* drainage problem areas are those where the water table lies within five feet of the surface of productive or potentially productive lands. *Potential* drainage problems exist where the water table currently is within 20 feet of the ground surface.[14] Only 169,000 acres within the current San Luis Drain service region are now considered to be *immediate* problem areas, but this figure is expected to expand to 345,000 acres by the year 2020, and to 493,000 by 2095.[15]

Presently, only farms within a 42,000-acre area in the Westlands Water District have the ability to use the drain. Of this area, only 8,000 acres are now effectively discharging wastewater into the drain at an average rate of 7,000 acre-feet per year. As will be discussed later, this 8,000-acre area is responsible for the selenium problem at Kesterson.

Although DOI applied its shutdown order to only 42,000 acres, a FWS official recently stated that selenium-laden drainage runoff

14. C. Kratzer, Agricultural Drainage Problems in the San Joaquin Valley (Doctoral dissertation, Environmental Science and Engineering, UCLA, 1985).

15. BUREC Field Draft of Special Report on Drainage and Water Service and Draft Supplement to the Final Environmental Statement, San Luis Unit, Central Valley Project, California (1983), *cited in* Kratzer, *supra* note 14, at 14.

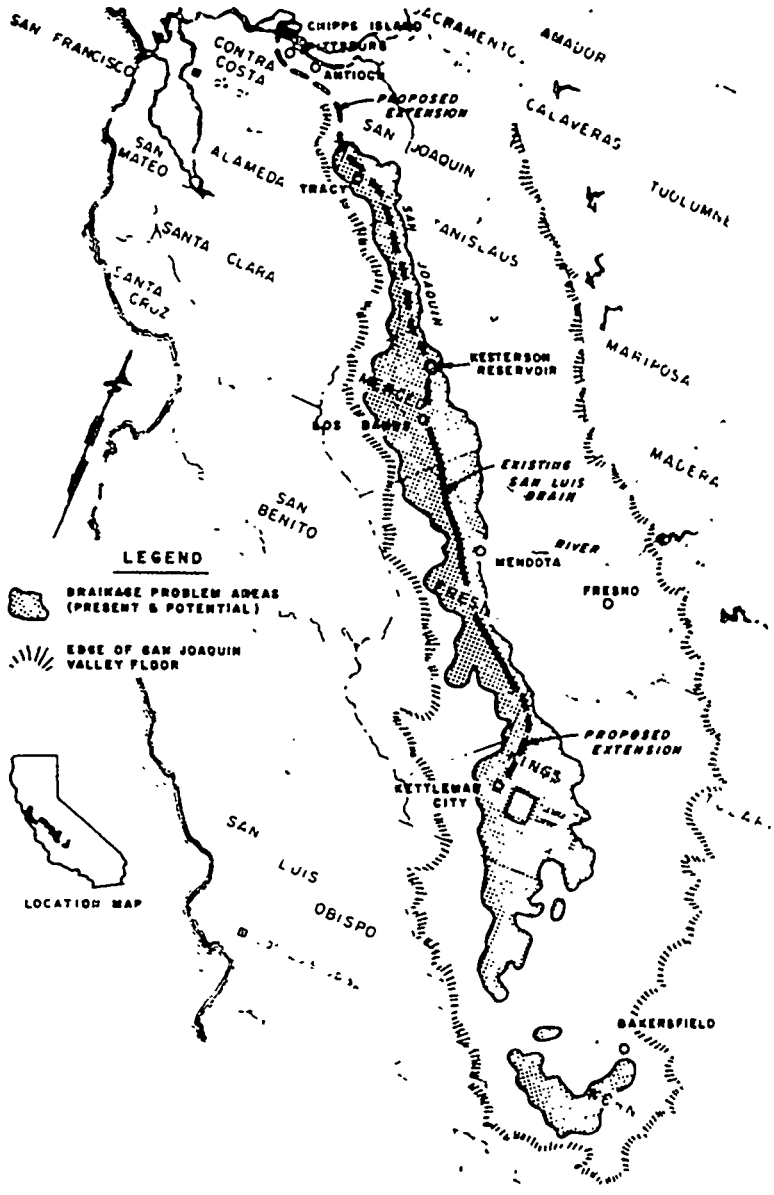

Figure 3. Distribution of the Drainage Problem Area (Source: Kratzer, Agricultural Drainage Problems in the San Joaquin Valley, *supra* note 14.

could be severely impacting wildlife in the Grasslands Resource Conservation District, a 68,000-acre wetland adjacent to Kesterson (see Figure 4).[16] The Grasslands also receives subsurface agricul-

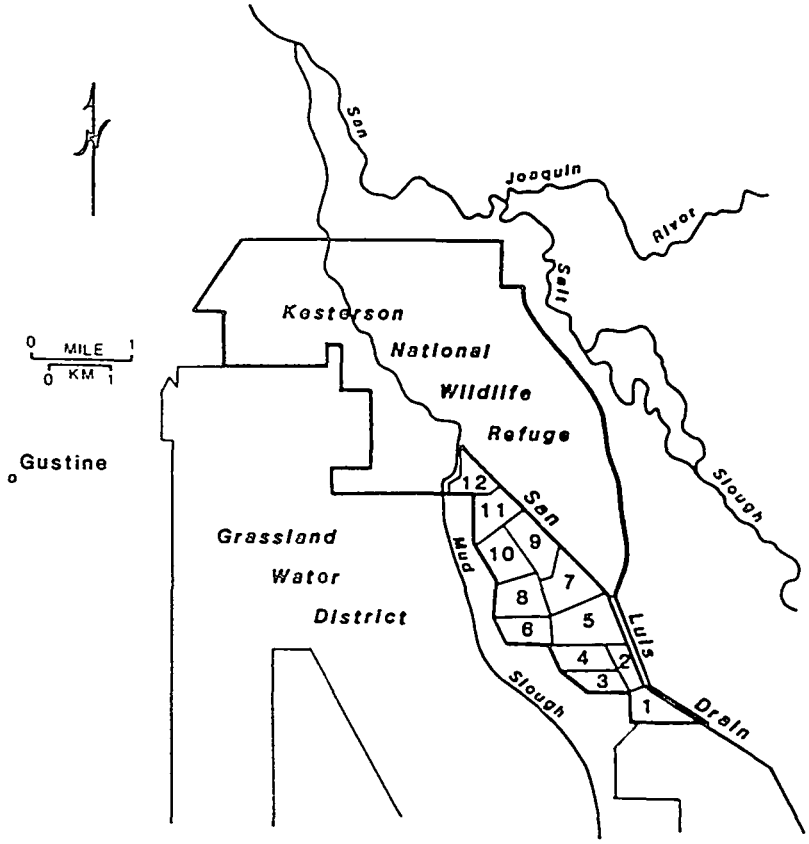

Figure 4. Kesterson Reservoir and Vicinity (Source: Kratzer, Agricultural Drainage Problems in the San Joaquin Valley, *supra* note 14.

tural runoff as well as freshwater and surface runoff, but because of a longstanding arrangement which allows these wastewaters to eventually be dumped into the San Joaquin River, routine water quality monitoring at Grasslands has not taken place.[17] Furthermore, the selenium problem may also be widespread not only in the

16. Internal memorandum from an unnamed FWS environmental specialist to the FWS regional director in Portland, Oregon, April 16, 1985 as cited in *Selenium Peril Spreads Beyond Wildlife Refuge*, L. A. Times, June 10, 1985, Part I, at 18.

17. *Selenium Poisons Refuge, California Politics*, 229 SCIENCE, 145-47 (No. 4728, 1985).

San Joaquin Valley, but throughout the West, making Kesterson only the tip of the iceberg.[18]

Causes of the Drainage Problem

The extensive irrigation on the west side of the San Joaquin Valley is the driving force behind the growing drainage problem. Water from irrigation, precipitation, and upslope drainage infiltrates into the soil and accumulates above impermeable clay layers lying 10 to 60 feet below the ground surface.[19] These "bathtub-like" conditions create what are known as perched water tables. As the water table rises, crops may become waterlogged and eventually die from oxygen deprivation. Also, salinity in the irrigation water and in the leachate from saline soils may concentrate near the root zone and severely damage crops. Salts may also concentrate in the soil as a result of evaporation of soil water and plant transpiration. Saline land must be periodically flushed to avoid a dangerous buildup of salts. This raises the water table and further exacerbates the problem.[20] Figure 5 shows how these problems are currently being managed.

IV.
THE DISCOVERY OF ASSOCIATED BIOLOGICAL IMPACTS OF SELENIUM CONTAMINATION AT KESTERSON

Selenium is a natural element in soils and is especially abundant in the arid regions of the western U.S. including the western San Joaquin Valley. Kesterson and Westlands lie within an alluvial geologic formation called the Panoche Fan, which is known to contain large amounts of selenium in the soil.[21] Like other saline minerals, selenium will concentrate in irrigation water that has percolated through affected soils. Highly concentrated selenium-laden subsurface runoff has now been implicated in the biological impacts observed at Kesterson.

In late 1983, the FWS, under instructions from the Interagency

18. *See, e.g., Toxic Chemical Threatens West*, Sacramento Bee, Sept. 8, 1985, at A1; *Potential for Peril Lurks Throughout State*, Sacramento Bee, *Mar. 24, 1985, at A1; Toxic Slaughterhouse*, Sacramento Bee, Sept. 8, 1985, at A1.

19. U.S. GEOL. SURV. WATER SUPPLY PAPER 1999-H, SUBSURFACE GEOLOGY OF THE LATE TERTIARY AND QUATERNARY WATER-BEARING DEPOSITS OF THE SOUTHERN PART OF THE SAN JOAQUIN VALLEY, CALIFORNIA (1972), *cited in* Kratzer, *supra* note 14, at 8.

20. Kratzer, *supra* note 14, at 11.

21. *Id.* at 84-85.

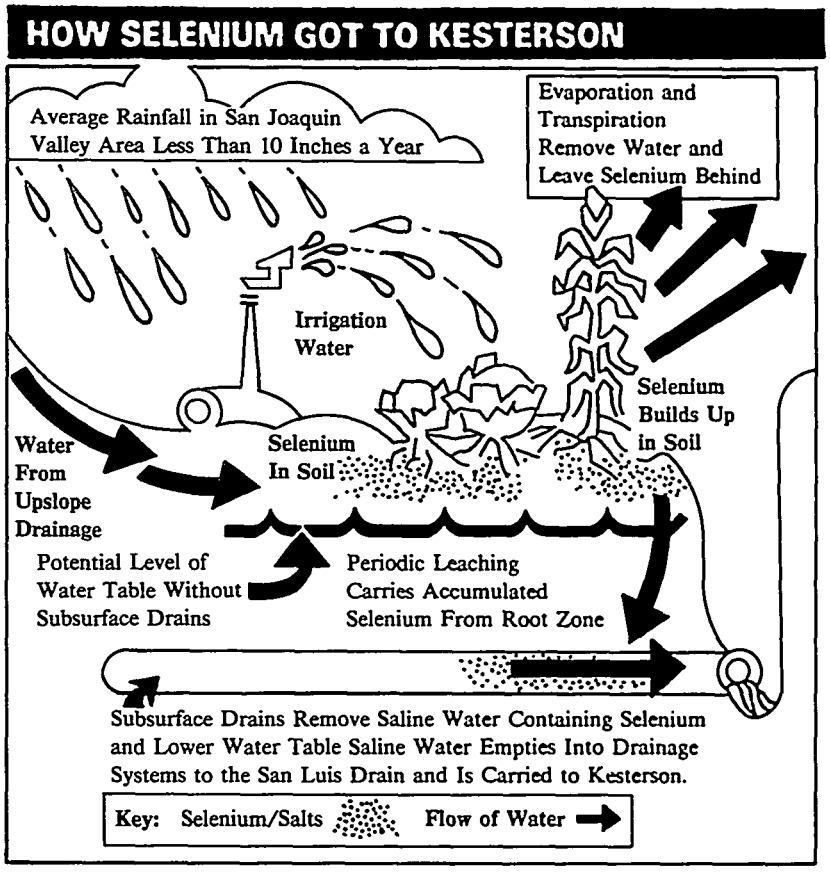

Figure 5. Salt Management Practices Leading to Problems at Kesterson (Source: Los Angeles Times, Mar. 16, 1985, Part 1, at 30.

Drainage Program, conducted a study at Kesterson to determine the suitability of using wetlands for permanent agricultural drainage disposal.[22] What they found was shocking. Twenty percent of the 347 nests examined in the study contained deformed birds while 40 percent of the eggs contained dead embryos.

In humans and animals, small concentrations of selenium are necessary for adequate nutrition, but in large quantities selenium

22. Research results (in press) of Harry M. Oldendorf, Field Station Leader, FWS, Davis, California, as cited in Kratzer, *supra* note 14, at 43 (Table 4). The Interagency Drainage Program was set up in 1979 and is made up of BUREC, State Water Resources Control Board, DWR, and other interested parties. Its purpose is to study long-term solutions to San Joaquin Valley drainage problems.

can be highly toxic. High levels have caused cancer in laboratory animals and other problems in farm animals. In fact, the dangers of selenium may have been recognized many years ago, as described in a series of technical bulletins published by U.S. Department of Agriculture (USDA) scientists in the 1930's and 40's.[23] The authors pointed out a "definite relationship" between selenium-loaded geologic formations and soils that produce disease in animals.

The federal water quality standard for selenium is 10 parts per billion (ppb),[24] although agricultural runoff is exempt from this standard.[25] Water quality testing at Kesterson has revealed selenium concentrations as high as 500 ppb.[26] The highest level found within the San Luis Drain service area was 4,400 ppb at an on-farm drain sump.[27] The median surface water influent to Kesterson was shown to contain 130 to 440 ppb of selenium.

Prior to 1981, Kesterson and the San Luis Drain supported a wide variety of fish including largemouth and striped bass, catfish, carp and mosquitofish. In 1983, the only fish remaining, mosquitofish, were shown to contain 30 to 60 ppm of selenium—100 times greater than the national average.[28] Selenium levels in plants on the west side of the San Joaquin Valley have measured between 3.4 and 119 ppm.[29]

The results summarized above indicate that selenium is mobilized in the water, taken up by plants, and bioaccumulated in the fish and waterfowl that feed on those plants (primarily algae), magnifying the concentration 50 to 100 times. These findings moved Robert Claus, an owner of a ranch and duck club bordering Kesterson, to

23. U.S. DEPT. AGRIC., SELENIUM OCCURRENCE IN CERTAIN SOILS IN THE UNITED STATES WITH A DISCUSSION OF RELATED TOPICS—FIRST REPORT, TECHNICAL BULLETIN 482 (AUG. 1935); SECOND REPORT, TECHNICAL BULLETIN 530 (DEC. 1936); THIRD REPORT, TECHNICAL BULLETIN 601 (MAY 1938); FOURTH REPORT, TECHNICAL BULLETIN 702 (JULY 1940).

24. 40 C.F.R. § 141.11 (1985).

25. 33 U.S.C. § 1342(l).

26. Hartshorn, *Down the Drain: Problems at Kesterson Reservoir,* WESTERN WATER, Mar.-Apr. 1985, at 6.

27. U.S. GEOL. SURV., WATER RESOURCES INVESTIGATIONS, REPORT 84-4319, AREAL DISTRIBUTION OF SELENIUM AND OTHER INORGANIC CONSTITUENTS IN SHALLOW GROUND WATER OF THE SAN LUIS DRAIN SERVICE AREA, SAN JOAQUIN VALLEY, CALIFORNIA: A PRELIMINARY STUDY at 63 (1984).

28. Kratzer, *supra* note 14, at 41-42.

29. Letter from G.J. Hoffman to Dr. W.G. Chase, Area Director, Pacific Basin Area, USDA-ARS (Dec. 19, 1984), with attached report, U.S. DEPT. AGRIC., Agricultural Research Service, U.S. Dept. Agric., Selenium Determinations on Water and Plant Samples.

file a lawsuit against the DOI.[30] Claus claims that the cause of unusual illnesses in his cattle was contaminated runoff. His action precipitated the DOI closure order and similar State Water Resources Control Board responses. At present, children and pregnant women have been warned not to eat birds from the polluted area. Especially at risk are Southeast Asian highlanders (the Hmong) who have settled in the area and traditionally rely on hunting to supplement their diets.[31]

V.

INSTITUTIONAL ASPECTS OF THE DRAINAGE PROBLEM

As noted earlier, it is widely believed that the drainage problem in the western San Joaquin Valley and the crisis at Kesterson are the result of extensive irrigation practices in an area of less than ideal growing conditions. Recent events have also raised important water resource questions which focus on Bureau of Reclamation policies that have allowed such practices to continue—policies which in some cases are, in fact, illegal. BUREC's relationship with the Westlands Water District provides interesting insights into the institutional framework that has shaped the current situation.

Westlands is the largest water district in the nation in terms of irrigated land and is also the largest recipient of federally-subsidized CVP water.[32] It consumes about 25 percent of all water delivered by the CVP and receives about a third of the total federal subsidies earmarked for the CVP.[33] In 1983, gross crop value from 567,184 acres of land totalled $547.6 million, with cotton, canning tomatoes, and cantaloupes accounting for 34, 17 and 9 percent of the total, respectively.[34] Therefore, the average acre of land brought in about $965.

A recent study by the Natural Resources Defense Council (NRDC)[35] illustrates how Westlands has used cheap federally-sub-

30. *Tragedy at Kesterson Reservoir, supra* note 12, at 10,391.

31. *Selenium Poisons Refuge, California Politics, supra* note 17, at 146.

32. E. Leveen & L. King, Turning off the Tap on Federal Water Subsidies, Volume 1, The Central Valley Project: The $3.5 Billion Giveaway (joint report by Natural Resources Defense Council and California Rural Legal Assistance Foundation, 1985) at 1 [herein cited as Leveen and King].

33. *Id.* at 29.

34. *Joint Hearing of the Assembly Water, Parks, and Wildlife Committee and the Senate Natural Resources and Wildlife Committee, San Joaquin Agricultural Drainage and Kesterson National Wildlife Refuge* at 504 (Nov. 16, 1984) (statement of Westlands Water District).

35. LeVeen and King, *supra* note 32.

sidized water to continue producing crops that would otherwise be unprofitable. When NRDC performed their analysis, BUREC was selling water to Westlands for $9.45 per acre-foot.[36] NRDC estimates that the actual cost of delivering this water to Westlands is $97 per acre-foot, resulting in a subsidy of $87 per acre-foot. Given that Westlands uses about 2.45 acre-feet of water per acre of land, the subsidy works out to be $217 per acre. Assuming that net income is about 30 percent of gross income ($965/acre), the net profits are about $290 per acre. Therefore the subsidy accounts for about two-thirds of Westland's net income. Essentially, farmers in Westlands are making a living from being on the government dole.

The study concludes that these subsidies encourage overproduction and are indirectly creating the crisis at Kesterson by allowing the profitable production of water-hungry crops.[37] Currently, 53 percent of the irrigated acreage in Westlands produces crops which are considered to be surplus (e.g. cotton).[38] This clearly was not anticipated by the framers of the 1902 Federal Reclamation Act,[39] who originally intended the subsidies be used to:

> —provide opportunity for a maximum number of settlers on the land and to promote home building;
> —spread the benefits of the subsidized irrigation to the maximum number of people; and
> —promote the family-sized farm [less than 160 acres] as a desirable form of social life.[40]

These goals are certainly not being met at Westlands when one observes that 1) subsidies are not benefiting the nation since 53 percent of the crops are already in surplus; and 2) 60 percent of the farms are larger than 320 acres (husband and wife are each allowed 160 acres).[41] Loopholes in the reclamation laws allow farmers in Westlands (and throughout California) to eschew the original Reclamation Act's "160-acre limit."[42] William Kahrl, a noted expert on California water and political issues, points out that "a federal-

36. Kratzer, *supra* note 14, at 98, quotes a figure of $10.90.

37. LeVeen and King, *supra* note 32, at 21-24.

38. *Id.* at 36.

39. 43 U.S.C. §§ 371-573.

40. BUREC, Special Task Force Report on the San Luis Unit (1978), *quoted in* LeVeen and King, *supra* note 32, at 10-11.

41. CAL. ASSEMBLY OFF. OF RESEARCH, AGRICULTURAL LAND OWNERSHIP AND OPERATIONS IN THE 49,000 ACRE AREA OF THE WESTLANDS WATER DISTRICT (1985).

42. The 1982 revision of the Reclamation Act (Reclamation Reform Act, 43 U.S.C. §§ 390dd, 390kk) has dealt with this problem by increasing the ownership limit to 960 acres.

state task force on Westlands charged . . . that the district had expanded its water deliveries illegally to lands never authorized by Congress, lands that the government had previously determined should never be irrigated."[43] Furthermore, if farmers continue to grow cotton, it will take them 270 years to repay their share of the CVP at the current rate of payment.[44] BUREC worked out a deal with Westlands farmers by allowing them to repay costs over a period longer than the 50-year maximum set by Congress.[45]

Subsidies and other water policies which encourage overproduction are partially responsible for falling crop values which are, in turn, placing great financial hardships on the farming industry. In fact, if subsidies to Westlands farmers were removed, the financial burdens would be too great, and most of the land would be forced out of production. This would alleviate the environmental problems caused by agricultural drainage, but at a loss of about $1.5 billion to California and the nation.[46]

No long-term plan has been agreed upon to alleviate the problems posed by agricultural runoff in the San Joaquin Valley. However, eventual solutions will probably emerge from one of two camps: those who believe that without some equitable restructuring of water pricing policies, the problems at Kesterson will repeat themselves many times over throughout the Valley; and those who feel that the cost of retiring lands is too great, preferring instead to develop technical solutions which allow agriculture to continue on these marginally productive areas. The following sections discuss the short- and long-term solutions to the drainage problem at Kesterson.

VI.
ANALYSIS OF SHORT- AND LONG-TERM SOLUTIONS

The objectives of any final solution(s) should include the cleanup of Kesterson and other associated environmental degradation, protection of drinking water supplies, and minimization of economic hardships, where possible, to affected segments of society. A study by Charles Kratzer, an engineer at the State Water Resources Control Board, provides a good overview of alternatives that are being

43. *Federal Bumbling Muddies Farmland Pollution Solution*, L.A. Times, Mar. 20, 1985, Part 2, at 5.

44. BUREC, SPECIAL TASK FORCE REPORT ON THE SAN LUIS UNIT (1978), *cited in* LeVeen and King, *supra* note 32, at 42.

45. LeVeen and King, *supra* note 32, at 55.

46. Statement of Westlands Water District, *supra* note 34, at 503.

considered and will form the foundation of this review.[47]

Short-Term Solutions

Many believe that because of institutional, scientific, and economic barriers, final solutions to the drainage problem are still years if not decades away. Therefore, a number of short-term solutions have been suggested so that cleanup at Kesterson can proceed at the same time that interim drainage control measures can be implemented. Short-term solutions include:

—shutting off the irrigation supply to the 42,000 acre problem area;
—plugging all subsurface drain outlets;
—constructing evaporation ponds at Westlands;
—recirculating drainage water at Westlands, and
—others (e.g. upgrading Kesterson to a Class 1 dumpsite, diluting and discharging to the San Joaquin River, and deep-well injection).

Alternatives listed as "others" are not included in the following discussion because it is felt that their adoption is highly unlikely given the current attitudes about waste disposal in the State.

Shutting off the Irrigation Water

Westland farmers in the 42,000 acre problem area would lose about $4.8 million per year if irrigation waters were shut off.[48] This action would, however, yield 105,000 acre-feet of unused water that would be worth about $1.1 million per year to Westlands (assuming it now costs Westlands $10.90 per acre-foot). Kratzer estimates that Westlands could receive about $10.5 million per year if the District sold unused water to the Metropolitan Water District (MWD), assuming that (1) the MWD will have to pay about $300 per acre-foot for future new sources of water, (2) current federal subsidies to Westlands will continue, and (3) the cost of transporting the water to southern California will be $150 to $200 per acre-foot.[49]

This solution would probably be the best short-term way of alleviating the drainage problem in the affected areas, but because of the strong influence and power of agricultural interests in California, the institutional barriers would be significant. However, the

47. Kratzer, *supra* note 14, at 96-158.

48. L.T. Wallace & D. Strong, Selected Economic Estimates of the Impact of Restricting Irrigation Inflows to Agricultural Lands in the Westlands Water District of California, (Cooperative Extension, University of California, 1985), *cited in* Kratzer, *supra* note 14, at 97.

49. Kratzer, *supra* note 14, at 98.

idea of transferring water rights and selling water on the open market is becoming more popular in California.

Plugging the Tile Drains

According to William R. Johnston, Assistant Manager and Chief of Operations for the Westlands Water District, plugging the drains would result in the saturation of about 1,400 acres of land with saline water, immediately eliminating agricultural production and $1.3 million in crop value.[50] As the water table rises, more land would become unsuitable for growing most crops. Eventually, this action might result in a loss of about $900,000 per year for farmers in the affected areas.[51] One Water Resources Control Board engineer believes that the farmers will be forced to plug their drains in order to meet the June 30, 1986 deadline.[52]

Construction of Evaporation Ponds

On May 20, 1985, the directors of Westlands unveiled a $15 to $20 million proposal to construct evaporation ponds at a site within Westlands about eight miles south of Mendota and 60 miles south of Kesterson.[53] To handle the 7,000 acre-feet of drainage flow, the site would have to be about 2,500 acres.[54] The proposal included features that Westlands officials claimed would avoid another "Kesterson-type" situation from occurring. These measures included vegetation control, steep sides, monitoring of vertical and horizontal movement of seepage water, and shallow pond depths.

However, given that the nature and extent of the Kesterson problem is still under investigation and that much more scientific work must still be done, officials are skeptical of the effectiveness of these safeguards. If the State were to classify the ponds as a hazardous waste site under the new Toxic Pits Cleanup Act of 1984, the construction costs could skyrocket. In fact, this proposal has now been tabled in lieu of a new desalting plant proposal (to be discussed

50. Statement of Westlands Water District, *supra* note 34, at 513.

51. *Id.*

52. Personal communication of C. Kratzer, Environmental Engineer, State Water Resources Control Board, with author (Dec. 9, 1985).

53. *Kesterson Alternative Ponds Would Also Be Near Wildlife*, L.A. Times, May 21, 1985, Part 1, at 3.

54. CH_2M Hill, Preliminary Plan Report on Alternative Drainage Disposal Facilities (1985), prepared for Westlands Water District, Fresno, California, *cited in* Kratzer, *supra* note 14, at 100.

later).[55]

Recirculating Drainage Water

A contractor to Westlands, CH_2M Hill, proposed a $21.6 million alternative of recirculating the subsurface drainage from the 8,000 acres and blending it with fresh irrigation supplies for the entire 42,000 acre area.[56] Implementing such a project would result in the slow and steady buildup of salinity, selenium, boron, and molybdenum in the irrigation water, soil, and crops. Therefore, the beneficial aspects of this alternative would continue as long as the trace contaminants remain below prescribed levels. It is uncertain how long it would take to reach such levels, so the lifetime of this alternative would be unknown.

If Westlands were to employ this option it would be a "very temporary" measure at best. The use of degraded irrigation water would probably be an unappealing alternative to both farmers and consumers, for obvious reasons.

Summary

Shutting off the irrigation water completely would be strongly opposed by agricultural interests. Nonetheless, it remains one of the most reliable short-term solutions to the drainage problem. Also, affected farmers could offset some of their losses by selling their water rights and placing the unused water on the market. Since the 1986 deadline is rapidly approaching, the fastest and possibly the easiest way to comply would be to plug the tile drains. Because of the potential economic losses, this would probably be used as a temporary measure until a more permanent solution could be arranged. Although the evaporation pond alternative has been tabled for now, Westlands might resurrect this solution, but at the expense of environmental opposition and greater financial costs.

Long-Term Solutions

Several alternatives have been proposed as permanent solutions to the drainage problem. They include:

—retirement of lands;
—reverse osmosis/solar ponds;

55. *San Joaquin Water Salvage Plan Pushed*, L.A. Times, Aug. 30, 1985, Part 1, at 1.

56. CH_2M Hill, Evaluating Alternatives to Dispose of Subsurface Agricultural Drainage Water (1985), prepared for Westlands Water District, Fresno, California, *cited in* Kratzer, *supra* note 14, at 110.

—evaporation ponds (at Westlands, Carizzo Plain, Mojave Desert);
—water disposal options (to San Joaquin River, Bay-Delta Estuary, Morro Bay, Monterey Bay); and
—biological treatment.

All these proposals are in different stages of analysis and decision-making but it is believed that the "best" solution will involve some combination of the above options.

Selective Retirement of Agricultural Lands

By the year 2095, 497,000 acres of land will probably require drainage, which could create problems dwarfing those seen at Westlands and Kesterson today.[57] One way to avoid future problems is to selectively retire lands which begin to require drainage. Given the long time periods involved, it is difficult to predict the economic impact of this alternative on farming. Nevertheless, Kratzer predicts that the annual net cost would be -$19.8 million to $12.5 million.[58] The first value (a net gain) derives from a set of favorable assumptions for the valley farmers including continued cheap federal irrigation water, future high demand and cost for municipal water (e.g. MWD), and manageable transportation costs.

As mentioned earlier, such a policy would probably not be institutionally possible without a restructuring of reclamation laws or adoption of a water marketing strategy. The possibility of amending the reclamation laws in the near future is remote given the power and strength of the California agricultural industry in Sacramento and Washington, D.C. However, because of the Kesterson situation, the lobbying potential of these groups has been weakened. Nevertheless, organizations like the NRDC continue to promote this fundamental change in policy which they believe would eliminate not only the drainage problem, but other related economic and social problems as well.

Desalting/Solar Pond Facilities

The solution that is currently receiving the most attention is a proposal to construct a series of desalting/solar pond facilities throughout the valley that are capable of treating 25 million gallons

57. *Joint Hearing of the Assembly Water, Parks, and Wildlife Committee and the Senate Natural Resources and Wildlife Committee, San Joaquin Agricultural Drainage and Kesterson National Wildlife Refuge* (Nov. 16, 1984), at 271 (statement of David G. Houston, Regional Director, Mid-Pacific Region BUREC).

58. Kratzer, *supra* note 14, at 123-24.

of agricultural wastewater daily.[59] The project has been proposed by two historic adversaries—the Environmental Defense Fund (EDF) and Westlands.[60]

Figure 6 shows how such a facility would operate. Selenium and other trace inorganic contaminants would be removed using the principle of reverse osmosis (RO). The purified water would then be resold to municipal users in southern California (e.g. MWD) and in the San Joaquin Valley to recoup the costs of construction, operation, and maintenance. Briny wastes generated from pretreatment and reverse osmosis could be used to operate solar ponds capable of generating electricity.

A number of questions still remain, including the effectiveness of the technology to remove selenium, the level of pretreatment required, the actual number of plants needed, and financing. The Department of Water Resources is currently operating a pilot RO plant in Los Baños, but results which show it to be an effective process are only preliminary. EDF and Westlands have stated that six plants, each costing $40 million to build and another $5 million per year to operate,[61] would be sufficient to handle the load. However, critics say that since farmers will not faithfully institute proposed water conservation measures, the actual number of plants needed might someday total 20.[62] The greatest obstacle by far will probably be financial. The proposal calls for farmers to finance all project costs, which would be recouped through the sale of purified water. However, to make the project economically feasible, farmers must secure long-term delivery contracts at rates users in southern California (e.g. MWD) would be willing to pay. Another plan would involve a "trade" whereby the reclaimed water could be reused on the farms while the water the farmers have contracted to buy could be delivered to other systems.

Momentum is gathering in Congress for this proposal as witnessed by the authorization of a $3.7 million loan to Westlands for feasibility studies.[63] The EDF will receive $250,000 to analyze the technical aspects of the cleanup plan.[64] Early signs now point to a

59. *Supra* note 54, at 22.

60. Environmental Defense Fund and Westlands Water District, A Research Project for Managing Subsurface Agricultural Drainage Water in the San Joaquin Valley in an Environmentally and Economically Sound Manner (1985), *cited in Tragedy at Kesterson Reservoir*, *supra* note 12, at 10394.

61. *Supra* note 54, at 22.

62. *Id.* at 22.

63. 50 Fed. Reg. at 47,462 (1985).

64. *Supra* note 59.

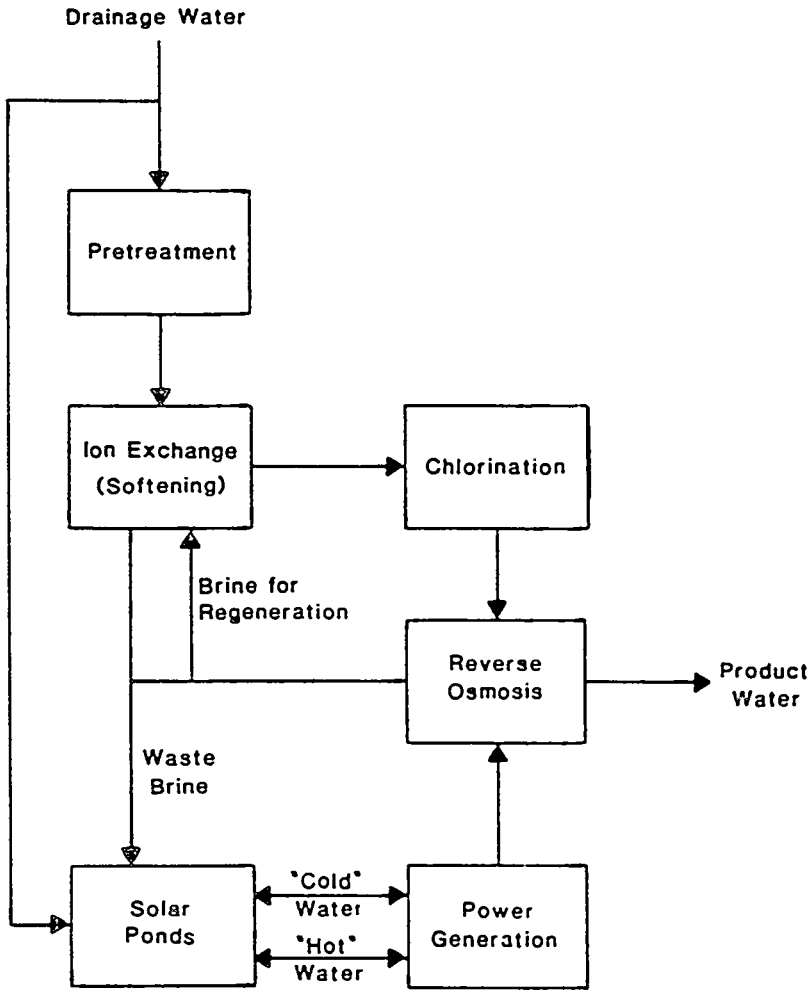

Figure 6. Flowchart of the Department of Water Resource's Los Baños Desalting Facility (Source: Kratzer, Agricultural Drainage Problems in the San Joaquin Valley, *supra* note 14.

commitment to desalting even though many unanswered questions still remain. Such a technical solution may tacitly encourage San Joaquin Valley farmers and BUREC to continue the very policies and practices that have led to the current problems.

Evaporation Ponds

The issues surrounding the long-term disposal of agricultural drainage in evaporation ponds are very similar to those discussed earlier for the short-term case. For the long-term case, ponds could be located either in the valley itself, in the Carizzo Plain located outside the valley 50 miles west of Bakersfield, or in the Mojave Desert. To handle the anticipated drainage volume of 274,000 acre-feet per year, such a site would have to be about 96,000 acres.[65] For the valley location, lands would probably have to be taken out of production due to the acreage requirements. However, transportation costs associated with the locations outside the valley would probably be comparable to agricultural production losses incurred by a valley site.

The ponds would have the potential for creating waterfowl problems, groundwater contamination, and concentrating some constituents to hazardous waste levels. Accumulated salt deposits would periodically have to be hauled away, resulting in additional costs. The likelihood of implementing this plan is not very high at the present time because of the public and regulatory fear of repeating the Kesterson problem. Also, since more options exist for the long term, the attitude towards evaporation ponds may not be as lenient.

Water Disposal Options

In 1979, the Interagency Drainage Program recommended that a 290-mile-long valley-wide drain be built to discharge agricultural drainage into the San Francisco Bay Delta.[66] This recommendation was, of course, dealt a setback after the U.S. Fish and Wildlife Service issued their late-1983 report[67] on the biological impacts of selenium contamination at Kesterson. Since then, BUREC, FWS, and USGS began to look at other long-term solutions including drainage discharge to the San Joaquin River, Morro and Monterey Bays,

65. Kratzer, *supra* note 14, at 126-27.
66. Hartshorn, *supra* note 26, at 6.
67. *Supra* note 2.

and the San Francisco Bay-Delta Estuary at Chipps Island (near Martinez).

Disposal of drainage to the Bay-Delta is not seriously considered any more because of the strong public opinion which views it to be a major threat to the surrounding ecosystem. Senate Bill 318 introduced by Milton Marks (R) of San Francisco, would have prohibited discharge of drainage into Morro Bay, the Delta, San Francisco Bay, San Pablo Bay, Suisun Bay, and the Carquinez Strait, but was narrowly defeated in June 1985. However, the public sentiment and media coverage generated by the bill will make a Delta discharge option very difficult. Passage of the Thurman Bill[68] in 1981 now prohibits any discharge of agricultural drainage into Monterey Bay.

Disposal of drainage water to the San Joaquin River would require large amounts of dilution in order to meet water quality standards. The huge allocation of fresh dilution water required makes a river discharge unfeasible.[69] Furthermore, the proposed river discharge point was to be upstream of export pumps for the CVP and State Water Projects, which would have resulted in the recirculation of contaminants in irrigation water delivered to agricultural customers.[70] In summary, disposal of drainage water to bays, rivers, or oceans does not appear to be a viable option at present.

Biological Treatment

Biological treatment involves the removal of selenium from wastewaters through (1) bioaccumulation in, and the subsequent removal of, algae, and (2) anaerobic microbial immobilization by bacteria.[71] Both techniques are still in early stages of research and development.

Selenium is bioaccumulated in algae at Kesterson. Thus, the algae could be used as a possible treatment process for selenium removal. One researcher recently proposed that a chemical flocculation technique could remove the algae from water impounded in treatment ponds. The contaminated algae would then be added to a methane fermentation pit for energy recovery.[72] After contaminated algae were removed, carbon, phosphorous, and nitrogen would be added to treatment ponds to enhance further algal

68. CAL. WATER CODE §§ 13953-13953.4.
69. Kratzer, *supra* note 14, at 128-29.
70. *Id.* at 129.
71. *Id.* at 135-38.
72. W. Oswald, Draft Proposal Submitted to BUREC, Potential for Treatment of Agricultural Drain Water by Microalgae (May 15, 1985).

growth. The cycle would be repeated until selenium concentration was reduced to an acceptable level. However, the process would create problems similar to those described for the evaporation pond alternatives. Furthermore, the technical feasibility of such a system has not yet been demonstrated.

Research has shown that anaerobic microorganisms in some of the sediments at Kesterson have the ability to immobilize and remove selenium that would have otherwise seeped into shallow groundwater.[73] Research at other locations has also shown that common anaerobic soil bacteria, such as *Clostridium* and *Desulfovibrio*, can be effective at reducing selenium concentrations by a factor of 32.[74] However, the construction of anaerobic ponds would present problems similar to those described for evaporation ponds and algal treatment. Similarly, the feasibility of this technology has not yet been demonstrated.

Summary

At present, no decisions have been made concerning the long-term solutions to selenium contamination and the drainage problem in the San Joaquin Valley. The proposal to build a desalting plant appears to have the most momentum given its support by both a major environmental organization and Westlands. Congress appears to be taking a serious look at this alternative as witnessed by the authorization of $3.7 million loan to Westlands.

Although retirement of agricultural lands affected by drainage problems would be the most logical way of alleviating the problem, current economic and institutional constraints make this alternative unlikely on a large scale. Disposal of drainage water into San Francisco Bay, the San Joaquin River, and Morro Bay will continue to be a very sensitive issue among agricultural and environmental interests. Currently, the only site protected by law from receiving agricultural drainage water is Monterey Bay. However, widespread public opposition in the other regions will probably render the other sites unfeasible. Evaporation ponds will probably not be used on any large scale because of the potential "Kesterson-type" environmental problems they may present. Biological treatment technologies have not yet proven to be feasible and are still in the research-and-development phase.

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73. Kratzer, *supra* note 14, at 136.

74. J. Kaufmann et al., Paper presented at the 188th National American Chemical Society Meeting regarding microbiological treatment of uranium mine waters (Aug. 26-31, 1984).

VII.
CONCLUSIONS

Today, the San Joaquin Valley is one of the richest agricultural regions in the world. Indeed, agriculture is the largest industry in California. The availability of cheap irrigation water from the Central Valley Project is one of the most significant reasons for this success. However, today, as a result of decades of agricultural overproduction, we are just beginning to see first-hand the environmental consequences.

The problems of salt buildup and poor agricultural drainage are not new to the farmers in the San Joaquin Valley. As early as 1951, farmers recognized that drainage could be a problem on the west side. The impacts of high selenium concentrations in animals may also have been recognized for many years. Natural high water tables and the need to flush out concentrated soil salts using large amount of irrigation water only serve to exacerbate the problem of contaminated agricultural drainage.

Many contend that the U.S. Bureau of Reclamation has allowed irrigation districts like Westlands to abuse existing reclamation laws so that farmers can continue producing crops which would otherwise be unprofitable. The problems at Kesterson are a symbol of past and present short-sighted, economically-driven agricultural practices and reclamation policies.

The proposed solutions to the drainage problem center either around retirement of land (which acknowledges the fundamental problem of overproduction) or technological solutions which treat the symptoms rather than the disease. It can be argued that the latter are necessary, however, to sustain economic development in an industry that is rapidly reaching its climax. Westlands and the farmers within the 42,000-acre affected area must meet the June 30, 1986 deadline to stop agricultural drainage into Kesterson via the San Luis Drain. To comply with this order, it will probably be necessary to plug the subsurface tile drains which discharge into the Drain. Other short-term solutions, such as building evaporation ponds and recirculating drainage water, are currently considered to be either too expensive or environmentally problematical. Shutting off the irrigation water to the 42,000 acres would be a logical choice, but because of the agricultural economic impacts, this solution may not be possible.

Presently, the long-term solution of constructing desalting plants appears to have the most momentum. Many uncertainties about the technology still remain, however. Therefore, it is somewhat dis-

concerting to see that we may be jumping on this particular "bandwagon." To do so would preclude a careful review of other possible solutions. Disposal of drainage water to San Francisco, Monterey, and Morro Bays, and the San Joaquin River does not appear practical at this time because of environmental opposition. Permanent retirement of affected agricultural lands is one option that the agricultural industry would rather forget. However, if the economic feasibility of water marketing could be demonstrated, this option might regain some viability.

The drainage problems in the San Joaquin Valley did not happen overnight and the long-term solutions could still be decades away. More scientific work needs to be done in order to better characterize the impacts of the drainage problem. However, as with other current scientific dilemmas of societal importance (e.g. acid rain), decisions must inevitably be made without a totally complete understanding of all the factors involved. The agricultural industry in the San Joaquin Valley is now at a crossroads, so we have a unique opportunity to correct the past economic, institutional and technical practices that have created the environmental problems evident at Kesterson and throughout the western San Joaquin Valley.

Postscript

All farmers in the Westlands Water District plugged their tile drains as of June 9, 1986, three weeks before the deadline.[75]

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